# SCHOOL MATHEMATICS QUALIFICATIONS AND WORK

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## Abstract

This article explores the relationship between school mathematics qualifications and the transition into employment. As part of a large-scale, three-year independent evaluation of pilot qualifications in 14-19 school mathematics, all 39 Sector Skills Councils and Employment Skills Boards in the UK were invited to provide evidence regarding their need for mathematical skills at work. Thirteen interviews were conducted with educational representatives of these bodies. Whilst mathematics was confirmed as playing a part in the activities of the workforce in each sector, the employer groups' representatives varied in the extent to which school mathematics qualifications were seen to be relevant indicators of appropriate mathematical knowledge and understanding. Each Sector Skills Council (in 2010 reduced in number to 23) was required to produce a 'Sector Skills Training Needs Assessment' by end of 2010, and so these were scrutinized for the appearance of the words 'mathematics', 'maths' and 'numeracy'. Some surprising omissions and variations in these training needs assessments are discussed in the light of the current policy focus on school mathematics qualifications and their relevance to transitions into employment. In this article we explore this boundary.

## Introduction

This article interrogates the assumed relationships between school mathematics qualifications and the workplace. This is timely because of repeated calls in England (e.g. Wolf, 2011) for more young people to leave school with good basic mathematics qualifications. Furthermore there are calls (e.g. ACME, 2011; CBI, 2011) for many more young people (in England) to study mathematics beyond the compulsory leaving age of 16.

The Mathematics Pathways Project (2005 – 2010) set out to develop and pilot in England and Wales a range of new pilot qualifications in school mathematics for school pupils aged 14 – 19 years. The project was evaluated (Evaluating Mathematics Pathways, 2007-2010) and the evaluation included considering the opinions of stakeholder groups including employers regarding the appropriateness of the new qualifications. The argument offered here was stimulated by evidence from discussions with representatives from employer groups and followed up with a scrutiny of 'Skills Assessment' documents produced by employer groups designed to identify future needs of employers. The central question underpinning this article is the extent to which school mathematics qualifications in themselves explicitly map onto the requirements of employer groups. This is an important issue as policymakers' desire to change qualifications and improve participation is predicated upon the assumption that school qualifications are, in and of themselves, valuable in the workplace. The research presented helps develop a perspective for future investigation into ways that school mathematics qualifications might prepare school leavers for the transition into employment on the one hand; and on the other, ways that learning mathematics at work builds on preparation in mathematics begun at school.

## Mathematics and Globalisation

The relationships between schooling and the subsequent contribution that citizens make to the economy is of direct interest to all countries, and forms a major part of a globalised education policy discourse (Rizvi and Lingard, 2010). A current preoccupation for industrialised OECD countries is the 'STEM' agenda which has the objectives of both strengthening science and technology in society, and increasing economic growth through strengthening national capabilities in Science, Technology, Engineering and Mathematics (Gago, 2004). Learning mathematics is central to this agenda, and

includes two principal strands: to increase the number of mathematically highly-qualified people in the workforce; and to extend the mathematical capability of the workforce at all levels. International comparisons, such as *Programme for International Student Assessmen*t (e.g. PISA, OECD, 2009) are important in influencing government perceptions about levels of skill in school students. In mathematics, assessments are intended to provide a measure of pupils' abilities to demonstrate knowledge of basic mathematical skills and their ability to use these skills in context, to apply knowledge to new situations, in essence to be able to engage with problem solving. The mix of ideas that lead to mathematics situated in some meaningful or applied context is described in different ways, such as realistic (e.g. Presmeg and Van Den Huevel-Panhuizen, 2003), mathematically literate (e.g. Steen, 2001), techno-mathematical literacy (Hoyles *et al*., 2010). 'Functional mathematics' (e.g. Roper *et al*., 2006) is one of the responses of England to PISA and also to the STEM agenda.

