MATHEMATICS IN VOCATIONAL YOUTH TRAINING FOR THE BUILDING TRADES IN BRITAIN, FRANCE AND GERMANY

by

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April 1992

Abstract

This paper examines the standards of mathematics that young trainees in the construction industry are expected to achieve in Britain, France and Germany in the course of their training. The aims of the former City and Guilds, German *Berufsabschluss* and French CAP building qualifications were focused on practical trade requirements for building calculations and all aimed for a similar standard. The change in 1991 from City and Guilds to National Vocational Qualifications has resulted in a drastic reduction of the mathematics content in British training courses.

The drive by the Department of Employment to increase numbers qualifying while increasing employers' share of funding of youth training are identified as principal reasons for the reduction in the general education content of British training courses.

The financial support of the Nuffield Foundation for the work presented here is gratefully acknowledged. Responsibility for the views expressed is the author's alone.

Introduction

This paper constitutes the first part of a study which is concerned with ways of setting and maintaining standards of general education for young people in training 16-19. For many young people from the less academic part of the population general education from 16-19 is provided within occupational training provision funded from a variety of sources but usually including funding and/or provision of training places by employers. The provision of training on employers' premises has important advantages - less academic young people are frequently more highly motivated to acquire general and vocational education in a work setting than in full-time formal school; the value of such provision to a young person's development and progress should not be under-estimated.[1]

Nevertheless, the attempt to involve employers, whose investment horizons may be limited to the short-term, in funding such provision either directly or indirectly, often creates pressures on young people to acquire occupationally specific skills which can be of immediate use in the work place at the expense of general vocational education and training. The result may be that general education - technical subjects, mathematics and use of language (which will be of use to the trainee for progression or updating at a later career stage) is neglected.

This paper attempts to determine the extent to which the scope and standards of general education in British training courses correspond to the aims and standards of training courses in two other European countries.

The study was undertaken at a time of drastic change in the organization of Youth Training in Britain and the consequences of this change for young people in Britain give rise to considerable concern for the reasons we shall set out below. Three countries - Britain, France and Germany - with different patterns of provision and funding were selected for

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[1] Ryan and Marsden have pointed out other advantages of apprentice or employer-based youth training when associated with occupational labour-market structures. These include higher youth employment shares and less frequent mismatch between training outcomes and labour market opportunities than in systems based on full-time college attendance and internal labour markets. P Ryan, D Marsden, The Structuring of Youth Pay and Employment in Six European Economies, in *The Problem of Youth* ed. P Ryan, P Garonna and RC Edwards, Macmillan 1991. For further discussion of these issues see the Comment by M Sako and the reply by Marsden and Ryan in the *British Journal of Industrial Relations* September 1991.

analysis and it was decided to concentrate the study on just two occupations, the building and retail trades. Together these occupations attract substantial numbers of trainees of both sexes in all three countries each year. In this paper mathematics courses in training for building are examined. The mathematical syllabuses set out and aimed at in training courses were chosen for detailed study first because the capacity to measure and calculate accurately is essential to efficient working in the building trades (this was confirmed in interviews with employers in the three countries) and second because comparisons of standards expected are facilitated by the common symbolic language and notation of mathematics.

The paper is arranged as follows. Section 1 examines skill requirements in the construction industry at craft level and outlines the organization of youth training in the building trades in the three countries. The second section describes recent important changes in the training of young people in Britain and compares the mathematical requirements of courses offered up to 1991 and the standards of those offered to young people since that date. Section 3 compares the mathematical requirements of building training for young people in all three countries and Section 4 sets out some conclusions.

Section 1: PROVISION FOR YOUTH TRAINING IN CONSTRUCTION IN BRITAIN, FRANCE AND GERMANY

Methodology

The principal data employed in this study are nationally-based statistics on numbers attaining qualifications, the mathematics component of recognised training syllabuses, the examinations set by recognised examining bodies in the three countries and internal assessment papers supplied to us by college lecturers. These were supplemented by observation of classes of trainees in the three countries and by discussions with teachers, school inspectors and local employers. Visits and classroom observation were inevitably constrained by time and resources; however, an attempt was made to ensure that classes were not drawn from nationally unrepresentative groups.[2]

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[2] In Germany, classroom observation took place in a large city - Berlin, where the standards reached by trainees are thought to be somewhat below the national average and in a small town situated in an area of rapid recent industrial growth (Baden-Wurttemberg) where standards of trainees are thought to be among the highest in Germany. In

Changing skill requirements in the construction industry

Climate, geography and social conditions are similar enough in the three countries considered for considerable convergence to exist in the structure of craft occupations in the building trades in all three countries. The principal materials in use for centuries have each developed an associated craft tradition and training; bricklayers, joiners and stonemasons still account for over two-thirds of all trainees qualifying annually in the three countries. While certain intra-country differences in the content of these training courses exist - in earlier National Institute studies it was noted that the bricklayer's training in Germany and France is broader than in Britain - the pattern is broadly similar.[3]

Technical progress, and in particular the off-site production of pre-fabricated components and the great variety of materials that must be delivered in correct sequence and coordinated on site have profoundly changed the nature of construction activity.[4] A recent report on the skill requirements of the construction industry underlines the findings of earlier work; 'increasing emphasis on skills associated with positioning and alignment' means that 'calculation skills, reading drawings and the ability to access information on computers' are increasingly important at craft and operative level.[5] The evidence from all the work of the last 20 years is that proficiency in measurement and calculation is increasingly required by employees at operative and craft level.

