

Assessment of applied numeracy skills among post 16 students and trainees.

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Summary Over the last ten years or so in England and Wales, the assessment of vocational (work-based) skills using competence-based assessment has expanded rapidly, and with some success. Such methods were also applied in the assessment of so-called generic skills, such as communication and applied numeracy, developed alongside some vocationally-based qualifications, but there was a widespread perception that the method of assessment was not effective.

The development of generic or 'key' skills is to do with fostering the individual's ability to apply such skills to raise the quality of main areas of their work and other activity, rather than to demonstrate the skills in isolation. The range of Key Skills is now being promoted across the full spectrum of learners over the age of 16, including those following traditional academic pathways. Demands for increased reliability and rigour of assessment have led to several changes in assessment approach, in the search for a system which is valid but also sufficiently consistent, manageable and rigorous to be workable and command credibility. But in practice such external assessment can itself distort the learning activity that leads to the qualification. In attempting to increase rigour, the testing of technical skills leads to an undervaluing of the subtle skills of application which the qualification was originally intended to foster. This paper presents, reviews and reflects on these developments, with particular reference to the area of applied numeracy.

The development of Key Skills – including Application of Number

Sets of so-called generic or 'Key' skills – such as communication skills, numeracy skills, skills of working with others, or problem solving – are being seen as of increasing importance and value in vocational training, in progression from education into employment, within employment and in other aspects of working life in Britain today. The development of these skills is to do with fostering the individual's ability to apply such skills to raise the quality of main areas of their work and other activity, rather than to demonstrate the skills in isolation.

These Key Skills include applied numeracy – called 'Application of Number' in the agreed national specifications. This is concerned with enabling individuals to select, use and apply numerical, graphical, spatial statistical and other related skills as tools in their main areas of work or concern. In other words they are about helping individuals to develop the power and capability of their 'mathematics for living'.

Each of the six Key Skills is specified nationally at four broad levels, from "below average 16 year old" to "close to degree level/junior-middle management". The specifications include both technical skills and skills of application and require evidence of underlying knowledge and competent demonstration. Progression from levels 1 to 4 is characterised by increased technical demand, (for Application of Number this includes carrying out calculations, understanding graphs etc.), and higher application skills required from the increased complexity of the settings where the skills are being used and the increased autonomy of the individual. For instance, at level 1 the individual largely follows clear directions whilst at level 4 the individual could have responsibility for a project lasting several months).

For Application of Number at level 3 for example, the technical requirements are similar to those for a good pass at GCSE¹ mathematics. However, the individual is also required to show competence in selecting and planning how to go about using their technical skills effectively, and in choosing, presenting and interpreting their findings and results clearly - calling on more sophisticated skills of application.

¹ The General Certificate of Secondary Education, taken by nearly all 16 year olds in schools in England and Wales.

The development of competence in three of the Key Skills - in Application of Number, Communication and Use of Information Technology - is being particularly emphasised. This emphasis follows general concerns in government, among individuals themselves, employers and those in higher education over many years over deficiencies in these skill areas. These concerns fed into the Dearing 'Review'² of Qualifications for 16 – 19 year olds', set up to advise the government on ways to strengthen and improve the framework of these qualifications. Among others proposals, the Review recommended that all 16 – 19 year olds in education or training should have opportunities to develop the three Key Skills and have them assessed, and that competence in these skills should contribute to overall examination scores for entrance to higher education.

It is this recommendation that is now being implemented in the majority of all schools and colleges for 16 – 19 year olds.

Originally these Key Skills were assessed as components of vocational qualifications only. However, following Dearing, the range of Key Skills is now being promoted across the full spectrum of learners over the age of 16, from those undertaking vocational courses or training to those following traditional academic pathways leading to higher education.

As the profile and status of the three key skills is raised, so all aspects of their assessment become more critical, while the opportunities and pressures for distorting the validity of assessment are increased.

