Resources to support the pilot of functional skills

Teaching and learning functional mathematics

Contents

General introduction

Preface

This resource has been prepared by the functional skills support programme for use in the 1000 centres that will be piloting functional skills from September 2007. These include schools, colleges, training providers, work-based learning, adult and community learning, and secure contexts. Functional skills will be piloted at all levels from Entry level to Level 2, and to learners aged from 14 upwards, including links with GCSE in the relevant subjects.

This resource is in four parts:

1. Managing delivery
2. Teaching and learning functional English
3. Teaching and learning functional mathematics
4. Teaching and learning functional Information and Communication Technology (ICT).

The aim is to offer support that will enable the reader to move forward with the implementation of the pilot for functional skills. It is expected that most specialist teaching staff (English, mathematics, ICT) and leaders/managers in the pilot centres will have had the opportunity to attend the CPD sessions organised by the functional skills support programme in June and July 2007, with follow-up sessions in October 2007 and February 2008.

Clearly, different practitioners, coming from different backgrounds, have very different areas of familiarity, interest and concern in relation to functional skills. An important aim of this material is to encourage common levels of understanding, so that teachers and leaders/managers coming from school, college, training provider, prison education and so on can develop a shared understanding, vocabulary and approach to functional skills that, while fit for each setting, have a common core.

It is important to understand two key points.

- This pilot is genuinely developmental, ie it is not expected that the pilot centres will ‘get it right first time’. Rather, supported by the functional skills support programme, by the awarding bodies, and by these and subsequent materials and resources, they will develop good practice and share experience during the three years of the pilot. This will inform the national roll-out of functional skills in 2010.
- These materials are about management, and about teaching and learning. It is not their role to give guidance on preparing learners for summative assessment, in whatever form or forms this will be piloted.

The functional skills support programme

Support for centres in the pilot will be available from the functional skills support programme, which is managed by the Quality Improvement Agency (QIA) and by the Secondary National Strategy (SNS), and from the awarding bodies.

QIA has contracted the Learning and Skills Network (LSN) to develop a range of support materials. See www.LSNeducation.org.uk/functionalskills

SNS will deliver support for workforce development. Initially, this support will be focused on those centres taking part in the functional skills pilots from September 2007. See www.standards.dfes.gov.uk

Other sources of information and support

DfES 14-19 website at www.dfes.gov.uk/14-19 Go to 'Qualifications' and then 'Getting the basics right: Functional skills'.

The QCA website at www.qca.org.uk/qca_6062.aspx has information about the functional skills standards and the pilot.

The Key Skills Support Programme has a continuing brief to provide centres with information about functional skills developments. See www.keyskillssupport.net

Many of the awarding bodies' websites have sections dedicated to functional skills.

Introduction

What are functional skills?

The DfES defined functional skills as:

> 'the core elements of English, mathematics and ICT that provide an individual with the essential knowledge, skills, and understanding that will enable them to operate confidently effectively and independently in life and at work.'
>
> *14-19 Education and Skills: Implementation Plan* (DfES, 2005a)

The origins of functional skills lie in the Tomlinson report on 14-19 reform (DfES, 2004) and in the government's response in the White Paper *14-19 Education and Skills* (DfES, 2005b). Tomlinson argued that it was possible for young people to achieve grade C and above in GCSE English and mathematics without having a satisfactory standard of literacy or numeracy. In the White Paper, the government promised a 'sharper focus on the basics' and to ensure that learners have a sound grounding in 'functional skills'.

Functional skills qualifications are therefore being developed in English, mathematics and ICT. The intention is that, in due course, functional skills qualifications will provide a single ladder of achievement from Entry to Level 3 that is available to all learners aged 14+ in all sectors.

A problem solving approach

A key characteristic of functional skills is that they are based on a problem solving approach. Learners who are 'functionally skilled' are able to use and apply the English/mathematics/ICT they know to tackle problems that arise in their life and work.