In the course of our research we interviewed around 15 building firms (approximately five in each country)to ask their views on the mathematics that they would expect craft trainees to master and how this would be used when working. We confined our interviews principally to small firms (under 50 employees) which constitute in all three countries more than three-quarters of employment in the building industry.

The German building employers we spoke to expected apprentices to acquire proficiency in building calculations and considered that mathematics were highly relevant to a craftsman's work on site - examples given were of calculations needed to observe health and safety standards on site and for calculating supplies of materials; indeed, most gave prospective trainees their own maths tests as part of the recruitment process. French building employers were equally concerned that trainees should be able to measure and calculate correctly. All the French employers we spoke with normally financed an extra year of apprenticeship training for trainees who failed the theoretical examination (maths French and science) and needed to resit the year. They hoped for employees who could work in an autonomous manner, check deliveries if alone on a site, take measurements and make rough drawings in a professional manner if sent out to visit clients' premises or homes.

France, our visits were concentrated on the city of Dijon which all statistical measures of performance show to be close to the national average. In Britain, we visited three different colleges in the Greater London area. In all, some 17 different classes of young people training to similar levels in the construction industry were observed. In order to standardise our visits as far as possible, observation was further concentrated on young people training for the bricklaying trade.

3 SJ Prais and K Wagner "Some Practical Aspects of Human Capital Investment: Training Standards in five occupations in Britain and Germany", *National Institute Economic Review*, August 1983. SJ Prais and H Steedman, Vocational Training in France and Britain: The Building Trades, *National Institute Economic Review*, May 1986. In Germany, a broad training is given in the first year of the bricklayer's training in contrast to the more specialised British course. The German apprenticeship is of much the same length (currently 2 2/3 years) as the British (2 years on YT alone and extra year to gain a craft certificate). At the end of their training the British and German trainees were found to be of a similar standard (Prais SJ and Wagner K .op.cit. p.54. French trainees also covered a broader syllabus and received good training in concrete work and associated areas of science. Training courses for bricklayers in France are of two years duration. We could not find any evidence that their skills were inferior at the end of their training courses but it was recognised that those who were trained full-time in college would not be able to work as fast as the British trainees until they had acquired further work experience.(Prais SJ and Steedman H op.cit. p.52).

4 Much has been written on this topic and there is no space in this paper to do more than refer to some previous work. Both the Phelps-Brown Report of 1968 and a report prepared in 1973 by four members of the academic staff of the Department of Building of the University of Manchester Institute of Science and Technology consider the question of Building Design in relation to construction skills. In a survey of a sample of architects, 'one-third commented on the difficulties of communicating design intentions to the man actually carrying out the work, particularly where there is departure from the familiar in terms of detail with the resulting need for passing an enlarged volume of information'. *Building Industry Wage Structure* IPC Building and Contract Journals Limited 1973 p.p. 33,34.

5 *Future skill needs of the Construction Industries* published by IPRA Ltd, 1992 and summarised in *'Skills and Enterprise Briefing'* Issue 6/92 Employment Department Group.

The British employers had distinctly lower expectations of employees and appeared to use additional layers of supervision to compensate - these differences between the three countries, which have already been analysed in relation to the engineering industry in an earlier paper, would merit further investigation.[6] It would be wrong to give the impression that the British employers with whom we spoke were not anxious for trainees to acquire proficiency in building calculations, they had, however, adapted their work organization to cope with the existing low levels of mathematics among their employees and their expectations were consequently lower.

Courses of training and numbers trained

Almost all young people in Britain and in Germany following craft training courses in the building trades spend the majority of their time in training on employers' premises. In France, training for the building trades is exceptional in that more than half of all building trainees study for the CAP (national craft qualification) while in a two year apprenticeship with one day a week college attendance. The remainder at this level study full time in vocational colleges. The standard required in the final examination is nevertheless the same for apprentices and full-time students. In all three countries, therefore, most construction trainees spend the majority of their time on employers' premises and study part time by block and/or day-release in college to meet the requirements of the 'formal' parts of their training course.[7]

In Britain, until 1991, the national vocational qualification certifying formal vocational qualification at craft level in the building trades was the City and Guilds Part II Certificate, in Germany it is the *Berufsabschluss* and in France the CAP (*Certificat a l'Aptitude Professionnelle).*[8]

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6 H Steedman G Mason K Wagner, 'Intermediate Skills in the Workplace: Deployment, Standards and Supply in France and Germany', *National Institute Economic Review* May 1991.

7 In Britain, craft trainees in Construction Industry Training Board (CITB) managed courses spend a total of 30 weeks (usually divided into 4 blocks)of a two-year training programme studying full-time in college. German trainees are required to spend their first year of training full-time in college but the apprenticeship is longer - 2 2/3 years. British trainees on Youth Training with employers outside the scope of the CITB attend college only on a part-time one day a week basis.

8 The City and Guilds written paper and course work assignments must be obtained in addition to passing practical skills tests set by the

Changes in numbers trained

Two studies carried out into numbers obtaining the craft level qualification in the building trades in Britain France and Germany were published by the National Institute in 1983 and 1986. At the beginning of the 1980's Germany trained four times as many young people to craft level in the building trades as did Britain, and France trained one and a half times as many as Britain. Since that time, numbers attaining this level in Britain have continued to rise so that the gap relative to France has disappeared and Britain now lies roughly half way between France and Germany.[9] The fall in numbers trained in Germany can be attributed in part at least to the sharp fall in the size of the age cohorts in the latter part of the 1980s. In France, the cohorts have not declined so dramatically but students have been encouraged to enrol for higher level qualifications (BEP leading to the vocational Baccalaureat) and many have chosen to do this. (Table 1).

