14 Assessment

Our objective as teachers is to prepare our students as well as possible for employment or further training. Formal external assessment clearly plays an important role by providing the qualifications necessary for students to be successful in competitive recruitment or application procedures. Furthermore, funding for Further Education has become increasingly linked to students achieving recognised national qualifications. The consequences of these pressures are well known to tutors: course delivery is almost exclusively focused on producing work for external assessment, or preparing for external examinations or practical tests.

It has become normal practice for an assessment syllabus to structure all the teaching activities for a course, leaving relatively little flexibility for teachers to vary the course content. This may not be a problem if the syllabus has been well designed, so as to motivate students with interesting and challenging learning activities and prepare them well for the next steps in their careers. However, a poorly designed or inappropriate syllabus can leave students uninterested in the subject and lacking the knowledge and transferrable skills that are actually needed for employment or higher levels of training. In this chapter we examine various assessment routes available in numeracy, and attempt to evaluate the extent to which these prepare students effectively for the world of work. Criteria we might use when examining the design of assessment tasks are:

- the extent to which mathematical techniques are likely to be of value to the students in their future careers.
- the realism of the vocational setting, so that students appreciate the practical importance of the mathematical techniques they are learning and are motivated to develop their numeracy skills.
- the opportunities for problem solving, considered analysis of results, and logical thinking.
- the opportunities which students are given to develop the wider numeracy skills of: research and data collection; communication of mathematical concepts; and use of information technology systems in a mathematical context.

We are currently in a time of enormous change in Further Education, particularly in the fields of literacy and numeracy where concerns have been raised about standards. Employers' organisations have commented on the difficulty of recruiting staff with adequate levels of literacy and numeracy skills. Developments in technology are making increasing demands on employees, as many manual jobs in manufacturing and administration become automated and higher levels of technical competence are needed. A further cause for concern has been the relatively poor international performance of fifteen year-old pupils in the PISA series of tests, with the United Kingdom falling below many East Asian and European countries in both the Mathematics and Reading tests.

In 2011, Professor Alison Wolf of King's College London published a review of vocational education, commissioned by the Department for Education. The review considered how vocational education for 14- to 19-year-olds could be improved. The recommendations of the Wolf review have been largely accepted by the Governments of England and Wales.

The Wolf review particularly addresses numeracy and mathematics education. A main conclusion was that emphasis should be placed on all students under 19 gaining a GCSE in Mathematics at grade C or above.

> It was considered that school mathematics should be more practical. Wolf considered that A-level sciences lack the range of mathematical techniques that students will need for undergraduate science courses. She mentioned that physics and chemistry A-level often left out calculus, and biology A-level ignored the maths needed to convert between different units.
>
> All young people should be expected to continue some form of maths or numeracy education after 16, whatever education or training route they pursue. Students following vocational routes should study Functional Mathematics related to their vocational area at Level 3.
>
> Students who achieve level C or above in Mathematics GCSE should be encouraged to continue with Mathematics to at least AS level. Alternatively, they should study a course in Use of Mathematics which would be relevant to a broad range of A-level courses such as geography or history.

Whilst the objectives of the Wolf report are very worthwhile, they may lead to difficulties in implementation. We will review some of the problems:

GCSE Mathematics grade C or above is considered the principal objective when preparing students for the numeracy demands of the workplace. We have identified inconsistency in the views of employers in relation to this standard. Whilst employers state that they highly value GCSE formal mathematics, they are often critical of the practical problem solving abilities of students in unfamiliar situations.

In recent years, various authors have expressed concern about a declining interest in mathematics in school, particularly as a choice of subject at A-level. There seem to be several features of school mathematics which are demotivating, particularly to weaker students:

- School mathematics pays hardly any attention to the activities of real mathematicians. This seems strange since so many exciting career opportunities are centred around mathematics – modelling climate change, analysing and enhancing performance in sport, and designing three-dimensional graphics for computer games, to mention just a handful of applications which appeared during one evening's viewing of popular television. Mathematics students work through tasks which lack immediacy and seem to have little personal relevance.
- School mathematics leads to solutions that are either right or wrong – there is little or no room for negotiation. This contrasts strongly with real-world mathematics, where stimulating debates can take place around the formulation of an appropriate mathematical model for a particular application. Most school subjects encourage

> students to improve problem solving and analytical skills through debate with their peers and tutors, often leading to a compromise which is acceptable to all parties. Mathematics students are generally denied this opportunity for personal development.

A study by Jones (2016) of student retention in a Further Education college in North-West England found a statistically significant increase in withdrawals from vocational courses during the past two years. This increase could be convincingly attributed to the compulsory re-sitting of GCSE Mathematics and English in the wake of the Wolf report.

In the adult world, formal learning through organised training courses is only a minor part of the way we improve and update our knowledge and skills. Equally or more important is the learning that happens in the workplace through observation and informal discussions with colleagues. In addition, we might identify learning through reflection on our experiences – finding out what works and what doesn't. School mathematics seems to focus heavily on formal teaching, to the exclusion of other equally valid educational experiences. Vocational education experts in countries as diverse as Denmark, France, Germany, Sweden and Canada all argue for a different approach to maths teaching for students in vocational programmes, in comparison to students in academic programmes preparing for entry to University.