Definitions of numeracy

'Numeracy' is a term which has had several meanings in Britain. One common meaning – as in 'basic numeracy' - is little more than being able to carry out simple calculations in basic arithmetic. A more comprehensive meaning of the term was proposed in 'Mathematics Counts'³, the influential report by W H Cockcroft and others into the teaching of mathematics in schools in England and Wales, published in 1982. The report still has considerable relevance today.

The report proposed that the terms 'numerate' and 'numeracy' should imply the possession of two attributes. First, an 'at-homeness' with numbers and an ability to make use of mathematical skills which enables the individual to cope with the practical mathematical demands of everyday life. Second, an ability to have some appreciation and understanding of information which is presented in mathematical terms, for instance in graphs, charts or tables, or by reference to percentage increase or decrease.

It is this interpretation of 'numeracy' that underlies the specifications of the key skill of Application of Number. To aid clarity, the term 'applied numeracy' will be used for it, to distinguish from other meanings of 'numeracy'.

Deficiencies in numeracy

An awareness of deficiencies in numeracy is not new, of course, as illustrated by this quote from the Cockcroft report.

"There are indeed many adults in Britain who have the greatest difficulty with even such apparently simple matters as adding up money, checking their change in shops or working out the cost of five gallons of petrol. Yet these adults are not just the unintelligent or uneducated.

² Dearing R et al 1996 'Review of qualifications for 16 – 19 year olds'. SCAA Publications London

³ Cockcroft, W H et al, 1982, 'Mathematics Counts'. Report of the Committee of Inquiry into the Teaching of Mathematics in Schools. HMSO London

They come from many walks of life and some are very highly educated indeed, but they are hopeless at arithmetic and they want to do something about it'⁴

This quote was substantiated by two studies by the Advisory Council for Adult and Continuing Education. These showed, for example, that many of those interviewed were both afraid of mathematics and ashamed of their own inadequacies in using it, that many had difficulties with understanding or using percentages, with rounding or approximate calculations, with ideas of a rate of increase as distinct from the increase itself, with reading timetables and charts, or with understanding calculator displays with decimals. All these findings can still be identified among many adults in Britain today.

Even those with mathematics qualifications had problems with using their mathematics in everyday situations. For instance, 'some arts graduates who had gained 'O' level⁵ mathematics were nevertheless so aware of a lack of confident understanding of the subject that their career choices were seriously reduced as a result of their determination to avoid mathematics' (Cockcroft 1982).

These findings were supported by a more recent study carried out by a team including the author at the School of Education in the University of Nottingham⁶. In this study, a sample of 200 students entering higher education was assessed to estimate what percentage of the students appeared to be able to operate at level 3. Only 44% of the sample could show that they were capable at Application of Number level 3, compared with 66% of the same students reaching level 3 in Communication. Of the sample, only 27% of the students who were starting on Arts degree programmes appeared to have reached level 3 in Application of Number. Many of these students stated that they had ceased to 'do maths' after the age of 16 and that they had lost aptitudes they had then through lack of use. This echoes similar concerns expressed in the Dearing report.

Assessment issues

Clearly a major objective of the Key Skills programme is that individuals should develop and be able to confidently demonstrate Application of Number and other Key Skills in the context of their main work- that is, integrated into their vocational or academic programmes, rather than through stand-alone courses, even though this objective is not straightforward to implement⁷.

To be valid, any assessment schemes should support this objective. The application skills are critical, though much harder to assess than the technical skills. At the same time, for their personal security and self-esteem, individuals need to know that assessment is consistent – the requirements and standards for a Key skills award should be the same from course to course within a school or college centre and between centres – and sufficiently demanding and rigorous to give value to the award. As the profile of the Key Skills has risen, so assessment has become 'higher-stakes' and these aspects of consistency and rigour become more critical. .

⁴ Stringer D 1979 'Make it Count' for London Independent Broadcasting Authority. Research study supporting a series of TV programmes aimed at adults who lacked numeracy skills. The Open University. Milton Keynes.

⁵ The school examination system which pre-dated the current General Certificate of Secondary Education.