## The problem of Mathematics qualifications in school

In England, the General Certificate Secondary Education (GCSE) in mathematics is the examination designed to assess the secondary school mathematics national curriculum completed by all 16 year olds. GCSE, and spans levels 1 and 2 in a national framework of qualifications that runs from Entry level to level 8[i], where, in terms of higher education, level 6 represents honours degree achievement and level 8 represents doctoral level. GCSE is a national examination in the sense that it is designed to assess, according to government specified criteria, the national curriculum for 14-16 year olds. Of concern is the relatively small proportion who progress voluntarily on from GCSE to Level 3 mathematics, i.e. A-level – (Matthews and Pepper, 2007, Vorderman, 2011) compared with other countries (Hodgen, Pepper, Sturman and Ruddock, 2010). GCSE is expected to meet the requirements of several stakeholder groups, and, alongside GCSE English, is seen by students, schools and higher education as being an important gatekeeper to a range of educational, employment and therefore life opportunities. GCSE mathematics, whilst intended to assure that students have had the opportunities to experience the national curriculum, i.e. they have been taught it, also serves to signal basic mathematical competence to various professions such as teaching and nursing; to certify that students progressing to more advanced mathematical courses have acquired some specific mathematical knowledge and skills (such as algebraic competence); and it also serves as a gatekeeper for entry to higher education. Additionally schools in England are judged by the success with which students perform well (i.e. grade C or above) in mathematics and English at the end of compulsory schooling. So even though in 2010 a new secondary curriculum that has far greater emphasis on problem-solving, functionality and mathematical thinking has become statutory for 14-16 year olds, this mathematics will not find its way into the curriculum unless it appears in the examinations. Even if it were possible to introduce authentic mathematical activity into schools, the very fact of the test itself introduces an elephant in the room, so to speak. This is one of the key limiters of the development of functional mathematics because traditional assessment modes are not reflective of typical human mathematical activity.

## Workplace mathematics and school mathematics

The relationships between qualifications and employment are complex, and arguably (Jackson *et al*., 2005) are used by employers in two main senses, serving to 'certify' that an employee has reached a certain level of knowledge and skill; and serving to 'signal' that a recruit is likely to possess some desirable attributes, such as motivation, or perseverance that 'cannot be known with any certainty until they are taken on' (Jackson *et al*., 2005: 11). In other words, an employer may be interested in the educational attainments of individuals not only as certifying specific competencies but further as a basis for making inferences about other attributes that are thought desirable in potential employees. The data reported here provides some general support for this assertion when considering higher level school mathematics qualifications, for more advanced qualifications in mathematics serve primarily as a signalling device, complementing other attributes such as aptitude for learning technical skills. However, in the case of lower level school mathematical qualifications, for several occupational areas

these seem to provide little in the way of either certification or signal, with occupational groups making a range of arrangements to secure mathematics credentials at the same level once again from a workplace vantage point. This seems to be despite the fact of the lower level mathematics drawn upon at work featuring in the school curriculum.

Situated learning (Lave, 1988; Lave and Wenger, 1991; Wenger, 1998) positions learning as being through engagement with a community of practice. Thus, learning becomes '*the historical production, transformation and change of persons*' (Lave and Wenger, 1991: 51) and involves the construction of new identities for the actors within the so-called community of practice. Occupational knowledge, it is suggested, occurs through newcomers entering an occupational group, transforming not only the newcomers, but also altering the approach of old-timers. Learning results not from the acquisition of structure but from learners' increased access to participating roles in expert performances and involves constructing new identities for everyone in the practice. In this formulation what is important are the relationships that create opportunities to learn. This theoretical lens first arose from Lave's (1981) study of people undertaking mathematical tasks which showed how the least successful mathematical performance was achieved in classroom-type test situations, and the most successful was when individuals were engaging in similar mathematical processing activities, but in the context of doing their own shopping. Lave presented an argument that introduced the degree of control and autonomy that actors exercised over the mathematical tasks as a factor into the likelihood of their being achieved successfully.