Three approaches to numeracy teaching and assessment can be identified in different vocational courses in Further Education:

> Numeracy taught entirely separately to the student's main subject or vocational area. The numeracy course would be assessed as a separate qualification - for example: the GCSE Mathematics–Numeracy qualification. ***This approach may be particularly valuable as a remedial activity where students lack understanding of basic mathematical techniques.***
>
> Full integration of numeracy tasks within a course or vocational context, being assessed only as part of the main specialist subject - for example, as components of vocational projects or forming parts of questions within specialist subject examinations. ***This approach may work well, provided that a numeracy or mathematics module is certified as part of the vocational course, or a separate mathematics/numeracy qualification is not required.***
>
> Numeracy activities carried out during vocational sessions, for example in a workshop or on site, and counted for assessment as part of a separate numeracy qualification - for example: as project work counting towards an Essential Skills Application of Number portfolio. ***This may work well, provided that the syllabus of the numeracy qualification is sufficiently flexible to allow realistic workplace numeracy activities to be carried out.***

We can look at each of these options in turn.

Numeracy taught separately

Mathematics courses in England and Wales have traditionally been strongly geared to the most able students requiring admission to Higher Education. Emphasis in examination syllabuses has been on recalling and using mathematical facts and standard methods, and following direct instructions to solve routine problems. A majority of examination questions are context-free, as in the GCSE Mathematics algebra and geometry examples below:

11. *(a)* Factorise $x^2 - 5x - 14$.

[2]

(b) Solve $\frac{x+2}{3} + \frac{x-2}{2} = 3$.

10. The circle shown has a centre O.
The lines PR and TR are tangents to the circle.

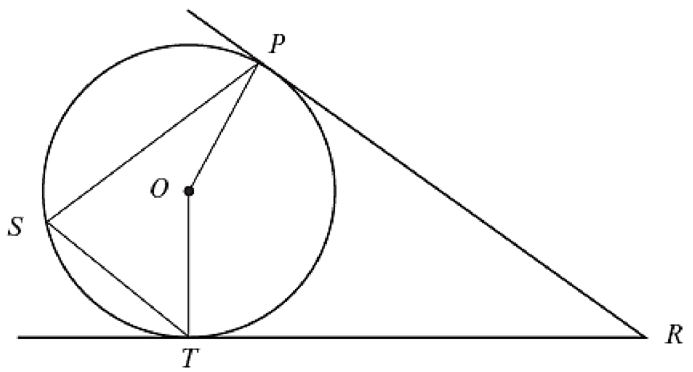


Diagram not drawn to scale

(a) Write down the size of $O\hat{P}R$ and give a reason for your answer.

[1]

Figure 461: examples of context-free GCSE Mathematics questions (WJEC, 2015a)

This approach may be suitable for the more able students in developing the mathematical techniques needed for scientific, technical or further mathematical study. However, the level of abstraction is likely to cause difficulties for students who are weaker academically but whose strengths and interests lie in practical activities.

A comment made by an employers' organisation was:

> The Qualifications and Curriculum Authority should consider the development of a GCSE in Practical Maths, designed specifically for students who are unlikely to need further mathematical study. This should be less 'academic' than the current Maths GCSE course, but emphasising the maths needed in practical real life situations. The grade C on this exam would then provide a suitable guaranteed minimum standard for students entering employment.

As a consequence of the Wolf report and the views of employers, a restructuring of mathematics education has taken place with the introduction of a GCSE Mathematics-Numeracy award in Wales. The stated aim of the examination board has been to reduce the content of mathematical facts and standard methods, and instead to increase the requirement for candidates to select their own methods to solve non-standard or unstructured multi-step problems. Questions are presented in the context of everyday life or workplace situations. An example question from a GCSE Mathematics-Numeracy examination is shown in figure 462.

5. Hari lives in Chester.
He wanted to catch the ferry to Ireland, leaving Holyhead at 12:05 p.m.
Passengers must board the ferry at least 30 minutes before sailing time.

In planning his journey, he allowed himself 20 minutes to travel from the station at Holyhead to the ferry.
He wanted to catch the latest possible train from Chester to be sure of arriving on board the ferry in time.

Part of the train timetable he used is shown below.

Chester (depart)	07:19	08:55	09:58	10:24
Holyhead (arrival)	09:22	10:35	11:22	12:23

Hari caught the train he wanted, and the train arrived at Holyhead station on time.
The time to travel from the station to the ferry took a total of 25 minutes.

Calculate the total time taken between Hari departing from Chester and arriving at the ferry. **[4]**

Figure 462: example of a GCSE Mathematics-Numeracy question (WJEC, 2015b)

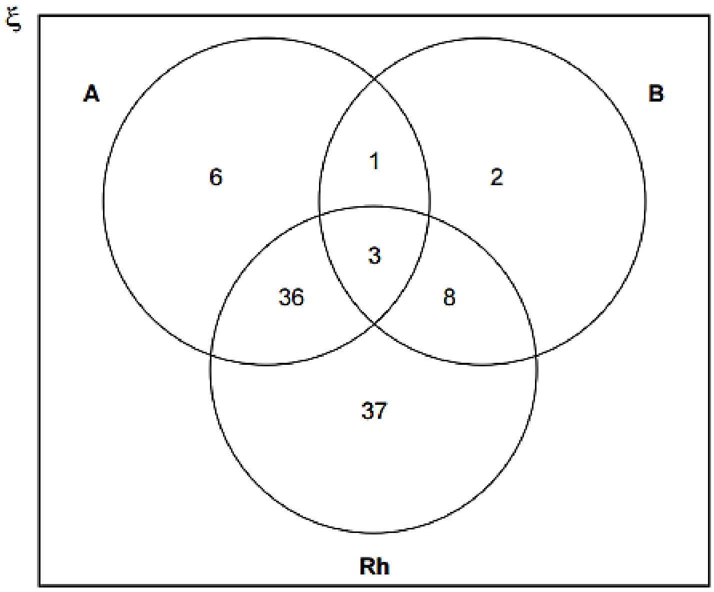
The types of question presented in the Mathematics-Numeracy paper will no doubt be more acceptable to a majority of vocational students than the context-free GCSE Mathematics questions. From our own interviews with students, the greatest difficulties were experiences with abstract algebra, whilst arithmetic problems set in a real world context were seen as the easiest to tackle. However, we still have concerns that the question topics are necessarily general and do not focus on the specific mathematics of particular vocational course, such as Construction, Business Studies or Health Care.

