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ABSTRACT

In order to help students learn mathematics skills and how to apply them, a staff development workshop for vocational tutors was held at Calderdale College (England). The workshop focused on three objectives: to identify and raise awareness of students' needs, to identify barriers to learning, and to identify ways of supporting students. Four key areas of mathematics were stressed: money, measurement, data handling, and spatial relationship. In the first half of the session, the tutors were asked to carry out four tasks: (1) to write a log of the ways in which they have encountered or used numbers in the past 24 hours; (2) to sort their logs into vocational and social uses of numbers; (3) to identify the numeracy needed by their students in their working lives; and (4) to analyze three or four vocational tasks into their basic numeracy components. Tutors also were made aware of the barriers faced by their students, such as the language used to perform calculations and the difficulties students may have in handling formal mathematical techniques. Finally, tutors were taught common mathematical errors and presented with samples of some of the teaching materials available. (KC)

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WORKING WITH NUMBERS

Is hardboard measured in imperial or metric units? Why is a knowledge of place value important in construction work? Vocational tutors are aware that numeracy problems get in the way of success for students and trainees, on courses and in work placements. They also know the practical and applied numeracy needed. Staff development can conduct a joint examination and analysis of how we all use numeracy, what skills are needed in different contexts, what the barriers and common errors are and how to respond to these. This is a good basis for building effective, focused support.

Derek Newton, Curriculum Manager (Learning Support) at Calderdale College, describes staff development work which began in the YT workshop and is now broadening across the college. It formed part of internal college training, but could equally fit within the Initial Certificate which is, increasingly, being offered to vocational tutors.

Maths for working life

The college in which I work has offered numeracy support to students on vocational programmes for some years. In particular, we run a Vocational Support Workshop for YT trainees from a wide range of vocational areas: health and caring, catering, clerical, engineering, horticulture, construction, sport and leisure. We are now trying to develop and extend this provision as part of our cross-college learning support service.

It hasn't always been easy to find materials or activities that could appeal to such a diverse group of students. We anticipate that this will be a significant issue when we try to reach a larger group of students. A recent survey carried out in the college suggests that a quarter of students need help with basic skills. If we are to respond effectively, we need to encourage collaboration between basic skills staff and vocational tutors. So we have to continue developing a numeracy curriculum which both students and vocational staff can recognise as relevant and worthwhile. With this in mind, we have had to ask ourselves, 'What kinds of maths do people really need in their working lives?'

In our experience, maths syllabuses linked to vocational qualifications or, indeed, lists of numeracy core skills, don't necessarily provide the best guides to student needs. These schemes are usually based on formal principles, which may have an internal logic, but which don't always correspond to the ways in which people actually encounter and use numbers. They are, in effect, subject-centred rather than student-centred.

In our numeracy work, we are not simply concerned with helping students to acquire techniques or a knowledge of mathematical principles. We want students to be able to use their skills in practical situations. We want them to have the confidence to perform calculations, interpret numerical information or solve problems. We want them to be able to retain what they have learned and to be able to transfer it to new situations. To achieve this, we need to make a connection between what students are able to do and what they are going to need to do.

Some time ago a group of the college's basic skills staff started to develop a practical numeracy profile. What we were after was a structure around which to develop our numeracy curriculum. Eventually, we decided to concentrate on four key areas: money, measurement, data handling and spatial relationships. We adopted this framework, with some amendments, as the basis of a survey of programme tutors. This has provided us with a database of tutors' perceptions of their students' numeracy needs. We have also used this framework to develop a practical numeracy assessment test. This framework has been very useful in enabling us to help students set meaningful goals for their programmes of study.

To some extent these initiatives have been overtaken by national developments, notably the publication of the ALBSU standards for basic skills. But we don't feel that our time has been wasted, and it has been encouraging to see the similarity between our ideas and those of the BSAI. We are now in a position where we want to develop our ideas by working more closely with the wider network of college staff.

We have always had informal contacts with vocational tutors. Now we feel a need to extend and formalise these contacts. To this

end, we have devised a staff development course aimed at vocational tutors. Its main purpose is to stimulate collaboration between basic skills tutors and vocational staff. It includes sessions concerned with numeracy, communication skills, support for bilingual students and assessment and accreditation.

The session on numeracy was designed to achieve three objectives: to identify and raise awareness of students' needs; to identify barriers to learning; to identify ways of supporting students. The methods used in the sessions are partly based on materials published for use on the *Initial Certificate in Teaching Basic Skills*. Obviously, in three hours it's not possible to deal with the issues in depth, but it is possible to set an agenda which can be followed up through subsequent activities. I want to describe the process I have used to try to achieve this.