These ideas are advanced further in the concepts of Engeström (2001) of expansive learning at work, whereby new knowledge is created through the interaction of individuals with the workplace 'activity system' in which they operate. The crucial thing to note about expansive learning is that because genuinely new knowledge is created, it is unpredictable in advance. This suggests that the *content* of school mathematics might not be the ideal preparation for mathematics at work; rather better to focus on the general expectation of needing to learn, and to solve problems. Moreover, as suggested by the work of Hoyles, Noss, Kent and Bakker, (2010), school mathematics might not be the ideal preparation for the world of work anyway, a world which demands greater emphasis on techno-mathematical literacies, including communication skills. Developing communication skills is important for graduate users of mathematics (Wood, 2012) and at lower levels too, using mathematics at work may be inseparable from other activities such as using technology and communicating with customers, as illustrated in a study of young people in the retail industry (Zevenbergen, 2011). Zevenbergen explains that younger retail workers (born since 1980) sometimes do mathematics in their heads and other times rely on the till, depending on the overall context of dealing with the customer in front of them. It is suggested that this distinguishes these younger workers from older workers who still see the ability to do mathematics mentally as the important issue, and that these younger workers:

> They are more likely to approach tasks holistically, to use estimation, to problem solve, to use technological tools to support their work and thinking, to use intuitive methods, and to see tasks aesthetically. (Zevenbergen, 2011: 98)

Gainsburg (2007), having studied the use of high level mathematics by structural engineers, argues that occupational use of 'heavy' mathematics not only involves solving immediate problems at work through mathematical modelling, but also that solving problems in itself is a learning experience that leads to developed expertise, becoming what Eraut (2004) would call 'routinised' knowledge of how to use mathematics at work. This, Gainsburg suggests, is difficult to replicate in the school setting for two reasons: first that knowledge of the sort of problems addressed at work is limited; and second that the authenticity of problems, even if they are known, is compromised when the problems are reconstructed for classroom application, precisely because as they are in a non-workplace context, the situated learning at work dimension disappears.

Thus we might expect to see people entering the world of work with some signalled mathematical competence from their school qualifications, but developing their actual mathematical skills once in specific occupational situations. Unfortunately there are complications that arise from this position, especially when providing training to assist in developing the necessary mathematical skills whilst at work. Adult basic skills have been a preoccupation of government all over the world, USA, Canada, France, Australia and New Zealand, (Wolf *et al*, 2010) but in the UK this has been manifested significantly in the shape of general basic skills training in the workplace, including literacy and numeracy. Basic workplace training has been encouraged by various forms of government subsidy since 2002 (e.g. Learning and Skills Council, European Social Fund via Regional Development Agencies, Learn Direct, Trade Union Fund) in the belief that a more skilled workforce enhances productivity. However, a study in the UK, having examined the impact of this general workplace skills training at work and on learners (Wolf *et al*., 2010) argues that research findings do not support this belief. Employers did not find improvement in the effectiveness of lower skilled employees having undertaken training, and without subsidy were inclined to discontinue providing it. Furthermore, the study shows that the 'memory' of training by employers was extremely fragile:

> Overall the subsidised programmes used an extremely costly approach, and left no lasting legacy. Wolf et al, 2010: 385

Despite this, learners in the study are presented (Evans *et al*., 2009) as having participated in workplace learning opportunities for varied reasons, with participation bringing individual benefits that transcended performance at work, but which transformed perceptions of personal confidence and self-efficacy. Thus there is clearly some disconnection between what employers see as improved performance and the ways that participants believe that engaging in training effects transformation at an individual level. Participants felt empowered by the training more than employers noticed the benefits.

A recent report (ACME, 2011) on the mathematical needs of learners and employers found that there has been a greater demand for mathematics skills as the employment market continues to move away from manual jobs, and this is corroborated by an industry report which states that:

> Businesses continue to report shortages of people with science, technology, engineering and maths (STEM) skills (CBI, 2010: 9).

## The study: methodology, methods and preliminary results

The Evaluating Mathematics Pathways project (Noyes *et al*., 2010) collected qualitative data from nearly 120 case study schools and colleges; carried out detailed analysis of 94 mathematics examination papers; surveyed around 500 teachers and nearly 1000 students and consulted widely. Included was a strand that required communication with stakeholder groups interested in mathematics qualifications, and linking these discussions into the overall recommendations as to whether pilot qualifications justified replacing existing ones. This strand of the evaluation was iterative, for in order to engage with stakeholders at all, it was necessary to provide some explanation of what the project was about, ways that schools were offering the pilot qualifications, how options might arise from the pilots and so on. The project team decided to engage with employer groups when it became obvious that unless the evaluation explicitly briefed employers and tried to find out what employers believe the purpose of school mathematics qualifications to be, it would be too late for these views to influence the new qualifications being developed. Thus the methodological approach can be termed as 'pragmatic and progressive illumination'.