A further concern is that many of the mathematical topics covered, such as calculation of percentages, or calculation of areas or volumes of regular shapes, will already have been studied in a similar format by the re-sit students. This may cause boredom if the topics had already been mastered, or bring back feelings of failure if the topics caused confusion. A fresh start with new topics in the context of the vocational course chosen by the students themselves might provide a more motivating environment in which to improve numeracy skills.

For a slightly different group of students, an interesting development has been the introduction of a Mathematical Studies qualification by the AQA examination board. This is intended for those who achieved grade C or above in GCSE Mathematics and are progressing to academic or higher level vocational courses, but without the high mathematical demands of the physical sciences or engineering. The syllabus includes new topics in statistics, probability and data analysis which are relevant to a broad range of subjects such as psychology, geography and biology. An example question is shown in figure 463 below:

7 Your blood has none, some or all of three substances: A, B and Rh.

The Venn diagram shows the **percentages** of people in a population whose blood has different combinations of these substances.



7 (b) David's blood contains substances A and B but not Rh.

For Sarah to be able to donate her blood to David, any substance found in her blood must also be in David's blood.

What is the probability that Sarah can donate her blood to David?

[3 marks]

Figure 463: example of a Mathematics Studies question (AQA, 2016)

In previous years, a majority of vocational students would have studied for a Key Skills Numeracy or Essential Skills Application of Number qualification. Following the Wolf review, most vocational students are now likely to develop their numeracy skills through the mathematical content of their main vocational course, augmented by GCSE resit examinations where necessary. An Essential Application of Number Skills qualification has been retained for learners over the age of 16 in Apprenticeships, Traineeships or other work-based and community settings.

The Essential Skills qualification is assessed by a set task carried out under supervision over an extended period, plus an examination. As in the case of GCSE Mathematics-Numeracy, the set task and examination questions are based on numeracy in the workplace or in everyday life, with an emphasis on arithmetic, shape and space, and data analysis techniques. Examples of the set task and an examination question are given below.

Task instructions:
Investigate investment and accommodation options

What do you need to find out?

The scenario
An American relative is moving to Wales for three years. He wants to find accommodation and has asked you for advice. He has $125 000.

He wants you to choose a property and look at two options:

Option 1

- Invest the money (compound interest 3.4% per year) and rent a property

Option 2

- Use the money as a deposit on the purchase of a property
- Take out a loan for the rest of the money to purchase the property (compound interest 3.5% per year)
- Sell the property at the end of the three years (Assume that he sells the property for the same price that he paid for it).
- Repay the loan and the interest.

You must investigate both options, prepare a report to compare them and recommend one of them.

Resources you should use:

Source 1
- Wales Market Rent Summary

Source 2
- House prices in 2013

Source 3
- Details of local properties in 2014

Source 4
- Exchange rate websites

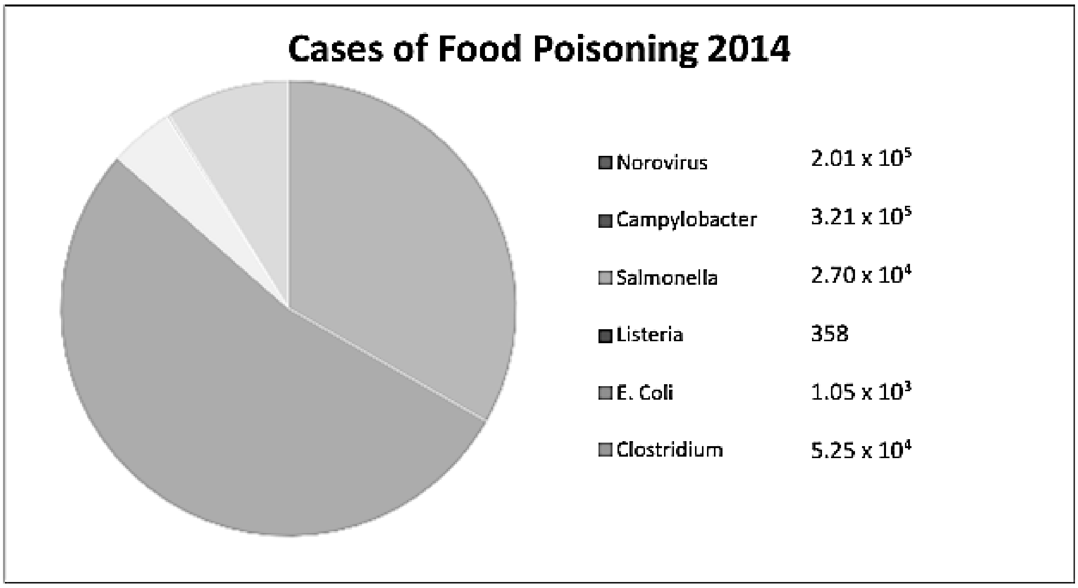
Source 5
- Formula for compound interest

- You must independently collect numerical data and information from source documents to help you to complete the Task.
- You must plan your approach to the Task based upon the source material provided.
- You must identify, analyse, effectively describe and plan how you are going to tackle the Task.
- Your plan must include details of how you intend to obtain relevant data and information and a clear sequence of tasks showing how you intend to use the data and information.
- You must identify the methods you will use, explaining why you have chosen those methods and showing that you are clear about how the data and information you have selected will meet your purpose.
- You should keep copies of the source material and records of the data and information selected to submit at the end of the Task.