Clearly, teachers cannot know what English/mathematics/ICT their learners will use as they move through their lives. This means that we cannot identify a curriculum core that every learner will use. Instead, and much more powerfully, learners should be taught to use and apply the English/mathematics/ICT that they know, and to ask for help with the areas with which they are less confident.

It is essential to think of learners becoming functional in their English/ mathematics/ICT, rather than thinking that there is a vital body of knowledge, known as functional English/mathematics/ICT.

The implications for teaching and learning are significant and will need to be introduced gradually and thoughtfully, but they do not threaten aspects of existing good practice. Helping learners to become more 'functional' is supported by existing practices including:

- learning through application
- learner-centred approaches
- active learning and a problem-centred approach

- partnership learning
- assessment for learning.

Why are functional skills needed?

> 'Employers and educators have identified these skills as vital for enabling young people and adults to have the practical skills to succeed in further learning, employment and life in modern society.'
>
> *'Functional' skills – Your questions answered* (DfES, 2006a)

The introduction of functional skills, both into the 14-19 curriculum and for adult learners, is being driven by a number of social, educational and economic concerns. For example:

- Only 45% of school leavers achieve five A*-C GCSEs including English and mathematics.

  The 'need to give every child a good command of English and maths' is seen 'as the way to overcome economic and social disadvantage and make equality of opportunity a reality' for every child.

  Higher Standards, Better Schools for All (DfES, 2005c)

- Without functional skills, pupils would find it 'almost impossible to succeed' because of the difficulty they would have in accessing the secondary curriculum.

  2020 Vision (the 'Gilbert Review') (DfES, 2006b)

- Basic skill levels of those leaving school and seeking employment are inadequate.

  Working on the Three Rs (CBI, 2006)

- Functional skills are central to achieving the outcomes of 'Every Child Matters' (DfES, 2003), particularly:
  - enjoy and achieve
  - make a positive contribution
  - achieve economic well-being.

Functional skills for employability – the skills agenda

For the UK to remain economically competitive, the knowledge and skills base of the population must increase. Low post-16 participation rates mean that learners are not staying in learning to achieve the Level 2 (GCSE A*-C) benchmark that will lead them into employability.

A series of government publications and policies, particularly in the last five years, has emphasised the importance of these skills for employability and set what has become known as 'the skills agenda'. The 'Leitch Report' (2006) said:

> ‘In the 21st century, our natural resource is our people – and their potential is both untapped and vast. Skills will unlock that potential. The prize for our country will be enormous – higher productivity, the creation of wealth and social justice.’

Leitch identified the following skills as ‘applicable in most jobs’:

- literacy
- numeracy
- team working
- communication

and set targets to close the ‘skills gap’ by 2020, including:

- 95% of adults to achieve functional literacy and numeracy (three times the current projected rate of improvement – 7.4 million adult attainments)
- more than 90% of adults to be qualified at least to Level 2 – 5.7 million adult attainments
- 4 million adult Level 3 attainments
- half a million apprenticeships a year
- 40% of adults to be qualified to Level 4 and above.

Leitch was very clear that, while the focus of his report was on the skills of adults aged between 19 and 65, these targets will not be achieved unless they are underpinned by 14-19 education and training:

> ‘… the Review also recognises how vital effective education for young people is to the new ambition. School standards have improved over the past decade, with more young people than ever achieving five good GCSEs. And yet, more than one in six young people leave school unable to read, write and add up properly. The proportion of young people staying in education past 16 is below the OECD average. The Review emphasises how critical reforms to GCSEs are to improve functional literacy and numeracy. The new 14-19 Diplomas must succeed.’

The development of functional skills in schools and colleges will make a major contribution to meeting these targets.

World Class Skills: Implementing the Leitch Review of Skills in England was published in July 2007. It presents the Government’s response to the Leitch Review.