Initial training on courses leading to craft qualifications in building now accounts for a substantial proportion of all young people receiving initial training in Britain (around 20 per cent of all young people on Youth Training). The substantial increase in numbers trained in this occupation in Britain must be counted a real achievement of the last decade of Training Initiatives - a word of warning must be attached to the British figures, however, since we have no means of knowing what proportion of the passes at Part II level are achieved by adults. Probably between 20 and 30 per cent of those passing are over 21.

Construction Industry Training Board in order to obtain a Certificate of Craft Recognition from the National Joint Council for the Building Industry. Previous National Institute studies have reviewed the standards required for the award of these certificates and concluded that they were broadly similar. City and Guilds was found to be narrower in scope than the corresponding German qualification and the French level of professional knowledge in the CAP was thought to be closer to City and Guilds Part III.

9 SJ Prais and K Wagner "Some Practical Aspects of Human Capital Investment: Training Standards in five occupations in Britain and Germany", *National Institute Economic Review,* August 1983. SJ Prais and H Steedman, Vocational Training in France and Britain: The Building Trades, *National Institute Economic Review,* May 1986. Britain now trains more than France in this area. In France, it should be noted that higher aspirations and a difficult youth labour market lead trainees to train to higher levels (above craft level) so that overall the numbers of young people qualifying have not fallen.

TABLE 1
PASSES AT CRAFT LEVEL IN SELECTED BUILDING OCCUPATIONS(1)
BRITAIN, FRANCE AND GERMANY 1981-1991

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	1981	1991
BRITAIN	13.86	23.73
GERMANY(2)	58.08	36.44
FRANCE(3)	21.27	15.59

SOURCES: SJ PRAIS K WAGNER SOME PRACTICAL ASPECTS OF HUMAN CAPITAL INVESTMENT IN TRAINING STANDARDS IN FIVE OCCUPATIONS IN BRITAIN AND GERMANY National Institute Economic Review AUGUST 1983 TABLE 3. UNPUBLISHED TABULATIONS SUPPLIED BY CITY AND GUILDS OF LONDON INSTITUTE. SJ PRAIS H STEEDMAN VOCATIONAL TRAINING IN FRANCE AND BRITAIN:THE BUILDING TRADES National Institute Economic Review MAY 1986 TABLE 1. MINISTERE DE L'EDUCATION NATIONALE NOTE D'INFORMATION NO. 89-46 TABLE 3. STAT. BUNDESAMT, FS.11, REIHE 3, 1990.

NOTES
(1) IN BRITAIN, PASSES AT CITY AND GUILDS PART II, IN FRANCE , PASSES AT CAP PLUS A PROPORTION OF BEP, IN GERMANY, PASSES IN THE BERUFSABSCHLUSS COURSES TAKEN AS FOR PRAIS AND WAGNER (1983) AND PRAIS AND STEEDMAN (1986).
(2)1990
(3)1988 PROVISIONAL FIGURES

Mathematics required for craft courses

The three craft qualifications considered here all require the student to demonstrate some mathematical knowledge which is formally set out in the form of syllabus requirements and tested by externally-set and marked final examinations. In France and Germany a separate examination in building calculations is set, in Britain the demands are lower; students are expected to demonstrate mathematical competence by answering a small number of general professional questions requiring mathematical calculations and to complete assignments (set by City and Guilds and marked by the college) demonstrating mathematical competence.[10]

Using these final examination papers together with national syllabuses and worksheets and work plans supplied by teachers in the colleges visited, the mathematical topics which trainees would be taught were identified in all three countries. These are discussed in Section Three and set out in detail in Appendix 1.

Section 2: RECENT CHANGES IN BRITAIN

Our inquiry was made at a particularly critical time for initial training arrangements in Britain. 1991 was, in many colleges, the last year in which government subsidies for Youth Training (which underpin practically all initial training for the building trades) were made available for courses leading to the City and Guilds Part II Craft Certificate. From 1992 onwards, financial support from the government for youth training is contingent upon the trainee 'working for' a qualification which conforms to the criteria agreed for that industry with the National Council for Vocational Qualifications (NCVQ).

National Vocational Qualifications (NVQs) have been developed by Industry Lead Bodies in conjunction with the National Council for Vocational

[10] Vocational certificates are not, however, a reliable guide to standards of mathematical attainments. They are, quite rightly, concerned to provide a reliable indication of a level reached in a whole range of professional skills and knowledge. In all three countries, the demonstration of practical vocational competence was considered of prime importance and the weighting of the various examined components reflected this concern. It is not, therefore, realistic to expect to draw reliable conclusions on trainees' precise mathematical attainments from performance in their craft examinations. These are, however, useful as a guide to *expectations* and therefore as a guide to the ground covered in mathematics classes with trainees in the college-based part of their course.

Qualifications and the Employment Department - an NVQ level is defined as, 'a measure of competence of an individual's capabilities to carry out a range of work to standards ... agreed by industry'. This systematization of the skills and competences required in a wide variety of occupations and at different levels has many advantages for the organization and promotion of training of adult employees in the workplace. Those with no formal qualifications but long experience in the industry can receive an attestation of competence on the basis of work-place assessment. Training plans and procedures for employees can be more easily formulated even by small and inexperienced companies without a training department. There are no restrictions on access to these qualifications by age or training mode (as there were with traditional apprenticeships). One serious disadvantage of codifying *existing* standards of competence is that, in industries where skill levels are seriously inadequate, these are perpetuated by NVQs rather than improved. Taken all in all, however, the initiative can be judged to be a positive one as far as *adult* employees and training and retraining of adults in the workplace are concerned.