Figure 464: example of Essential Skills Numeracy scenario (WJEC, 2015c)

Questions 8 and 9 are about food poisoning data.

8 The pie chart shows the number and causes of food poisoning in the UK in 2014.



8. What was the combined total number of food poisoning cases caused by Norovirus and Salmonella?

A	2.28×10^5	
B	22.8×10^5	
C	2.71×10^4	
D	2.71×10^5	

9. Each case of food poisoning costs the economy £25 per day taken off work.
For Salmonella poisoning people take on average 4 days off work.
What was the cost to the economy of Salmonella poisoning in 2014? (1)

A	£2.7×10^2	
B	£6.75×10^4	
C	£1.7×10^5	
D	£2.7×10^6	

Figure 465: example of an Essential Skills Numeracy examination question (WJEC, 2015d)

As in the case of GCSE Mathematics-Numeracy, the question topics are necessarily general and do not focus on the specific mathematics of the particular vocational area of the apprentice or trainee. This lack of flexibility is disappointing, and seems to be a missed opportunity for trainees to develop their numeracy skills in the practical context of their own everyday work activities.

Full integration of numeracy tasks in a vocational context

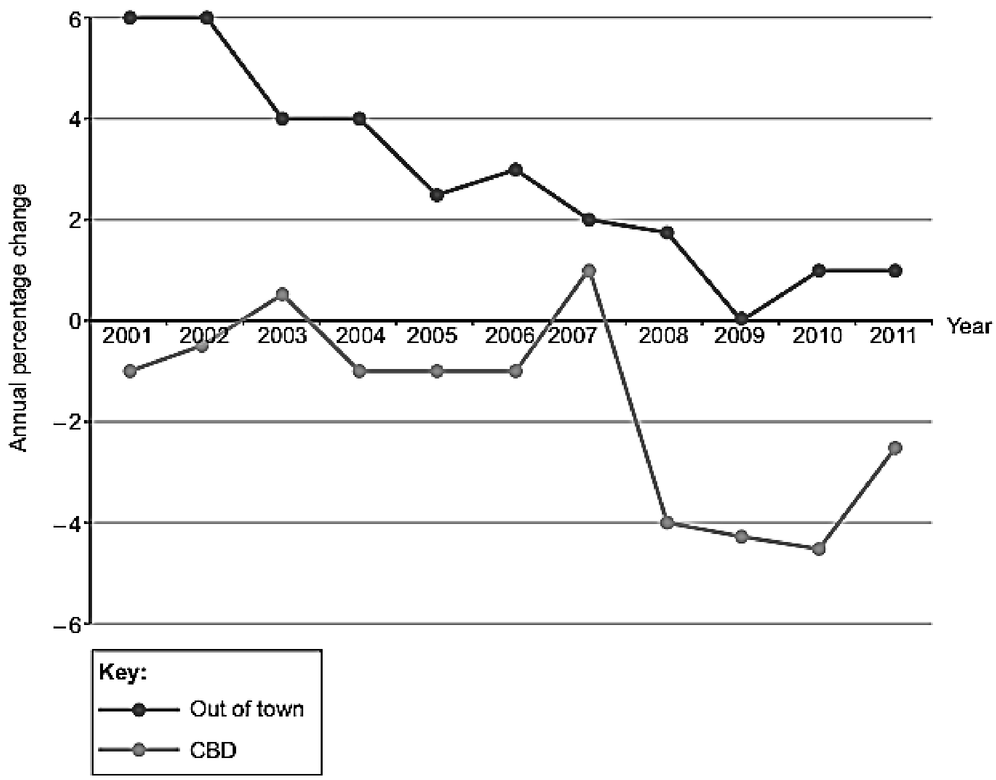
A-level courses often provide opportunities to develop specific vocational numeracy skills during project work. Examples of A-level projects included in earlier chapters of this book are:

- River and coastal sediment studies in Geography.
- Theatre design and mechanical excavator animation in Computing.
- Use of Mann-Whitney and Spearman Rank statistics in Psychology investigations.

There appears to have been some movement by examination boards away from open-ended project modules in which students are free to select a topic of personal interest. This is possibly due to difficulties in verifying that the project submitted was the unaided work of the student, or difficulties in assessment where projects presented are very diverse. However, the value of individual project work can greatly outweigh any difficulties with the assessment procedures, and we feel that project modules should be retained and, where possible, extended to additional subjects.

A-level examinations frequently contain questions in which students are required to interpret or make use of realistic data related to the subject. Examples are given below of questions from geography and biology papers.

Figure 2: Annual percentage change in retail space in use in the UK, 2001-2011



2. *(a)* Use **Figure 2** to describe changes in retail space in use in the UK. [5]

Figure 466: example question from WJEC A-level Geography module ' Changing Human Environments'

An experiment was carried out to determine the relative percentages of the bases in DNA from various organisms. The results are shown in the table below.

Source of DNA	Relative percentage of base in sample			
	Adenine	Guanine	Thymine	Cytosine
human	30.9	19.9	29.4	19.8
sea urchin	32.8	17.7	32.1	17.3
wheat	27.3	22.7	27.1	22.8

(c) DNA is a double stranded molecule. Explain how the data in the table supports the concept of complementary base pairing. [2]

Figure 467: example question from a WJEC A-level Biology paper

These types of question can be particularly interesting and motivating for students, and frequently provide opportunities for the student to demonstrate analytical and problem solving skills in a realistic vocational context.