The same message comes from the Confederation of British Industry (CBI):

> ‘Weak functional skills are associated with higher unemployment, lower earnings, poorer chances of career progression and social exclusion… The time has come to ensure that school-leavers in future have the functional skills they need for work and daily life. In short, British business sees concerted action on functional skills as a key priority.’
>
> *Working on the Three Rs* (CBI, 2006)

This is not simply a matter of young people not being 'good at maths' or 'not being able to spell and punctuate'. While some may have these weaknesses, the real problem is that even those who can demonstrate the knowledge and understanding required by GCSE do not know how to use and apply their knowledge in practical work-based contexts; this is a problem of skills rather than of knowledge. As explained above, functional skills are not only about knowledge – they are about the use and application of English, mathematics and ICT in real contexts.

Functional skills in higher education

English, mathematics and ICT skills, and the ability to apply them in contexts, are critical to successful progression in education and training post-19. In recent years, many higher education institutions (HEIs) have highlighted the lack of these skills among school leavers. They have shown how weaknesses in these skills have a negative impact on retention and achievement in degree level courses. As a result, many HEIs have to provide remedial courses in these subjects, even to undergraduates who have good grades at GCSE. As with young people entering employment, this is not simply a matter of undergraduates being weak in English, mathematics and/or ICT. The problem is that even those who have achieved good grades at GCSE do not know how to use and apply their knowledge in practical contexts, whether these are in the humanities, the sciences, engineering, business, or the plethora of vocational degrees that are now available. Functional skills are designed to develop these applied skills.

Functional skills in everyday life

Official and unofficial reports dating back to the 19th century have identified poor standards of literacy and numeracy as a problem affecting not only the employability of individuals and the impact on the economy, but also the quality of people's lives in the broadest sense. Recent research from the National Research and Development Centre (NRDC), for example, has confirmed that people with poor levels of literacy and numeracy have poorer physical and mental health, live in lower standard accommodation, have higher rates of family breakdown, are more politically apathetic, are more likely to have been in trouble with the police, and have lower self-esteem. In recent years, the ability to cope with ICT, even at a very basic level, has become necessary for people to operate effectively in everyday life.

Functional skills are therefore:

- central to the success of the reforms in 14-19 education and training and to the 'skills agenda'
- crucial for the personal development of all learners aged 14 and above
- needed for degree level study
- a platform for the development of employability skills
- fundamental to tackling the skills gap in England.

How are functional skills being developed?

The standards

QCA has developed draft standards for functional English, mathematics and ICT at Entry levels 1, 2 and 3, Level 1 and Level 2 (QCA June 2007). Figure 1 shows how these levels relate to the National Qualifications Framework.

Figure 1

Functional skills levels	National Qualifications Framework levels	Examples of qualifications at each level
Entry 1	Entry	▪ Adult Literacy and Numeracy certificates
Entry 2		
Entry 3		
Level 1	1	▪ GCSEs grades D-G ▪ Level 1 Key Skills ▪ Level 1 Certificates in Adult Literacy and Numeracy ▪ Level 1 NVQ
Level 2	2	▪ GCSEs grades A*-C ▪ Level 2 Key Skills ▪ Level 2 Certificates in Adult Literacy and Numeracy ▪ Level 2 NVQ ▪ BTEC First
Level 3 (NB standards not yet drafted)	3	▪ AS and A levels ▪ Level 3 Key Skills ▪ Level 3 NVQ ▪ BTEC National

It is important to recognise that the 'levelness' of a functional skill is determined by a combination of factors:

- the complexity of the situation or problem the learner is tackling
- the familiarity to the learner of the situation or problem
- the technical demand of the skill required
- the independence of the learner in identifying and selecting the skills they will need, and in tackling the situation or problem.

A learner who is 'functional' in mathematics, English and/or ICT is able to consider a problem or task, identify the functional mathematics, English and/or ICT skills that will help them to tackle it, select from the range of skills in which they are competent (or know what help they need and who to ask), and apply them appropriately. This interplay of the four factors means, for example, that tackling a complex problem in a situation with which a learner is unfamiliar but that requires relatively undemanding English/mathematics/ICT skills may involve a higher level of 'functionality' than a relatively straightforward task in a familiar context that requires more advanced 'subject' skills. It is the combination of the four factors that confirms the functional skill level.