In the UK, Sector Skills Councils (SSC) are independent employer-led organisations recognized by governments in the UK as broadly providing the employer leadership for assuring the workforce in

that sector has the skills needed. Following the 2010 general election, the number of SSCs has been streamlined from thirty-nine to twenty-one, and they cover 1,707,885 occupational enterprises and 90% of the workforce across the UK. At the time the data were collected, we approached all thirty-nine SSCs to request a 30-minute telephone interview. Thirteen interviews about the place of mathematics qualifications in the sector took place during December 2009 – June 2010. At the time of the interviews the UK workforce numbered approximately 27 million people, and the respondents represented employers of approximately 12.5 million people, i.e. about 46% (Sector Skills Assessments, 2010).

The interviews explored the following questions with employers and employer groups representing: sport and leisure; construction; administration; electronic and information technology; environment and land-based industries; financial; insurance; transport; government training; logistics; the Merchant Navy; teacher training.

1. What mathematical skills are required for working in the sector?
2. What expectations does the sector have of young people's mathematics qualifications on entry?
3. What are the expectations in the sector of on-the-job training in mathematical competence?

*1. What mathematical skills are required for working in the sector?*

Most of our respondents all thought that mathematics, numeracy and statistical skills run right through their respective sectors. However there were surprising nuances. The representative of the financial sector thought that mathematics skills are required 'probably not as much as you would imagine'; though 'there are a few specialist jobs that are well paid jobs' and 'if you can't do maths at all you aren't going to get very far'. Nor did we find unequivocal support for the policy rhetoric of needing to enhance the skills of school leavers. The logistics industry pointed in general to drivers, particularly older workers, who 'are in the sector because they didn't do very well at school in maths or English or anything else - we have one of the lowest levels of educational attainment within the workforce'. This is despite the sector needing 'all kinds of maths skills'. And the civil service training group also raised the issue of 'older workers, 40 plus age group, as we tend to get a better qualified intake with our new entrants'.

Employer groups point to occupational differences requiring different levels of mathematics. More scientific, technical or analytical roles require more specific mathematical and statistical skills and sectors in which people are self-employed point to mathematics being incorporated into activities such as financial and project management and running a business. Whilst emphasising that applied skills and problem solving skills are the most desirable, each respondent also identified specific mathematical skills and understanding that are needed in specific contexts, and where skills were missing. So for example, we were told that in administration the use of excel spreadsheets is important, as is the use of formulas, and, because of the frequency with which office spaces are changed around, so are practical mathematical skills such as using percentages and both imperial and metric measurements. We were told by the respondent from the construction industry of the need for basic estimations of materials for example, to be able to look at a plan or specification, or take measurements from a plan, use scale drawings, etc. From the electronic industries:

> Someone creating a game would have to be aware of the mathematics involved in doing explosions and movement and that kind of thing.

In the transport industries dealing with numbers and money, reading timetables and clocks is important because it is important to work out journey times and deviations from the time. People working for the government work with evidence and so need to understand what the evidence is saying about the effectiveness of policy. In the Merchant Navy there are certain mathematics skills especially around geometry and trigonometry that people require and which it is acknowledged may

not have been covered sufficiently in the GCSE.

So far so good. The mathematics content here, with the exception of the Merchant Navy would in theory at least be familiar to every teacher and student of school mathematics. There is little identified that is outside the school curriculum. In the case of the Merchant Navy, in appreciating that specialist knowledge is needed, a structured programme of training up to degree level that is linked to occupations within the industry is provided by specific organisations, such as the nautical colleges. Entry to each level is predicated on school qualifications such as GCSE or A-level mathematics, with access courses that include mathematics units being available for those without these pre-qualifications.