It is when these same qualifications are set as the target to be attained by young people in initial training that questions arise as to their appropriateness. Undoubtedly, NVQs have the virtue of being formulated by industry and therefore, of closeness to current requirements. Furthermore, a range of NVQ units provides a sound basic grounding in occupational skills i.e. general *training*. It is argued here, however, on the basis of the longer term skill requirements of the industry that, by concentrating exclusively on occupational skills and omitting to build upon and extend trainees' capacities in mathematics and English, NVQs represent a retrograde step in the development of provision of vocational *education* and training for young people in Britain.[11]

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[11] In October 1991 the NCVQ published a Consultation Paper on proposals for General National Vocational Qualifications (GNVQs). These are not vocational qualifications (they 'should not seek to attest to occupational or professional competence') and incorporate attainments in 'core skills' - problem-solving, communication, personal skills, and numeracy. These qualifications will require some numerical skills but it is not as yet clear of what standard. It is not yet known whether the introduction of GNVQs will change provision made for trainees in the building trades. It does, however seem likely that most young people studying for GNVQs will do so full-time in college and that they will not therefore be available to the young people under consideration here.

Until 1991, funding arrangements for Youth Training allowed the trainee to be registered for any (or no) vocational qualification and college fees would be paid on behalf of the trainee by the Department of Employment. In practice, most building trainees were registered on college-based City and Guilds courses and worked towards the Part II examination. Many trainees obtained the Part II Certificate within a two year YTS. Some funding was also available from the CITB (now also some YT funding can also be obtained) for a third year if this is required or if a trainee wants to continue to Part III; alternatively, a trainee could study in the evenings or approach his employer to fund a third year of part-time study in college (wages and fees) so that he could obtain the City and Guilds Part II. It is not possible to determine from the records of City and Guilds examinations how many passed the examination after two years of study.

That a substantial (and growing) proportion of young people were persevering in this path is demonstrated by the steady increase in numbers entering and obtaining a pass at Craft (Part II level) over the decade 1981-1991. (Table 1). In many ways this decade represented a period of convergence of training for the construction industry in Britain, France and Germany, with course content covering a core of common topics, and numbers in Britain increasing to come closer to levels in other European countries. The revised funding criteria for Youth Training schemes (which make government funding for Youth Training dependent on the trainee "working for "National Vocational Qualifications) will undoubtedly lead to to divergence of British course content from practice in continental Europe.

Under YTS funding regulations, the trainee was entitled to 130 hours of off-the-job training; now even that modest requirement has disappeared and the competence-based Level II could in theory be acquired without the trainee ever leaving the workplace.

From 1992, therefore, Youth Trainees can no longer be enrolled on City and Guilds Craft Certificate courses, since these do not meet the criteria laid down for National Vocational Qualifications; in particular, City and Guilds courses had not been elaborated according to industry standards and assessment of performance was not based on 'outcomes' ie.

demonstration of competence.[12] The only qualification that trainees can "work towards" is one given the National Vocational Qualification seal of approval. In two years, most may hope to achieve Level II, thus raising at a stroke the number of young people on Youth Training obtaining a recognised vocational qualification to numbers greater than those found in continental Europe.

The greater *numbers* thereby gaining a recognised vocational qualification may appear at first sight to represent an advance on previous arrangements. This improvement has, we would argue, been achieved at the price of quality and more specifically by abandoning serious attempts to provide general education for trainees in basic subjects to standards similar to those in Europe. In fact, in the opinion of college lecturers, the amount of time that can be devoted to mathematics on the new college courses preparing for National Vocational Qualification has been substantially reduced - or even completely eliminated.

The college, as agent of delivery of National Vocational Qualification *and* assessor, finds itself heavily burdened with ensuring that students acquire the range of practical skills required by these new qualifications. To achieve NVQ Level II students must acquire a range of practical competences similar to those which would be acquired in their first few months in the workplace; however, as a result of the lack of continuity in training places (trainees may be moved from one employer to another because of business difficulties or for other reasons) and because of the low level of trainee supervision available in the workplace, in practice, colleges must provide all the basic skills

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12 To be accredited as a National Vocational Qualification, a qualification must be:

1 based on national standards required for performance in employment, and take proper account of future needs with particular regard to technology, markets and employment patterns;
2 based on assessments of the outcomes of learning, arrived at independently of any particular mode, duration or location of learning;
3 awarded on the basis of valid and reliable assessments made in such a way as to ensure that performance to the national standard can be achieved at work;
4 free from barriers which restrict access and progression, and available to all those who are able to reach the required standard by whatever means;
5 free from overt or covert discriminatory practices with regard to gender, age, race or creed and designed to pay due regard to the special needs of individuals.

training required for NVQ Level II.

The more formal teaching and learning of mathematics is therefore squeezed out by pressures of time and has to be 'picked up' incidentally in workshop-based sessions. There is no requirement for mathematics teaching and learning in the new National Vocational Qualification Level II and, beyond the demonstration of practical skills of bricklaying, a trainee is not required to demonstrate ability to carry out building calculations in order to obtain a certificate.

Differences of approach to assessment between City & Guilds and NVQs are very substantial. City and Guilds Part II certificates were awarded on the basis of a combination of marks awarded internally but externally moderated and an externally-set and marked examination requiring the pupil to answer multiple-choice questions. In this test the candidate was required to demonstrate on paper and under examination conditions the ability to carry out mathematical calculations. Assessment of trainees for National Vocational Qualifications will normally be carried out by college staff assessing competence against a detailed list of criteria and using instructions issued by the CITB.[13] The guide to assessment issued by the National Council for Vocational Qualifications clearly states that there is no longer any requirement for students to put their answers in written form, nor are they required to respond using conventional speech forms.[14]

National Vocational Qualifications thus diverge fundamentally not only from the City and Guilds Craft Certificates but from practice in France and Germany where marks are awarded for internal assessment of practical

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13 Concern was also expressed to us about the extent to which assessors will be allowed to exercise independent judgement; the managing agent which selects the college which provides assessment receives a substantial premium for each Level II student who receives an NVQ Level II award! Colleges are under increasing pressure to become self-funding and income from managing agents' fees for Youth Trainees forms an important part of FE income.