In the case of vocational courses, subject specific mathematics or numeracy modules may be included as essential components. An example is the module 'Mathematics for Engineering Technicians' within the BTEC Advanced Diploma in Engineering. Whilst specifying a series of topics for study, the course tutor has considerable flexibility to design appropriate learning activities. Assessment is by means of assignments graded internally by the college, then checked by an external verifier from the examination board. The degree of flexibility in designing assessment tasks for the 'Mathematics for Engineering Technicians' module is indicated in the examination board's guidance notes:

> The application of these skills should reflect the context/area of engineering that learners are studying. Formulae do not need to be remembered but correct manipulation of the relevant formulae is very important in solving these problems.
>
> Learners should have plenty of practise when drawing graphs for learning outcome 1 and sketching trigonometric functions in learning outcome 2.
>
> During the delivery of this unit there should be opportunities for learners to use statistical data that they have collected from engineering contexts or situations. It is much better to put statistics, required by learning outcome 3, in an engineering context than use generalities such as learners' height, etc.
>
> Again, for learning outcome 4 opportunities to practise differentiation and integration must be given to ensure learners understand these activities within the range of the content and before they are given assessment activities.

We have included examples of tutor-designed tasks for the calculus component of this module:

- Use of integration to determine the volume of an aircraft engine component.
- Measuring capacitor charging and discharging, and the circuit for rectifying alternating current.

1 Be able to use algebraic methods

Indices and logarithms: laws of indices ($a^m \times a^n = a^{m+n}$, $\frac{a^m}{a^n} = a^{m-n}$, $(a^m)^n = a^{mn}$), laws of logarithms ($\log A + \log B = \log AB$, $\log A^n = n \log A$, $\log A - \log B = \log \frac{A}{B}$) eg common logarithms (base 10), natural logarithms (base e), exponential growth and decay

Linear equations and straight line graphs: linear equations eg $y = mx + c$; straight line graph (coordinates on a pair of labelled Cartesian axes, positive or negative gradient, intercept, plot of a straight line); experimental data eg Ohm's law, pair of simultaneous linear equations in two unknowns

Factorisation and quadratics: multiply expressions in brackets by a number, symbol or by another expression in a bracket; by extraction of a common factor eg $ax + ay$, $a(x + 2) + b(x +2)$; by grouping eg $ax - ay + bx - by$; quadratic expressions eg $a^2 + 2ab + b^2$; roots of an equation eg quadratic equations with real roots by factorisation, and by the use of formula

2 Be able to use trigonometric methods and standard formulae to determine areas and volumes

Circular measure: radian; degree measure to radians and vice versa; angular rotations (multiples of π radians); problems involving areas and angles measured in radians; length of arc of a circle ($s = r\theta$); area of a sector ($A = ½ r^2\theta$)

Triangular measurement: functions (sine, cosine and tangent); sine/cosine wave over one complete cycle; graph of $\tan A$ as A varies from 0° and 360° ($\tan A = \sin A/\cos A$); values of the trigonometric ratios for angles between 0° and 360°; periodic properties of the trigonometric functions; the sine and cosine rule; practical problems eg calculation of the phasor sum of two alternating currents, resolution of forces for a vector diagram

Mensuration: standard formulae to solve surface areas and volumes of regular solids eg volume of a cylinder $= \pi r^2 h$, total surface area of a cylinder $= 2\pi rh + 2\pi r^2$, volume of sphere $= \frac{4}{3} \pi r^3$, surface area of a sphere $= 4 \pi r^2$, volume of a cone $= \frac{1}{3} \pi r^2 h$, curved surface area of cone $= \pi r \times$ slant height

3 Be able to use statistical methods to display data

Data handling: data represented by statistical diagrams eg bar charts, pie charts, frequency distributions, class boundaries and class width, frequency table; variables (discrete and continuous); histogram (continuous and discrete variants); cumulative frequency curves

Statistical measurement: arithmetic mean; median; mode; discrete and grouped data

4 Be able to use elementary calculus techniques

Differentiation: differential coefficient; gradient of a curve $y = f(x)$; rate of change; Leibniz notation ($\frac{dy}{dx}$); differentiation of simple polynomial functions, exponential functions and sinusoidal functions; problems involving evaluation eg gradient at a point

Integration: integration as reverse of differentiating basic rules for simple polynomial functions, exponential functions and sinusoidal functions; indefinite integrals; constant of integration; definite integrals; limits; evaluation of simple polynomial functions; area under a curve eg $y = x(x - 3)$, $y = x^2 + x + 4$

Figure 468: specification for the BTEC Advanced Diploma in Engineering module ' Mathematics for Engineering Technicians' (Edexcel-Pearson, 2015)

Vocational activities counted for a numeracy qualification

We have examined a range of independent numeracy qualifications, and numeracy assessment opportunities within a student's main vocational subject. A third possible model is for activities such as project work to be carried out in the vocational area, then submitted as assessment material for a separate numeracy qualification.

In previous years, this assessment model was available for components of the Essential Skills Application of Number award, and for modules of AQA Use of Mathematics A-level. Both of these qualifications have now been superseded by schemes in which all assessment tasks are specified by the examination board, and students' choice of project has been removed. We see this as an unfortunate and backwards step. There are a number of advantages in giving vocational students the opportunity to select their own numeracy projects and topics to develop for assessment:

- Allowing the student autonomy in choosing their own topic of study, within limits set by the tutor, can be very motivating. The student can select a problem to investigate which is of genuine interest within their chosen vocational area.
- Students can be guided in the use of advanced mathematical techniques where these needed for a specialist vocational task or investigation. Students will see the relevance of the techniques, and will find the mathematics easier to understand in a practical context.
- The student will have the opportunity to collect their own data, either by direct measurement or from published sources. They will be able to decide on the range and quantity of data required for the task, and assess its accuracy. These are all important skills to develop in numeracy.
- The student will gain experience in problem solving. They will need to clearly formulate the objectives of the project, plan the data collection and processing strategies, and analyse and evaluate the results.