Following extensive consultation in 2005/06, small-scale trials of the draft standards were carried out in 2006/07. The resulting revised standards are being piloted by the awarding bodies from autumn 2007.

The focus of the draft standards is on:

- the application of transferable, practical skills underpinned by knowledge and understanding
- enhancing current GCSE provision
- offering a single ladder of achievement and progression with each level incorporating and building on the level/s below.

The draft standards:

- set out the expected knowledge, understanding and skills as well as their scope and level of demand
- are not detailed curricula or schemes of work
- do not set out models of assessment.

Details of how to 'read' the standards in each functional skill subject are included in the appropriate part of this publication.

Standards are, of course, only the first stage in developing qualifications. When they are finalised, QCA works with the awarding bodies to develop the assessment methods and the qualifications.

Assessment

The assessment regime for functional skills will influence:

- models of delivery
- approaches to teaching and learning
- learner motivation and engagement
- continuing professional development (CPD).

The assessment methods for functional skills qualifications must be fit for purpose across a wide range of learners in a wide range of contexts. It may be that no one method will be appropriate to all settings.

During the pilot, 12 awarding bodies will pilot a range of models of assessment. QCA has produced three documents, one for each functional skills subject, entitled 'Assessment arrangements and principles for pilot'. These documents define the parameters within which the awarding bodies will develop assessment models and materials for functional skills qualifications during the pilot. These models and materials will be accredited by QCA. Many of the principles are common to all three functional skills, including:

- the assessment can be entirely task-based, or a combination of tasks with test-style items
- the assessment should not be entirely test-based
- assessment items may be externally set by an awarding body or requirements may be externally set and provide for internally contextualised task-based assessments
- assessment is of the candidate's own ability to solve a problem or reach an outcome by independent application of skills.

For details of assessment, you should contact your awarding body.

The pilot

What has been learned from the trials of the standards and the approaches to assessment will inform the certificated pilots that run for three years from September 2007 (ie, candidates in these pilots can be awarded a functional skills certificate). These will involve approximately 1000 centres, most of whom will be schools but also including colleges, training providers, work-based provision, adult and community settings and secure settings.

From 2008, functional skills will be piloted within the first phase of Diplomas. Some 800 of the pilot centres are also piloting the Diploma (having passed through the 'Gateway'). They will therefore pilot all three functional skills. The other centres have been identified by QCA and the awarding bodies and may pilot one, two or all three functional skills.

Timelines

Start date	
September 2007	Three-year pilot (approximately 1000 centres) of functional English, mathematics and ICT in a range of contexts, including stand-alone.
September 2008	All three functional skills trialled within the first tranche of Diplomas (construction and the built environment, creative and media, engineering, society health and development, IT).
September 2010	Functional English, mathematics and ICT available nationally.

Where do functional skills fit in the 14-19 reform programme?

Functional skills are at the core of the 14-19 reform programme.

The key features of the reform programme are:

- a strengthened core – functional skills
- the Foundation Learning Tier
- revised GCSEs (from 2010)
- revised AS and A levels (from 2008)
- new Diplomas (from 2008)
- age 16 no longer a fixed point
- a new 'extended project' qualification at Level 3
- personalisation of learning.

'… passing these functional skills qualifications will be a requirement for achieving a C or better in GCSE English, maths or ICT. Young people will therefore have to master the functional skills in order to achieve a… Diploma or an apprenticeship.'

White Paper *14-19 Education and Skills* (DfES, 2005)

In effect, therefore, achievement of functional skills will be a requirement for all 14-19 learners.

Key Stage 3

Level 1 functional skills will be embedded in the programmes of study for English, mathematics and ICT at Key Stage 3.