⁶ Murphy R Burke, P, Gillespie J, Rainbow R Wilmut J.1997 'The Key skills of students entering Higher Education' Project report, University of Nottingham.

⁷ Gillespie J 2000. *The integration of mathematics into vocational courses - some issues and concerns*. in Mathematics at Work (Selected papers from 8th International Congress in Mathematical Education, Seville. Ed. Bessot A and Ridgeway J. Kluwer Utrecht

Assessment approach 1 - through portfolio review

Until recently, the assessment of Application of Number, Communication and Information Technology was based solely on a review of evidence of the use of the three Key Skills which was presented by the individual in a portfolio. This would normally be the main part of the individual's collection of evidence for a competence-based vocational award. It could contain statements verifying active competences (such as that the individual had been able to select and present the main findings from a survey, or that the individual had demonstrated) as well as written evidence from the individual. After internal assessment within the school or college the evidence was then verified by an external verifier appointed by an appropriate examining body⁸.

This system certainly could enable valid assessment of Key Skills performance to take place. But in practice, external verifiers were themselves less concerned with the details of evidence of the use of any of the Key Skills than with evidence for the vocational award itself. In addition, many college-based vocational awards required that individuals should show competence in the three Key Skills as a requirement of the vocational award. Perhaps there was then a reluctance on the part of some external verifiers and others to fail individuals who showed vocational competence but whose Key skills evidence was dubious.

Of course, such a problem could have been overcome by increasing the rigour of the external verification and by removing the Key Skills pre-requirement for the vocational awards, so that demonstration of particular Key Skills were not tied so rigidly to them. Also, the over-complex Key Skills specifications then in use were not helpful.

In addition, it certainly proved difficult to show common standards of acceptable performance in the three Key Skills in different vocational areas, or between different college and school centres. This led in some instances to a lowering of respect for the Key Skills assessment and a reduced incentive for individuals or their tutors to fully meet the specification requirements. Again it might have been possible to address these concerns by strengthening the training of verifiers and increasing their time allocations per individual portfolio.

Assessment approach 2 - through externally-set assignments

In the climate following the Dearing Review which affirmed the importance of rigour on standards and the raised status of Key Skills across academic as well as vocational programmes, a fundamental change was proposed for the Key Skills assessment procedures. The perceived shortcomings were addressed by a political decision to reject the portfolio /verification system. In its place, on an experimental footing for a minority of centres, a systems of externally set assignments was introduced as the basis for assessment of the three Key Skills.

In retrospect this could be seen as a reversion to old-style academic exam-based assessment, suitable for traditional knowledge-based classroom testing but questionable for Key Skills and the philosophy behind them. In passing, it is worth noting that although there have been some benefits from the political pressures which have led to the rapid rise in status for Key Skills, there have been considerable disadvantages. Political time-scales are short, and decision-making may not always take into account the realities for the individual and staff trying to implement centrally-made decisions on the ground. A rapid pace of change – being seen to take decisive action, even though evidence bases and considerations of alternatives may be insubstantial - may bring political rewards but lead to less than optimal solutions.

⁸ Examining or 'awarding' bodies are authorised by government to award national academic and vocational qualifications at school and college level, such as National Vocational Qualifications and GCSEs

The external assignments were devised so as to attempt to mirror typical applications of the Key Skills. Detailed marking schemes were devised to ensure parity of assessment, one effect of which was to reduce the opportunities for more 'open' questions to be included. In Application of Number, individuals were presented with situations that they might reasonably have met in the course of their main vocational work. But in practice, even though a choice of assignments (so-called 'extended assessment activities') in different contexts was provided, the majority of individuals saw the assignments as unrelated to their own vocational work. What was familiar for one group was alien for many others.