Using numeracy

In the first half of the session tutors are asked to carry out four tasks: to write a log of the ways in which they have encountered or used numbers in the past 24 hours; to sort their logs into vocational and social uses of number; to identify the numeracy needed by their students in their working lives; to analyse three or four vocational tasks into their basic numeracy components.

I have used the idea of writing a numeracy log several times (*Handout 1*). It's important, in introducing the task, to stress that people are being asked to record not only the occasions on which they have performed calculations, but also the other ways in which they have encountered numbers. Some examples may be helpful, such as reading a speedometer or telling the time. Once the logs have been completed, participants are asked to share them with the whole group. This is essential because some participants will have identified more examples than others and different participants will have identified different examples, and because the main purpose of this task is to help participants see how extensively numbers permeate our everyday activities.

A NUMERACY DIARY

Think about the ways in which you have used a number in the past 24 hours.
List as many examples as you can think of.

Example 1

looking at clock
Road signs (no's – M62)
Petrol guage
Speed
key in no. to draw out money
count £'s
Register no.
Timetabled times
classroom no.
No. on key for door (classroom)
looked up tel. number
used telephone
Student enrolment no.
Counted out money
compared petrol prices

Handout 1

Participants are then asked to work in pairs or small groups. They are asked to combine their data and to list those uses of number which are mainly vocational and those which are mainly personal or social. They are asked to put this information onto flip charts and to report back to the whole group (*Example 2*).

These two exercises can generate a great deal of discussion. Most people are only vaguely aware of the extent to which they deal with numbers on a daily basis. They may be surprised at the extent to which they use numbers without performing calculations, for example, when they use PIN numbers or telephone numbers or when they have to interpret road signs or recognise house numbers.

VOCATIONAL AND SOCIAL USES OF NUMBERS

Example 2

Vocational	Social
• Time: schedule	• Time – calculate time to travel to work
• Registers	• Travelling – check speed limits
• Dividing students into groups	• Judging distances for braking and parking
• Sorting out materials	• TV stations
• Measuring, using formulae, performing calculations	• Points on TV quiz show
• Managing time	
• Handling cash – buying at the shop – depositing money in the bank	
• Checking quantity of tools	
• Room numbers	
• Cooking times (microwave)	
• Photocopying	

People may think that the maths needed in their vocational area is well defined; approached in a different way they would simply refer you to the course syllabus. These exercises can help them to broaden their concept of the maths needed to hold down a job. Since vocational training is concerned with enhancing people's employability this is a vital issue.

A number of significant themes can emerge from these discussions. One is the extent to which people are engaged in budgeting and handling money. Another is the importance of time-management in people's lives. A third is the extent to which people have acquired numerical concepts which are used more or less intuitively, for example, in judging distances or in assessing the size or weight of an object or in estimating quantities. A fourth is the extent to which people use practical reasoning in performing calculations; they may, for example, use approximation and estimation far more often than they use more formal techniques.

It's important to stress to participants that their students inhabit this same number-saturated environment. Even though students may not appear very competent in dealing with numbers through formal methods, they may well be dealing quite adequately with situations which involve number, by using 'rule of thumb' approaches. On the other hand, to be successful in a working environment they may have to deal with a much wider range of numeracy-based activities than are normally comprised within the maths syllabus. Handling money and managing time are two obvious examples.

I have analysed several numeracy logs from previous staff development sessions, and I find it useful to share this information

PRACTICAL NUMERACY SKILLS

- recognise numbers, write numbers, memorise numbers (numbers on phone, street numbers, speed limits)
- numerical order
- count items, count out items
- approximating/estimating
- read a digital display, read a dial (volume, temperature), read clock display
- tell the time (hours, minutes, seconds), calculate time between events (estimate journey time), times of TV programmes
- recognise difference between ages
- recognise different coins, give correct money, check change
- add up prices, compare prices
- check a bank statement
- measure powder, calculate quantities in a mixture
- measure length, weigh items, measure volume of liquid
- understand clothes sizes, recognise weights, temperature settings, speedometer, air pressure
- percentages (VAT, discounts)
- graphs

Handout 2

with participants. (*Handout 2*). For one thing, it's helpful for participants to have their own findings confirmed. There again, participants may have overlooked some aspects of our everyday use of number. Obviously, this list isn't exhaustive. It does, however, provide a usable and valid starting point for thinking about the number curriculum.