2. *What expectations does the sector have of young people's mathematics qualifications on entry?*

Table 1 summarises the responses by sector to the need for GCSE and A-level mathematics on entry, and the extent to which the sector uses existing qualifications as a means of developing people once recruited.

Table 1: School Mathematics qualifications required by sector.

| *Sector* | *GCSE Mathematics for entry* | *A-level Mathematics for some occupations* | *Industry training* |
|---|---|---|---|
| Leisure | Generally yes | Yes although some gravitation towards practical applications | Apprenticeships and top up for Levels 1 and 2<br>A-level mathematics as continuing professional development. |
| Construction | No.<br>Generic test for all apprentices aged 16. | Yes for technical or supervisory levels.<br>Have developed a Maths for Engineers A-level in partnership with universities and industrial society | Free Standing Mathematics Qualifications (FSMQ), and technical qualifications such as Nationals and Higher Nationals[i]. |
| Administration | No | Don't know | Apprentice framework.<br>People take maths units because general level of numeracy is poor. |
| Electronic and information technology | Generally yes | Yes | People expected to have the skills for the job, and specialist skills developed by individuals not the employer. |
| Environment and land-based industries | Not always. | Not known | |
| Financial | Generally yes, but not at lower levels e.g. call centre work. | Yes | Apprenticeship framework at level 2 and 3 involves mathematics at one level below qualification level . |
| Transport | Not always | Yes | |
| Civil service | Not always | Yes | Apprenticeships |
| Logistics | No | No | Level 2 and 3 training to become occupationally competent. |
| Merchant Navy Training Board | Recommended | No | Provide degree and HNC and HND programmes through nautical colleges |
| Training and Development Agency (TDA) | Yes | No | Top up mathematics provided for teachers of mathematics. |

It can be seen that these employer groups' representatives are ambivalent towards traditional school mathematics qualifications. Entrants to some sectors must have GCSE mathematics unless they are aiming for low-level jobs (such as ratings in the Merchant Navy, or farm labourers). Employers in the

sports and leisure industry tend to require traditional qualifications on entry, as does the electronics and information technology sector where mathematics GCSE is unequivocally a requirement. Apprentices in environment and land-based industries must be successful with functional mathematics. However, for some, GCSE mathematics is not always an imperative even though mathematics at that level and above may be used in the sector. The transport and logistics industries also do not necessarily require GCSE mathematics except for transport planning occupations where it is:

> The only reference point we've got. But it's purely theoretical. If you look at the outputs of GCSE or A-Level maths, they have zero application as far as we're concerned.

Some employer groups prefer to use their own aptitude tests, both for selection and for deployment. It was suggested to us that requiring GCSE mathematics sets up an unnecessary barrier, potentially discriminating against good recruits who have potential for learning on the job. Recognising that GCSE mathematics and A-level mathematics cannot provide the breadth of application that is needed for working life – as one put it 'it's the academic versus the practical' – alternative applied qualifications are being considered in some groups as an alternative. For instance the construction industry sector provides higher level applied qualifications for apprentices and technical apprentices having first used a test of literacy, numeracy and spatial awareness as a recruiting tool for apprenticeships, regardless of whether the applicants have GCSE or not.

Generally technical occupations – such as would be entailed in being an officer in the Merchant Navy – provide specific bespoke training in mathematics, but expect recruits to be able to benefit from the training and so look to school mathematics at advanced level as indicating a certain level of academic and scientific understanding. Construction also looks for recruits to technical or supervisory occupations to have advanced school mathematics, for example site technicians, engineers, surveyors, etc.

*3. What are the expectations in the sector of on-the-job training in mathematical competence?*

Most of the sectors interviewed have schemes in place to help develop employees' mathematical skills. At apprentice entry level, there are schemes for people to acquire mathematics as a key or functional skill as a minimum. In some, such as in the Merchant Navy, there is a structured programme of training up to degree level that is linked to occupations within the industry and provided by specific organisations, such as the nautical colleges. Entry to each level is predicated on school qualifications such as GCSE (level 2) or A-level (level 3) mathematics, with courses that include mathematics units being available for those without these pre-qualifications. Other industries such as leisure and logistics provide an integrated suite of mathematics that combine bespoke and industry specific materials with existing qualifications such as A-level mathematics. Mathematics generic key skills are frequently contextualised by employers in the context of work. The electronic and information technology group is developing specialist 'data manipulation' units focused on the types of operations that are needed to manipulate data stored on a computer that are 'actually maths but more focused on how maths is used to create data'. Another development is, as shown by the construction sector, is to use the existing A-level standard to develop a specific and relevant A-level 'Mathematics for Engineers'.