We recommend that thought be given by examination boards to the re-introduction of numeracy qualifications including a project component which can be selected and designed by the student, then carried out in a practical context over an extended period.

We complete our review of student assessment by looking more broadly at assessment events beyond the formal national qualification structure, but which can provide valuable experiences for students.

Looking beyond college

The PISA international mathematics test

As mentioned earlier, the PISA international tests held in recent years have placed England and Wales well down the world rankings. In the 2009 test, the United Kingdom is listed 26th in mathematics performance, similar to the Czech Republic, Latvia and Portugal but well behind a number of East Asian and Western European countries.

It is interesting to examine the type of question included in the PISA tests, and to relate this to the mathematics which British pupils would have experienced in their GCSE Mathematics courses at school.

UK students are recorded as scoring satisfactorily in the areas of change and relationships and quantity. An example question in this topic area is shown below:

SELLING NEWSPAPERS

In Zedland there are two newspapers that try to recruit sellers. The posters below show how they pay their sellers.

ZEDLAND STAR

NEED EXTRA MONEY?

SELL OUR NEWSPAPER

You will be paid:
0.20 zeds per newspaper for the first 240 papers you sell in a week, plus 0.40 zeds for each additional newspaper you sell.

ZEDLAND DAILY

WELL PAID JOB THAT TAKES LITTLE TIME!

Sell the *Zedland Daily* and make 60 zeds a week, plus an additional 0.05 zeds per newspaper you sell.

Question 3: SELLING NEWSPAPERS *PM994Q03*

John decides to apply for a newspaper seller position. He needs to choose the *Zedland Star* or the *Zedland Daily.*

Which one of the following graphs is a correct representation of how the two newspapers pay their sellers? Circle A, B, C or D.

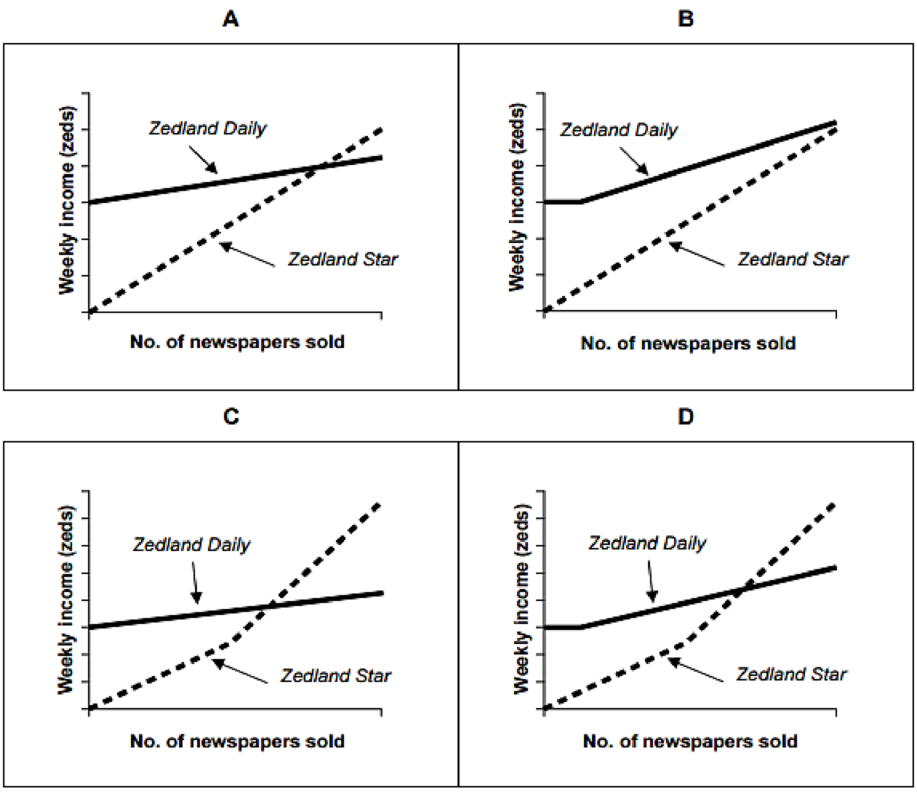


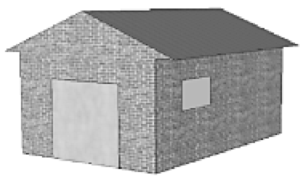
Figure 469: example PISA question on relationships and change (OECD , 2013)

UK students performed relatively badly in questions on space and shape, which include aspects of spatial visualisation which are not generally found in GCSE Mathematics courses. Skills in spatial visualisation are, however, important in a wide range of vocational contexts including construction, design and the operation of vehicle control systems. We would like to emphasise that mathematics is about the study of ***patterns***, rather than number. The patterns we study may be produced by numbers, but could equally well be produced by shapes. An example of a question testing spatial visualisation is given below:

GARAGE

A garage manufacturer's "basic" range includes models with just one window and one door.

George chooses the following model from the "basic" range. The position of the window and the door are shown here.

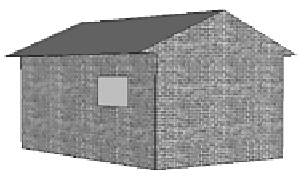


Question 1: GARAGE *PM991Q01*

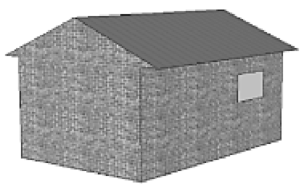
The illustrations below show different "basic" models as viewed from the back. Only one of these illustrations matches the model above chosen by George.