14 'Candidates should have the opportunity of demonstrating their knowledge and understanding by answering questions either orally or in a written paper... Oral questions may be answered by the candidate in a number of ways, ie through speech, or by pointing/indicating, sketching, etc., the main criteria being that the information given in the model answer is effectively communicated to the assessor'.
CITB and City and Guilds National Vocational Qualification: Competence Requirements QLT 027. Bricklaying (Construction) Level II.

competence and combined with marks on externally-set and marked formal examinations in separate general educational subjects (mathematics, science, German/French).[15]

A comparison of the mathematics required for City and Guilds syllabus 588 Brickwork and Masonry and NVQ Level II (our interpretation) set against National Curriculum Levels to give an idea of degree of difficulty is set out in Table 1 Appendix 1.

This study is, of course, not the first to draw attention to the likely impact of the NVQ approach on Youth Training. A comparative study of productivity levels in the clothing industry in Britain and Germany published by the National Institute in 1989 found that the competences embodied in NVQ proposals for two year Youth Training in the clothing industry would be acquired in the first few months of the German apprenticeship course and were substantially less than those required for a City and Guilds Craft Certificate.[16] More recently, grave reservations concerning the likely pressure from NVQs on standards of youth training and on the independence of assessors was expressed in a study of the functioning and outcomes of Youth Training Schemes during the five-year period 1983-1988.[17]

The NVQ criteria are based on standards of competence elaborated by the industry as appropriate for an employee at this particular level. It is difficult to understand, therefore, that so little emphasis should be placed by employers in the industry on building calculations - only one

15 For a fuller critique of the differences between the approach adopted by the NCVQ and the approach to the awarding of vocational qualifications in other European countries see SJ Prais, "How Europe would see the new British initiative for standardising vocational qualifications", *National Institute Economic Review*, August 1989. In a subsequent article, "Vocational qualifications in Britain and Europe: Theory and Practice", *National Institute Economic Review*, May 1991, Prais analyses the widening gap between Britain and other European countries with respect to the relative weight accorded to reliability and validity by British and other European assessment procedures.

16 H Steedman, K Wagner Productivity, machinery and skills: clothing manufacture in Britain and Germany, *National Institute Economic Review*, May 1989.

17 D Lee, D Marsden, P Rickman, J Duncombe, *Scheming for Youth : a study of YTS in the Enterprise Culture*, pp.177-182, Open University Press, 1990.

mathematical skill is explicitly mentioned, estimating quantities, a Level 3 topic in the National Curriculum.[18] One explanation might be the composition of the Industry Lead Body responsible for drawing up the list of competences required. If large employers were in the majority on the lead body, their needs and building techniques, which differ quite sharply from those of small employers, may have unduly influenced decisions taken.[19] Large employers sub-contract most site work and their staffs consist in the main of professional and technical staff. Small employers, especially those working in repairs and maintenance which constitute around one half of all building activity are more reliant on craft skills on small sites where it is not feasible to provide specialist technical supervision.

Section 3: COMPARISON OF MATHEMATICS CONTENT IN CRAFT TRAINING FOR CONSTRUCTION IN BRITAIN, FRANCE AND GERMANY

As a result of similar trade requirements a common core of professional mathematics requirements can be identified in traditional craft courses - the German apprenticeship (Berufsabschluss), the French CAP qualification and City and Guilds Part II - which are (or were, in the case of City and Guilds) specified, taught and tested for all trainees in the building trades in each country.

On these courses, trainees must be able to calculate areas and volumes of regular shapes. They will be permitted use of a calculator but must be able to multiply and divide decimal fractions, to calculate percentages, and to calculate on the basis of given ratios. Tables showing in detail the mathematical topics covered in France and Germany compared to both the City and Guilds syllabus and the NVQ Level II requirements are to be found in Tables 2 and 3, Appendix 1.

18 NVQ Level II is the standard expected of a trainee at the end of a two-year training period. It is hoped that, as at present, some trainees will continue beyond this stage to achieve NVQ Level III. Proposals for Level III have not yet been made public so that comment is not possible at this stage. Work for Level III will have to be financed by employers and trainees as only limited YT funds are available for a third year of study. It is difficult to imagine that Level III can take a student even up to the old C&G level in one year and quite impossible at this stage to see how such a qualification could come to be accepted as equivalent to A-Level standard as proposed by the government in their plans for an Advanced Diploma.

19 This point is being followed up with the CITB.

Until 1991, when some 20,000 young people obtained a City and Guilds craft qualification and a larger number followed the course for two years, the mathematical topics that were specified for trainees in the building trades in Britain covered much of the common core of practical building calculations found in the German and French courses.

For example, British students would be required to work out the rise of a lean-to roof where the rafter is 8.5m and the span 8m.; German students would be given the question 'The short side of a building angle is 66cm long. How long will the other two sides be if the proportion is 3:4:5?'; French students are asked 'calculate the length of a side AE of a right-angled triangle' where the length of the other two sides is known.[20] All these questions require the student to know and apply the formula of the Pythagorean theorem.