Employers sometimes use existing qualifications to accredit on-the-job training in mathematics, but not GCSE Mathematics which was limited to sometimes being one of the recruitment criteria. Sectors seem to take two approaches. The first is to provide specific mathematics 'for engineers' or relevant to industry needs as exemplified by the Merchant Navy. The second is to support general qualifications such as Diplomas and Higher Diplomas that include mathematics and provide a progression route into higher education for people looking to move towards supervisory, higher technical or managerial careers in the industry.

## Discussion

In 2010 each of the streamlined twenty-three SSCs was asked by the Westminster parliament to produce a skills assessment report outlining the recruitment, employment, wastage predictions in the sectors, and training needs for that sector. The documents are largely available on line, and for the purposes of this article, in 2011 – 2012 the authors also conducted a word search for the word 'mathematics' and 'maths' and 'numeracy' in each of them. The number of instances that each word occurred and the length of the document are shown in Table 2.

Table 2: Sector skills assessments: instances of 'Mathematics', 'Maths' and 'Numeracy' in UK reports, 2010/2011.

| Sectors Skills Assessment UK Reports 2010-11 | No of pages in report | | Mathematics | Maths | Numeracy |
|---|---|---|---|---|---|
| Asset Skills | 212 | Property, planning, housing, facilities management, cleaning and support services, and parking industries | 1 | 1 | 38 |
| Cogent | 161 | Science based industries | 30 | 0 | 2 |
| Construction | 153 | | 0 | 0 | 3 |
| Creative & Cultural Skills | 138 | Crafts, Music, Performing, Heritage, Design and Arts | 1 | 0 | 1 |
| Energy (England) | 167 | Energy, Waste and Utilities | 1 | 1 | 4 |
| e-Skills | 80 | Information Technology and Telecoms | 1 | 1 | 0 |
| Financial Skills Partnership | 36 | Finance, Accountancy and Financial Services | 0 | 6 | 0 |
| Institute of the Motor Industry | 83 | Retail Motor Industry | 0 | 0 | 2 |
| Improve Report *costs to download* | | Food and Drinks Manufacturing and Processing | | | |
| LANTRA | 214 | Environmental and Land-based | 0 | 0 | 0 |
| People 1st inc Go Skills | 118 | Hospitality, Leisure, Passenger Transport, Travel and Tourism | 0 | 0 | 0 |
| Proskills | 90 | Process and manufacturing sector | 0 | 0 | 2 |
| SEMTA | 95 | Science, Engineering, Manufacturing, Technology | 2 | 0 | 3 |
| Skills Active | 130 | Sport and Recreation, Health and Fitness, Outdoors, Playwork and Caravanning Industry | 0 | 2 | 19 |
| Skillset | 59 | TV, Film, Radio, Interactive Media, Advertising, Animation, Computer Games, Facilities, Photo Imaging, Publishing, Fashion and Textiles | 0 | 0 | 0 |
| Skillsmart | 181 | Retail | 0 | 0 | 8 |
| Skills for Care & Development | 174 | Social Care, Children, Early Years and Young People's Workforces in the UK | 0 | 0 | 10 |
| Skills for Health | 178 | | 0 | 0 | 33 |
| Skills for Justice (England only) | 69 | Policing & Law Enforcement, Youth Justice, Custodial Care, Community Justice, Courts Service, Prosecution Services, Forensic Science, Fire Rescue Services and | 0 | 0 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| | | Legal Services | | | |
| Skills for Logistics *Yet to download* | | Freight, Logistics and Wholesaling Industry | | | |
| Summit | 403 | Building Services Engineering | 0 | 37 | 8 |