Which model did George choose? Circle A, B, C or D.

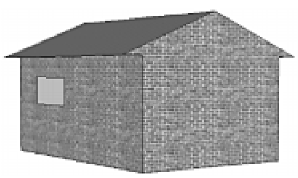
A



B



C



D

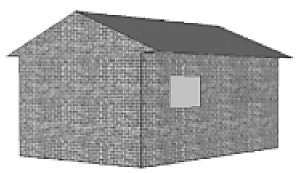


Figure 470: examples of a PISA mathematics question relating to spatial visualisation (OECD , 2013)

We would suggest that the PISA test identifies some areas of numeracy which are vocationally important, but are not adequately incorporated into existing assessment schemes in the United Kingdom.

Numeracy testing by employers and Universities

Some employers have lost confidence in GCSE Mathematics as a measure of an individual's mathematical knowledge and skills, or wish to make their own independent assessment of key mathematics needed for entry to vocational training. Organisations are increasingly using a range of numerical reasoning and calculation tests to evaluate their applicants' numeracy skills. Examples of test questions for nursing and midwifery applicants are given in figure 471.

Universities may try to attract particularly talented students by offering scholarships or bursaries towards the cost of study. These will often be awarded on the results of specialist examination papers, set by the university and requiring a higher level of problem solving and reasoning skills than the more routine A-level questions. An example problem from a chemistry scholarship exam is given in figure 472.

When students are entering the application process with an employer or university, it is important to be aware of any tests which may need to be taken, and the numeracy skills required in the test. Applicants should also determine beforehand whether the use of a calculator is permitted, as some employers wish to use their admission test to assess candidates' abilities to make calculations or estimates manually.

Question 10

A patient decreases in body weight from 50 Kg to 44 Kg over a 5 month period.

a) How much weight has she lost?

b) Calculate the average monthly weight loss in kg/month.

c) What percentage of her original body weight has she lost?

Florence Nightingale School of Nursing and Midwifery, King's College London

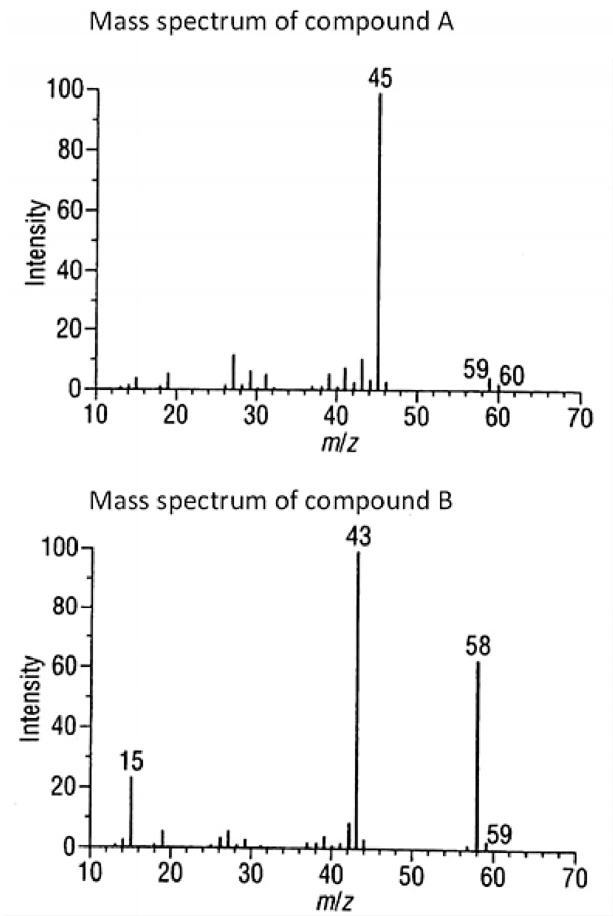
9. A patient is prescribed 250mg of the antibiotic Flucloxacillin every 6 hrs. Flucloxacillin is available as 125mg in 5 mls.

What is the maximum amount the patient should take in 24hrs?

a) 125mls b) 40mg c) 40mls d)20mls

Keele University, School of Nursing and Midwifery

Figure 471: examples of questions from entry tests for nursing and midwifery training



c. Draw a table to show the possible fragments and their masses (to the nearest whole number) in the mass spectrum of fluoromethane, CH_3F. (2 marks)

d. The most sensitive mass spectrometers can determine m/z values to 4 decimal places. The accurate molecular mass of a compound was found to be 43.9898. Use the following data to decide if the compound is CO_2 or C_3H_8. H = 1.0078; C = 12.0000; O = 15.9949. (2 marks)

Figure 472: example question from an Aberystwyth University scholarship exam in chemistry

Questions from past test papers set by employers and universities can provide a rich source of interesting and relevant numeracy examples within particular vocational areas.

Competitions

Competitions for trainees are arranged in a wide range of vocational areas, from cookery to construction, engineering and computer programming. Taking part in a competition can be highly motivating for the students, and can develop important numeracy skills in problem solving, careful measurement, spatial awareness and good communication of technical information.

Requirements for the carpentry competition at the 2012 Skills Show are given in the design drawings below, followed by photographs of the work produced by one of our students. He was given the set of plans for a timber construction, the materials and timed conditions of nineteen hours, over three days, to complete the structure. It was necessary to check the plan, calculate, measure, cut and assemble the materials. He was also, at various stages of the competition, questioned by the judges as to his methods – his communication skills were also part of the competition assessment.