Even though some individuals enjoyed working through the assignments, it was practically impossible for the assignment work to be integrated into the individual's main work, because they were set remotely from the individuals. The key skill assignments became a separate concern for individuals – remote from the intended use of Key Skills to improve individuals' performance in their main areas of work. Preparation for the assignments became a main concern for staff and individuals, so that a substantial proportion of the 50 or so hours per year likely to be available for the development of each Key Skill was devoted to preparation for the external assignments rather than to developing and using Key Skills in practice. Efforts to make the assignments seem more 'natural' by, for instance, providing data in advancement or arranging for assignments to be undertaken at times to suit centres within a three week 'window', meant that even more time was taken by the assessment process. The natural collection of evidence through the use of Key Skills in the course of other work was replaced by a sampling of some of the assessment criteria within the constraints of a timed assignment.

Furthermore, staff and centres who were now to Key Skills assessment, tended to treat the external assignments as models of what should be in the portfolios, distorting further the underlying objective of integrating the portfolio applied numeracy with the individuals' main work.

In addition, in response to recommendations in the Dearing Review, short tests were also included for Application of Number, very loosely set in 'real world' contexts. Many individuals who had bad memories of school maths tests approached these tests with fear, though reactions after the tests were more positive. However, at levels 1 and 2 calculators were not permitted to be used, which made the tests even less representative of normal everyday practice, as well as making it harder to ask questions with realistically complicated numbers.

To summarise, consistency across centres and some measure of rigour and reliability of assessment might be seen to be gained by the assessment system being piloted – both requirements of the raised profile of Key Skills following the Dearing Review – but validity of assessment was very much reduced. But what was now being trialled seemed to lean more towards some people's recollections of their own school days rather than enhancing the development of generic skills of application.

Those concerned with these developments, the author included, could only watch with concern as politically based decisions relating to the future form of Key Skills Assessment were taken. The political urgencies meant that college staff were faced with rapid changes and there was, in the author's view, insufficient time to take measured decisions on optimal assessment approaches.

Assessment approach 3 - through portfolios and tests

To general relief, the external assignment system was not proceeded with. In its place, a modification of the old portfolio system was combined with the shorter tests referred to above. Here was a way of quickly assessing underlying knowledge and technical skills through a test as well as the skills of application through the portfolio. Individuals were required to pass both a test and portfolio assessment to gain a Key Skills award. Many saw this procedure as a step forward, even though the calculator ban at levels 1 and 2 was maintained. At these levels the tests are 40 item multiple-choice, intended to sample the underlying knowledge and technical skills; at level 3 the multiple choice questions are replaced by short and more extended questions requiring written answers.

This system has been trialled for one cycle and is now being brought into general use. But we can already see problems over the validity of the combined assessment, particularly as the whole programme expands across all educational and training pathways. Staff who come fresh to Key Skills and who are familiar with tests and examinations tend to see the familiar style of the Key Skills tests as a model for Key Skills as a whole. External assessment, set and marked remote from a centre, is seen as having higher status and greater weight than the internal assessment of portfolio evidence and so comes to have greater influence on learning programmes and so the validity of the assessment procedure is further reduced.

At the same time, the much harder problem remains - of integrating the applied numeracy into other main areas of work, and then seeing the benefits from it in the raised quality of this work. It is the author's view that this is essentially a complex cultural matter, dependent upon the co-operation between vocational, academic and Key Skills support staff. It calls for the development of a mutuality of understanding - of Key Skills support staff for the goals and aspirations of vocational or academic course staff, matched by these staff's growing understanding of the potential benefits their courses can gain from the integration of applied numeracy and other Key Skills.

Conclusions

In reviewing the developments of the last five years, we can see a welcome increase in status for key skills including applied numeracy. With this goes an inevitably increased emphasis on assessment - with consistency of assessment better established. But sadly validity of assessment seems likely to suffer - and with it so will the development of applied numeracy itself. What is being valued through assessment is what applied numeracy will be seen to be.

Clearly there was a need to raise the rigour and consistency of assessment. And any assessment regime will have to balance the often conflicting demands of validity against reliability and consistency. But in what we have now, validity appears to have lost its place of primacy. In reverting to a more traditional form of assessment, the significant opportunity for expanding and developing applied numeracy across the whole post-16 spectrum has been diminished. At the same time the potential for a more rigorous and well-controlled portfolio verification or moderation system which would enhance validity is yet to be realised.