Differences between the three countries also emerge. The French syllabus is the only one to insist on elements of algebra as well as arithmetic and geometry. Algebra is included not because of its relevance to the building industry but because the mathematics syllabus for the CAP is laid down by the Ministry of Education with only nominal input from industry and considerations of progression and general education - taking students on from topics covered in school and covering topics which would be a necessary part of higher level study - outweigh considerations derived exclusively from the requirements of the industry. Students studying for the CAP are put through their paces in algebra because higher level academic, technical and vocational qualifications also require it and the French aim to make it theoretically possible for a student to keep all options open at this stage.[21]

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20 Source: Course based assessment paper supplied by the Construction Department of a Further Education college in the Greater London area. Intermediate Examination for Bricklayer apprentices set by the Berlin Chamber of Commerce, internal test paper set by the Apprenticeship Centre(CFA) for Building Apprentices, Dijon.

21 Building employers with whom we spoke in France agreed with college lecturers in finding the new mathematics syllabus for the CAP (issued in 1989) beyond the capacities of many apprentices. In practice, teachers concentrate on a somewhat narrower range of topics, but some algebra is included. A final-year class observed in an apprenticeship centre in Dijon was tackling the problem quoted above and requiring use of the formula relating the square on the hypotenuse to the other two sides of the triangle. The overall level of attainment of the group observed was very modest - of 12 students, 8 had come to the course from Special Education Classes. Nevertheless, about half were able to calculate the

Both German and French students are regularly required to tackle problems involving the calculation of the length of circular arcs and the volume of cones and spheres - these are more likely to be specified in Britain at the next level up - City and Guilds Part III (Advanced Craft). The higher expectations of mathematical attainment in Germany relative to Britain was predicted from earlier National Institute studies of mathematical attainments of school leavers.[22]

The City and Guilds syllabus is less extensive than that of France and Germany and aims to ensure that the trainee revises and consolidates simple mathematical skills learnt at school and acquires extensive practice at applying these in a practical context to acquire a sound basic knowledge of basic building calculations. The City and Guilds course aims in mathematics are on no measure ambitious; the syllabus ranges from topics at Level 4 of the National Curriculum (the level expected of the average eleven-year old) to Level 7 (the level expected of an above average 16 year old) - whereas in the French and German syllabuses prescribe topics which are found at Level 9 of the National Curriculum. (Normally to be expected of the ablest 10-15 per cent at 16 in Britain) Topics covered lie within just two areas, arithmetic and geometry. The City and Guilds syllabus, like the German syllabus is focused on those areas of mathematics which will be of immediate practical use to an employee asked, for example, to measure a client's window for a pane of glass or to quote a price or to calculate the volume of concrete required to fill a trench. Although this forms only a modest base for progression, skills acquired at school are revised and consolidated in the City and Guilds course and new work, particularly in geometry, is introduced. A number of college lecturers in Britain showed us worksheets which aimed to take students well beyond these requirements.

The replacement of City and Guilds Part II by NVQ Level II as the

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answer correctly. However, the mathematics requirements of the French syllabus are too demanding for the weakest students who are almost invariably found in apprenticeship and who have only two years of part-time education(compared to two years full-time for students in the full-time colleges).

22 S J Prais, 'Schooling standards in England and Germany: some summary comparisons bearing on economic performance', *National Institute Economic Review*, May 1985.

qualification to be aimed at by all young people in Youth Training has resulted in the loss in Britain of the requirement that trainees in the building industry be taught and assessed in the mathematics recognised as essential to the building trades. Colleges are required to instruct trainees in a large number of practical trade skills to achieve NVQ Level II and are under pressure from many quarters to do so in the shortest possible time in order to achieve a cost-efficient throughput of students. Instruction in raking back a brick wall will have to take precedence over learning how to calculate the number of bricks required to build it. Ideally, mathematics is to be introduced as and when the trainee requires it. Lecturers fear that neither time nor facilities will permit this.[23]

Section 4: SUMMARY AND CONCLUSIONS

This paper aims to establish what, in practice, are the mathematical topics that will be taught and tested in the training provided for young people in the building trades in three countries. The structure of the industry in the three countries and numbers taking such courses are sufficiently similar for instructive comparisons to be undertaken and wider conclusions to be drawn about the direction of British policy in this area.

Mathematics was deliberately chosen for study because it forms a central part of the general vocational education traditionally offered to young people in vocational education and training courses and because it is important both for vocational competence and for progression to more advanced levels within the profession or to more general courses of further and higher education. Research began before proposals for the new National Vocational Qualifications in the Building Trades were in final form. Having set out to study the established pattern of building craft qualifications, this study additionally reports on the consequences for mathematics education of such changes. Briefly, almost all the

23 College lecturers may continue to try to cover with their trainees a much fuller range of mathematical topics than those set out in Table 2. It is doubtful that future funding arrangements for Further Education will make this feasible in the longer term (this issue is examined in more detail in a companion paper). At one college visited, most instruction took place out of doors since the covered accommodation was not large enough to permit trainees to build test pieces to the specification laid down by NCVQ. Opportunities for maths instruction were, under these circumstances, quite inadequate.

mathematical elements which were formerly taught to students studying for a City and Guilds qualification in building are now no longer specified or assessed for the new National Vocational Qualification at Level II. These elements - and more besides - are still required for trainees of similar age and prior school attainments in France and Germany.

Since government funding of Youth Training is now contingent on registration for assessment by means of the new NVQs, it appears likely that in future in Britain young people in training for the building trades will be significantly deprived of general education relative to their European counterparts.