The first thing to note is the general lack of reference to mathematics, except in the science based industry sector 'Cogent' with numeracy being the generally preferred term. Because of the reorganization of the SSCs, a true comparison is not possible, but we note that, though several sectors, despite assertions in the interviews, barely refer to 'mathematics', 'maths' or 'numeracy' at all in the Skills Assessments. This includes Construction, E-Skills, LANTRA, People 1st, The variation evident in the table is at first sight curious, and can be partly explained by the differing views expressed in the reports by the SSCs. SSCs such 'Cogent' (science based industries) emphasise the importance of mathematical skills and the importance for science of GCSE mathematics in providing the base of the chain from which people with more advanced qualifications progress.

> A levels (together with their Scottish equivalent) form the foundation stage for a complementary academic training route within the higher education sector. GCSE level education (including Scottish Standard, Intermediate 1 and Intermediate 2) is the supply chain for both, and so the qualification rate mathematics and science subjects is a strong determinant of the final industry supply.' (Cogent p146)

The 'Energy' SSC also point to the importance attributed by employers to numeracy:

> Literacy/numeracy regarded as valuable by employers and amongst top five skills found lacking in 17-18 year olds. P.124

Some, such as the Construction SSC report, are less concerned with specific mathematical skills than skills gaps in terms of approach to working life per se:

> 'The skills most commonly felt to be lacking (regardless of route of education) was a lack of working world/life experience or maturity followed by poor attitude/personality or lack of motivation.' P.87

The Building Services Engineering group (SummitSkills) however makes a point of stating that numeracy has improved in recent years:

> 84% of the companies surveyed felt that the apprentices they had recruited had sufficient maths and English skills to carry out their jobs effectively. Considerable improvements in maths and English ability and job readiness are very welcome to SummitSkills, which has been working with partners and stakeholders on this issue for a number of years. Pp 12-.13

Two, Skills Active (sport and leisure sector) and SEMTA (science, engineering, manufacture and technology) raise more subtle issues. The report of the sport and leisure sector (Skills Active, 2010) discusses the fact that whilst employer perceptions may be that numerical and mathematical skills are not necessarily required in occupations in the sector, that this perception is erroneous, and that numeracy skills are most likely to be in need of development. Skills Active has devised some online materials to support learners.

> The sales and customer services and elementary occupations all noted a range of soft skills are more likely than average to need improving or updating over the next 12 months (specifically oral communication, customer handling, team working skills), as are numeracy skills for both groups…. However Literacy and numeracy skills come a considerable way down the list of skills needed for these occupational groups, below such skills as communication skills, customer handling skills, team working skills, problem solving skills, technical and practical skills and management skills. In addition, they are not amongst the skills which are most likely believed to be in deficiency in either applicants or amongst

existing workers. P.95

The ninety -five page report of the science, engineering, manufacturing and technology industries (SEMTA, 2010) mentioned 'mathematics' twice and 'numeracy' three times. This curious anomaly in itself apparently runs counter to the STEM rhetoric that asserts the need of technological industry for employee-recruits with evidence of mathematical problem solving skills. In fact the SEMTA report states, explicitly with respect to graduate recruitment:

> Like all recruitment, what is being sought from applicants is much more than just a particular sort of technical knowledge, or even a particular qualification (academic or otherwise). The 'other things' being sought very often lead employers to pay comparatively little attention to the specific university course, since the other things may often be found (perhaps are even more likely to be found) in graduates from other disciplines, even subjects well beyond science and technology. Many other sectors value the attributes of science and engineering graduates, not least for their numeracy and problem solving abilities. (SEMTA, 2010: 71)

Our data corroborates other research (Jackson *et al*., ibid) that points to the decreasing exchange value in the skilled labour market of qualifications for 16 year olds. There was little concern expressed about advanced school mathematics as this is seen as *signaling* aptitude for technical work rather than particular knowledge (Jackson *et al*., ibid), but employer groups express concern about poor mathematical understanding *certified* at GCSE. Steps are taken to ameliorate the problems through re-branding mathematical learning in different ways; or through lowering entry requirements and then providing top-up mathematical training.