Working in context: from VAT to fuse ratings

The next task for participants is to draw up a list of the numeracy skills needed by their students. (*Handout 3*). By now they should be able to approach this task from a broader perspective than they would have done otherwise. Naturally, people from different vocational backgrounds will produce very different kinds of list. The examples below were produced by a clerical tutor and an electrical installations tutor. Although they require further work, these 'brainstormed' lists are very useful as a starting point for curriculum development.

VOCATIONAL AND SOCIAL USES OF NUMBERS

Example 3

Clerical

- Read timetables
- Recognise bus numbers
- Use money to pay fares
- Estimate time for travel
- Telephone – use and look up numbers – extension numbers
- Franking machine – enter useage/ amounts, etc
- Dates on letters – addresses
- Computer keyboard – function keys
- Petty cash – giving out money (imprest system)
- Checking invoices – discounts, percentages, x by 3, etc
- Stock control – adding and deducting, recognising stock nos.
- Calculating postage from weights
- Postage times
- Photocopying – PIN numbers, amounts, costing
- Spreadsheets
- Fax machine
- Electronic mail
- Spatial awareness – layout of letters
- Arranging travel – calculate mileage, cost of accommodation
- Booking facilities, room costs, use timetables, etc
- Filling in forms (invoices, statements, orders)
- Banking procedures
- Wages/salaries, tax, NI contributions
- Interpret pay slips
- Book-keeping, ledgers, etc

Electronic Installation

- Read time
- Check timetables
- Know bus routes and numbers
- Fetch sandwiches, fish and chips from shop
- Handle money, check change
- Material amounts
- Measurement of distance
- Read electrical meters – digital or dial
- Know fuse ratings
- Check wattage and voltage
- Sizing of cables, clips, fixings, screws
- Estimating costs, VAT, writing invoices
- Checking delivery notes with order notes

Handout 3

One thing that is apparent from these lists is the extent to which students need to carry numerical information in their heads or to have it at their finger tips. Clerical students need to know about such things as postal rates, income tax and national insurance rates and rates of VAT. Construction students need to know about the sizes of screws and fixings, about scales of drawings, about different kinds of voltages, about fuse ratings. They also need to be able to operate in both imperial and metric systems of measurement. For example, they may need to work with sheet materials such as plasterboard and hardboard. Hardboard is still measured in imperial units, whereas plasterboard sizes are given in metric units.

Calculators: is the answer probable?

The fourth task that the participants have to carry out is to identify three or four vocational tasks which involve numeracy, and to analyse them in terms of numeracy sub-skills. (*Handout 4*). This task can lead to some interesting discussions about how calculations are performed in practice. Vocational tutors are aware that a lot of their students rely on calculators. The trouble is that the students often lack the ability to decide whether or not an answer is within the range of probability. It's quite easy to enter a decimal point in the wrong place and come up with an answer that is out by a factor of ten, a hundred or even a thousand. Students need to be encouraged to develop the skills of approximating and estimating so that they can monitor the answers being given by the calculator.

Activity	
Addition	
Subtraction	
Division	
Multiplication	
Decimals	
Fractions	
Percentages	
Use of calculator	
Measurement	
Estimation	
Accuracy needed	
Mental Arithmetic	
Paper/Pen	

Handout 4

Practical and formal

There are real differences between the ways in which we perform calculations in a practical situation and the way in which we perform them on paper. To take one example, if we were to try to add up a column of figures in our head by adding the units then the tens, it would be very difficult indeed. In practice, we don't do this. Instead we add up two whole numbers then add the next number to that total, and so on. Most of us have acquired a variety of practical methods of performing calculations such as this, and use them almost unconsciously. Our students also do this, and we can draw on the fact to increase their confidence in their ability to handle numbers. Sometimes, though, it can cause them problems. The ability to use a practical method may interfere with a student's ability to use a formal method of performing calculations. The formal method may seem very odd compared to their more intuitive approach.

Accuracy and approximation

In many vocational contexts it's important to know how accurate to be, whether you're performing a practical task or performing a calculation. For example, it's sometimes more appropriate to cut something approximately to length than to cut it exactly. This is a matter of judgement, which comes with experience. In wiring an electrical circuit, for example, it's important to know how much cable to allow extra for making connections. Sometimes it's a question of 'having an eye' for things, for example, being able to tell when things are square, straight, level or plumb. Students may be very uncertain and confused about this, and need to be given the opportunity to develop a sense of what is required and then to have their perception confirmed.