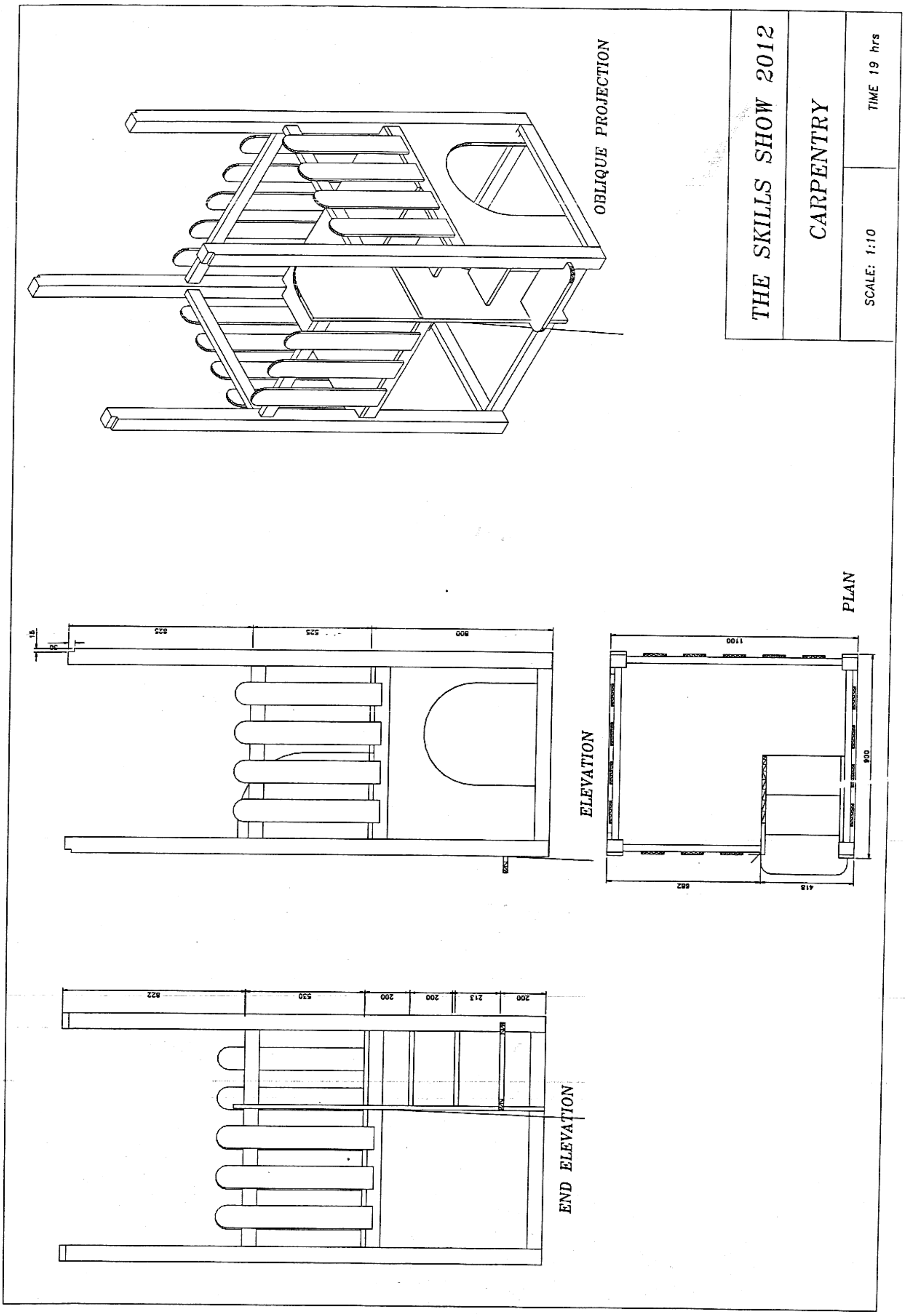


Figure 473: child's play structure, set as the test piece for the 2012 Skills Show carpentry competition

Figure 474: views of the completed child's play structure (Slaney, 2013)

Summary

In this chapter we have examined a number of ways in which vocational students might be assessed, both inside and outside of the formal national qualifications structure.

Huge changes have taken place recently in numeracy assessment, and it may take some years before the effectiveness of the changes are known fully. We therefore make the following preliminary observations:

- The requirement that all vocational students will be expected to achieve a grade C or above in Mathematics will be a major challenge. The introduction of the GCSE Mathematics-Numeracy examination will certainly help in this respect, but a number of weaker students are likely to become demotivated.
- The Mathematics modules within vocational courses, assessed by realistic workplace tasks, provide an excellent opportunity to develop numeracy skills.
- For academic students going on to study general A-levels, the level 3 Mathematical Studies qualification can be a valuable way of developing useful higher level skills in numeracy.
- The Essential Application of Number Skills qualification is now offered to a more restricted group of trainees. It is also unfortunate that the student project element of this award has been replaced by a set task, which may not be vocationally relevant or motivating for all candidates.
- We recognise the excellent opportunities for developing specialist numeracy which are provided by A-level individual projects in a range of subjects. It is hoped that project modules will be retained by the examination boards, and perhaps extended into additional subject areas.

For an effective assessment strategy, a number of components need to work together to create a course syllabus structure which is motivating for students through having relevance in their chosen vocational area. Numeracy tasks during the course need to be real or realistic simulations of workplace activities, providing students with opportunities to develop both their mathematical techniques and their wider numeracy skills in areas such as problem solving, measurement and working with information technology systems. At the core of the strategy must be a capacity to make fair assessments of the abilities of candidates. This all presents a major challenge to examination boards.