For 16 year olds, GCSE mathematics is not always a gatekeeper for entry to work. Apprentices operate in contextualized situations and are frequently taken on aged 16 without having been successful at school mathematics. Because of this there is some suggestion that school mathematics examinations present barriers to school-leavers who learn the mathematical skills they need once at work. For 18 year olds however, advanced school mathematics qualifications do provide a gate-keeping service for several occupations particularly technical and supervisory or scientific. Advanced school mathematics provides an indicator of aptitude for learning new mathematics skills in a technical environment. Increasingly, in some industries recruitment is moving towards this higher level and graduate entry, although for young people in their late teens/early twenties other personal qualities come into play alongside specific previous qualifications. High-level mathematics is practiced by a few (usually very well paid) employees, with the majority of graduates being expected to have mathematical fluency alongside other characteristics such as readiness for work and personal qualities such as commitment and perseverance.

Industries expect to provide on the job mathematics training with a focus on application, in part because there is concern about what school mathematics qualifications actually mean in terms of knowledge skill and understanding, and their appropriateness for the world of work. At least as significant for employers is the aim to provide opportunities for progression within the industry and to recognize attainment and talent where it occurs at work. There is a belief amongst employer groups that many young people are not well served by school generally; that once at work people flourish despite perhaps unimpressive qualifications on entry.

From a content point of view there is actually quite a good alignment between the GCSE mathematics course and the beginnings of occupational requirements for school leavers. Yet the mathematics used at work across the industrial sectors sampled quickly becomes so specific to different industries and so varied across them that it would be impossible to construct a single school curriculum that meets the entirety of all of these different needs, even if that were considered a worthwhile project. Actually the evidence suggests that it would not be worthwhile, for being at work is different from being at school in the important respect of when one is at work one undertakes activities that embed rather than

separate out the mathematics. This is acknowledged to be the case at higher levels of work.

Transition to work is an important transition, and being functional with mathematics is recognised as being an important element, at all levels of operation. Faced with the apparent lack of confidence of employers in lower level school mathematics qualifications, it will be important to develop functional mathematics at school that helps students undertake mathematical problem solving and encourages their readiness to learn. Equally important is thinking about what forms of assessment might signal more clearly the skills and mathematical understandings that can be built upon in the workplace. Alongside is the critical issue of addressing the cultural divides that will need to be bridged, for instance to raise the profile of what employers can reasonably expect from school mathematics qualifications, and to sustain the profile of and funding for training at work.

Thus the discourse of mathematical needs of industry is complicated, at least how it is seen in these kinds of official documents, with the nature of mathematical problem solving better understood at higher levels of practice as being entwined with other necessary practices situated in the workplace. At lower levels of practice, there is no single perspective regarding mathematical skill. Low level school qualifications, if regarded as necessary, are seen as providing a larger base from which to progress to higher levels of qualification. However it is noted by some sectors that both numeracy and literacy have improved over recent years. Others allude to erroneous assumptions by employers of the need for mathematics at all, and set about raising the profile by providing a qualification structure for new recruits to develop the mathematics they need at work. Thus, enquiries about the mathematics involved in particular occupational areas become a complex interrogation of understandings and these diverse practices. At these lower levels of mathematical activity, however, where skills assessments are not using the language of mathematics then training needs in mathematics are unlikely to be addressed explicitly at work. If further this is coupled with evidence that specific training in the workplace tends in any case to be ineffective, then the discourse of mathematical needs are likely merely to provide an empty rhetorical device that serves to maintain dissatisfaction between industry and schools in terms of mathematical competence on the part of school leavers.

[i] For full description of National Qualifications Framework please see http://www.direct.gov.uk/en/EducationAndLearning/QualificationsExplained/DG_10039017

[ii] *Free Standing Mathematics Qualifications* are currently available at Foundation, Intermediate and Advanced levels. Each unit focuses on a particular area of mathematics that is studied in depth. *National Diploma* is a title that is used to represent a standard of academic or vocational education. *Higher National Diploma* (HND) is a qualification can be used to gain entry into universities, and is considered equivalent to the second year of a 3-year university degree course.

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