The introduction of NVQ occupational competence statements as the sole defining requirement of what is to be provided to young people while they are in training for the building trades marks a significant departure from the previously well-established pattern of on-the-job training or experience and day release on a college course. A basic tenet of the NVQ approach to training is that 'traditional barriers such as age, duration, mode of training, where and how skills have been acquired are removed'.[24] The party (whether employer or managing agent) which contracts to enable a trainee to reach an NVQ Level by providing training gives no undertaking to provide access to a college course or a pre-defined syllabus as was previously the case for trainees coming within CITB schemes. Unlike their counterparts in France and Germany, British trainees are no longer recognised as being entitled to some education provision delivered outside the workplace as well as vocational training.

These fundamental changes, which have been established without any real informed public debate, mean that the British teenager in a training programme is now uniquely disadvantaged in Northern Europe - in France and Germany a training contract entitles the young person to off-the-job vocational education provided by trained teachers in an educational environment. This is no longer the case in Britain.

The eagerness of those in charge of policy to bring numbers in Youth Training receiving a recognised vocational training qualification up to levels close to those in Europe while seeking to increasingly shift the

24 National Vocational Qualification Competence Requirements QLT 027 Bricklaying (Construction) Level II. CITB and GGLI, p.3.

cost of Youth Training to employers may be the most important reason for the sudden fall in standards expected. The City and Guilds Part II qualification, while pitched at a quite modest level relative to what other European countries expect in a two-year training period, was beyond the capacity of many of those on the two-year Youth Training Scheme - well-rehearsed arguments about the inadequacy of the preparation received in the compulsory school are clearly relevant here.

The even more modest requirements of the National Vocational Qualification at Level II, with its reminder that students need not write as long as they can demonstrate the competences required is undoubtedly attainable by many more trainees. Numbers attaining a recognised Vocational Qualification will undoubtedly rise, but the quality of trainees available to the industry may well be lower than before.

All the units specified at NVQ Level II relate to matters in which it would be necessary to any employer to instruct a new and inexperienced employee.[25] The five core NVQ units do little more than codify the training required for any employee if they are to survive for any length of time on a building site without injuring themselves or others; the six additional units cover basic building skills; their novelty lies in the fact that a range of very basic competences and skills qualify the employee for the award of a vocational qualification. It is now well-accepted in economic analysis to assume that employers will be more willing to pay for job-specific training than for more general training and education which the trainee could subsequently use to his own benefit and that of another employer. At present, the cost of training in NVQ Level II is, in effect, paid for by employers; it is understandable therefore, that college courses provide training rather than broad vocational education. In France and Germany, the trainee and the state bear the cost of vocational education and colleges are insulated from direct pressures to provide specific job training.

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[25] Core Units at NVQ Level II in Construction are:
Unit 001 Construction Industry Activity Identification
Unit 002 Health and Safety in Site Operations
Unit 002 Communicating in Site Operations
Unit 004 Using scaffolded structures in site operations
Unit 005 Handling, Storing and Protecting Construction Materials

In addition, the trainee must pass 6 other units concerned with aspects of brick and concrete work to obtain an NVQ Level II.

Three serious points of concern emerge from this brief analysis. First, the changes outlined here are not confined to the construction industry but are being introduced in all areas of Youth Training. The overall quality of education and training for young people in YT is not improving and may well be falling, with serious consequences for the education post-16 of around one quarter to one third of all young people, and, ultimately for the quality and efficiency of business and industry. Second, NVQ at this level now cover so little of the professional knowledge and competence of vocational qualifications in other European countries that it is difficult to see how a case can be made for mutual recognition.[26]

Third, and perhaps most important, opportunities for progression and career development of young people will be severely restricted by failure to offer opportunity for consolidation and development of vocational education within youth training provision.

In the field of Youth Training, Britain has long been faced by the need to make progress relative to fast-moving targets - other countries were already ahead when YTS was first introduced and have been making faster progress since. The latest solution as outlined here - to move the goalposts so far apart that almost nobody can fail to score, thereby losing important elements of general education - is no real solution.

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[26] This issue is being followed up with the European Centre for the Development of Vocational Training in Berlin (CEDEFOP) the body given responsibility for harmonizing vocational qualifications within the EC by the European Commission. Wages are more commonly linked to recognised vocational qualifications at shop-floor level in continental Europe and non-recognition of 'foreign' qualifications has, in the past, led to lower wage levels for non-indigenous groups of workers. Recognition accepted by trade-unions in other European countries will be essential if British workers are to be appointed at skilled wage rates and with all other benefits conferred by skilled status in other European countries.

ACKNOWLEDGEMENTS

This work has benefited from the contributions and comments made by Elaine Beadle and Julia Hawkins of the National Institute of Economic and Social Research, Alison Wolf, Institute of Education, University of London, Marie-Thérèse Rapiau, IREDU, University of Dijon, Dr Karin Wagner, Technical University, Berlin. S J Prais has provided advice and encouragement. The author gratefully acknowledges the help generously given in advising and commenting on this paper and in providing facilities for our visits by teachers and lecturers in the three countries, by educational advisers and by the firms whom we visited. Responsibility for any errors in this paper rests with the author.

Appendix 1. Table 1

COMPARISON OF TOPICS TO BE COVERED IN MATHS IN CONSTRUCTION TRAINING IN BRITAIN BY CITY AND GUILDS PART 2 AND NVQ LEVEL 2 IN CONSTRUCTION (BRICKLAYING). SET OUT ACCORDING TO NATIONAL CURRICULUM LEVELS AND ATTAINMENT TARGETS.