When people are cutting out materials they have to be able to calculate how to leave as little waste as possible. This is a very significant factor in working efficiently and cost-effectively. Or again, it's important to know how much material will be needed to

do a particular job, especially if you are working on a site where materials have to be carried backwards and forwards from the store. For example, how many sheets of plasterboard, how many floorboards, how many nails or screws are needed. Unless students gain this working knowledge of quantities they may fail, sooner or later, in their work placements.

Barriers

What barriers do students face in acquiring competence in numeracy? There seem to be two main factors which vocational tutors need to know about. The first of these is to do with the language we use to perform calculations, and the second concerns difficulties the students may have in handling formal mathematical techniques.

By the time we come to the session on numeracy I have already spent some time with vocational tutors in discussing communication skills. In particular, we have looked at the language needed to perform core academic and vocational functions such as giving instructions or describing objects and processes. The tutors are familiar with the idea of using language consistently to enable students to develop the language structures needed to perform these functions. They have no difficulty, then, in seeing the problems which can be caused by, for example, the variety of ways in which we use language to perform basic numeracy operations. (*Handout 5*). Of course, this is only one instance of the way in which language can interfere with the ability to perform mathematical functions, but it does serve to make the point. It's often quite reassuring to realise that the barrier a student has to learning is linguistic rather than, say, conceptual. This is, obviously, a particularly significant issue where bi-lingual students are concerned; they may easily have well-developed numeracy skills which they find it difficult to transfer to an English language context.

NUMERACY AND LANGUAGE

+	**Addition**	plus, and, add, sum total
−	**Subtraction**	minus, take, take away, subtract, from, difference between, less, less than
×	**Multiplication**	multiply, multiplied by, times, product
÷	**Division**	divide, divided by, share, goes into
=		equals, is, makes

Examples:

+ 2 + 2 = 4 (addition)

two plus two equals four
two and two is four
two add two equals/is four
the sum of two and two is four
find the total of two and two

− 4 − 2 = 2 (subtraction)

four minus two equals two
take two from four
four take away two is two
subtract two from four
two from four is two
what is the difference between four and two?
what is four less two?
what is two less than four?

× 2 × 2 = 4 (multiplication)

two twos are four
multiply two by two
two multiplied by two equals four
two times two is four
what is the product of two and two?

÷ 6 ÷ 2 = 3 (division)

divide six by two
six divided by two equals three
share twos into six
how many times does two go into six?
two goes into six how many times?

Handout 5

Common errors

If we are going to help students overcome their difficulties with formal mathematical techniques, we need to look closely at what they actually do when they perform calculations. I have produced a short list of errors commonly committed by students in performing basic numeracy operations. (*Handout 6*). Many students have difficulty in correctly identifying numbers larger than, say, 1,000. They may lack a clear sense of the significance of place value, and this may also show up in the way that they set out calculations, not consistently placing numbers in columns, for example. Some students performing addition are unclear about the need to start by adding the right-hand column. This may be because of the way in which we normally read numbers, left to right, or because the students are accustomed to adding whole numbers. The familiar example of people who can work out dart scores, but can't do formal addition, may be due to something of this sort.

ANALYSIS OF COMMON NUMERACY ERRORS

Large numbers	
Place value	
Addition	setting out sums (place value)
	sequence of operations (right to left)
	carrying figures
Subtraction	setting out sums (place value)
	sequence of operations (right to left)
	method for borrowing
	subtraction of greater from lesser
	subtraction from 0
	subtraction of 0
Multiplication	tables
	carrying figures
	multiplication of 0
	multiplication by 0
	long multiplication: method
Division	tables
	confusion between divisor and divided
	carrying figures
	division of 0
	division by 0
	long division: method

Handout 6

On course support

It's often useful to refer to the students' practical experience when trying to help them overcome these difficulties. Many students can, for example, perform calculations involving money, which they would find difficult to do with ordinary numbers. Many students have difficulty with subtraction, particularly where noughts are involved. I have found it helpful to explain the method of decomposition by referring to the idea of changing ten pound notes into one pound coins, and so on. Talking about money is also the easiest route into dealing with decimal numbers.

By the end of this session vocational tutors will have gained an insight into some of the key issues surrounding the development of numeracy skills. They are usually keen to help their students overcome their barriers to learning, and are pleased to discover that there are ways of doing it. It's a good idea to round off the session by looking at some of the numeracy teaching materials that are available. Often only the basic skills specialists know about them. It's always a relief to realise that the wheel has been invented.

On many occasions, vocational tutors will be in a better position than the basic skills specialists to help students overcome their difficulties with numeracy. Collaboration between vocational staff and basic skills staff can only be to the benefit of the students. Recent developments in basic skills have probably made it easier for us to achieve it. ■

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