NC LEVELS	AT2 NUMBER			AT4 SPACE & SHAPE		
LEVEL	TOPIC/ SOA	C&G PART II	NVQ LEVEL II	TOPIC/ SOA	C&G PART II	NVQ LEVEL II
4	Make estimates & check results.	-	✓			
	Add & subtract decimal fractions	✓	-		-	-
5	Convert one metric unit to another	✓	-			-
	Fractions & % of quantities	✓	-	Areas & primeter of plane figures*	✓	✓
6	Multiply decimal fractions	✓	-		-	-
	Calculate using ratios	✓	-			
7	None specified	-	-	Volume of solid shapes	✓	-
	None specified	-	-	Pythagoras theorem	✓	-

* Areas only for NVQs.

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NC LEVELS	AT2 NUMBER			AT4 SPACE & SHAPE		
LEVEL	TOPIC/ SOA	C&G PART II	NVQ LEVEL II	TOPIC/ SOA	C&G PART II	NVQ LEVEL II
4	Make estimates & check results.	-	✓			
	Add & subtract decimal fractions	✓	-		-	-
5	Convert one metric unit to another	✓	-			-
	Fractions & % of quantities	✓	-	Areas & primeter of plane figures*	✓	✓
6	Multiply decimal fractions	✓	-		-	-
	Calculate using ratios	✓	-			
7	None specified	-	-	Volume of solid shapes	✓	-
	None specified	-	-	Pythagoras theorem	✓	-

* Areas only for NVQs.

APPENDIX 1 TABLE 2

COMPARISON OF REQUIREMENTS FOR MATHEMATICS IN CONSTRUCTION TRAINING BRITAIN, FRANCE AND GERMANY SET AGAINST NATIONAL CURRICULUM ATTAINMENT TARGETS IN MATHEMATICS

NC LEVELS	AT2 NUMBER TOPIC/SOA(1)			NC LEVELS	AT3 ALGEBRA TOPIC/SOA			NC LEVELS	AT4 SPACE AND SHAPE TOPIC/SOA		
	BRITAIN C&G II	FRANCE	GERMANY		BRITAIN C&G II	FRANCE	GERMANY		BRITAIN C&G II	FRANCE	GERMANY
4	+/- DECIMAL FRACTIONS	-	-	4	-	-	-	4	-	-	-
5	CONVERSION METRIC UNITS FRACTIONS AND %s	CONVERSION METRIC UNITS FRACTIONS AND %s	CONVERSION METRIC UNITS FRACTIONS AND %s	5	-	-	-	5	AREAS AND PRIMETERS OFPLANE FIGS.	AREAS AND PRIMETERS OFPLANE FIGS.	AREAS AN PRIMETE OFPLANE
6	CALCULATE USING RATIOS * DECIMAL FRACTIONS	CALCULATE USING RATIOS * DECIMAL FRACTIONS	CALCULATE USING RATIOS * DECIMAL FRACTIONS	6	- -	LINEAR EQUATIONS CARTESIAN COORDINATE	- -	6	-	-	-
7	-	-	-	7	-	-	-	7	VOLUME OF SOLID SHAPES PYTHAGRAS THEOREM	VOLUME OF SOLID SHAPES PYTHAGRAS THEOREM	VOLUME OF SOLID PYTHAGRA THEOREM
8				8	POWERS & ROOTS SUBSTITUTE NEGATIVE NUMBERS			8	-	-	-
9	-	-	-	9	-	-	-	9	- -	LENGTH OF CIRCULAR ARCS TRIG RATIOS	LENGTH O CIRCULAR ARCS TRIG RATIOS
									-	VOLS OF CONES& SPHERES	VOLS OF CONES& SPHERES
10	-	-	-	10	-	-	-	10	-	-	-

(1)STATEMENT OF ATTAINMENT

APPENDIX 1 TABLE 3

COMPARISON OF REQUIREMENTS FOR MATHEMATICS IN CONSTRUCTION TRAINING BRITAIN, FRANCE AND GERMANY/FS SET AGAINST NATIONAL CURRICULUM ATTAINMENT TARGETS IN MATHEMATICS

NC LEVELS	AT2 NUMBER TOPIC/SOA(1)			NC LEVELS	AT3 ALGEBRA TOPIC/SOA			NC LEVELS	AT4 SPACE AND SHAPE TOPIC/SOA		
	BRITAIN NVQ II(2)	FRANCE	GERMANY		BRITAIN NVQ II	FRANCE	GERMANY		BRITAIN NVQ II	FRANCE	GERMANY
4	ESTIMATES OF MEASURES	-	-	4	-	-	-	4	-	-	-
5	-	CONVERSION METRIC UNITS FRACTIONS AND %s	CONVERSION METRIC UNITS FRACTIONS AND %s	5	- -	-	-	5	AREAS	AREAS AND PRIMETERS	AREAS AND PRIMETERS
6		CALCULATE RATIOS	CALCULATE RATIOS	6	- -	LINEAR EQUATIONS CARTESIAN COORDINATE	- -	6	-	-	-
7	-	-	-	7	-	-	-	7	-	VOLUME OF SOLID SHAPES PYTHAGRAS THEOREM	VOLUME OF SOLID SHAPES PYTHAGRAS THEOREM
8				8	- -	POWERS & ROOTS SUBSTITUTE NEGATIVE NUMBERS		8	-	-	-
9	-	-	-	9	-	-	-	9	- -	LENGTH OF CIRCULAR ARCS TRIG RATIOS	LENGTH OF CIRCULAR ARCS TRIG RATIOS
									-	VOLS OF CONES& SPHERES	VOLS OF CONES& SPHERES
10	-	-	-	10	-	-	-	10	-	-	-

(1)STATEMENT OF ATTAINMENT (2)NATIONAL VOCATIONAL QUALIFICATION