Clearly, success at 14-19, and hence the success of the reforms as a whole, depends on establishing firm foundations at Key Stage 3. Hence, the emphasis on functional skills starts with reform of the Key Stage 3 curriculum and programmes of study.

QCA is currently reviewing what pupils learn at Key Stage 3 by revising the national curriculum programmes of study in order to provide:

- greater flexibility
- improved coherence
- increased personalisation.

One of the aims of the revised curriculum is to develop successful learners who possess 'the essential learning skills of literacy, numeracy and information and communication technology'.

> 'Individuals at any age who possess these skills will be able to participate and progress in education, training and employment as well as develop and secure the broader range of aptitudes, attitudes and behaviours that

will enable them to make a positive contribution to the communities in which they live and work.'

www.qca.org.uk/secondarycurriculumreview/

Key Stage 4

Level 2 functional skills will be embedded in the programmes of study for English, mathematics and ICT at Key Stage 4.

The functional skills standards are being incorporated into the revised GCSE criteria for English, mathematics and ICT.

While delivery of the underpinning knowledge and understanding is likely to remain the responsibility of specialist GCSE teachers, functional skills will only become transferable when they are embedded across the curriculum. All staff will need to raise their awareness of the relevance of these skills and support learners in applying them in their subject areas.

Every Child Matters (DfES, 2004) includes outcomes that require schools and other providers to focus on employability. These skills are developed at Key Stage 4 through work-related learning and enterprise education. Functional English, mathematics and ICT will provide learners with a platform on which to develop these wider employability skills.

The functional skills qualifications will therefore be:

- available as **free-standing qualifications** for learners aged 14 and over
- linked to the revised GCSEs in English, mathematics and ICT that will be available nationally from 2010. To achieve a grade C or above, candidates will have to achieve the relevant functional skill at Level 2. During the pilot, candidates who achieve the GCSE standard but do not reach the required level in the functional skill will still receive the GCSE award
- a mandatory component of the new **Diplomas**. The Diplomas are a key area of the reforms set out in *14-19 Education and Skills* (DfES, 2005b). They are employer-led qualifications, designed to offer young people a motivating and relevant learning experience through a high quality programme that combines general education with applied practical learning.

  They are intended for young people of all abilities and backgrounds and will offer clear routes for progression, whether to further or higher education or to skilled employment. At each stage of their learning, learners will be able to move from the traditional routes of GCSE/A level and vocational programmes to the Diploma, or vice versa, as well as across Diploma lines.

  The Diplomas will extend learners' employability skills through a range of assessed learning and development activities that include:

  - a focus on a particular economic sector

- a mandatory functional skills component
- personal learning and thinking skills (PLTS)
- work experience.

The qualifications are being developed jointly by the DCSF, QCA and the Skills for Business Network. Diploma Development Partnerships (DDPs), who represent employers, further and higher education, schools and awarding bodies, are responsible for developing the content.

The Diplomas are being developed in 14 lines of learning which will be introduced in three phases between September 2008 and September 2010.

'Generic learning' is a mandatory component of all the Diplomas and includes:

- functional skills in English, mathematics and ICT
- personal, learning and thinking skills (these link closely to the key skills of Working with Others, Improving Own Learning and Performance, and Problem Solving. It is expected that these key skills qualifications will continue to be available)
- work experience
- a project (extended at Level 3).

Achievement of all three functional skills at the appropriate level is therefore a requirement for gaining a Diploma:

Diploma level	Functional skills level
Foundation	Level 1
Higher and Advanced	Level 2

The Diplomas will be delivered by collaborative local partnerships which will involve a consortium of providers (including schools and colleges). To ensure high quality provision, these partnerships have been required to pass through a 'Gateway' process to confirm their readiness to deliver the Diploma from 2008.

The full specifications for the first five Diplomas will be available to centres by September 2007.

Foundation Learning Tier

The Foundation Learning Tier (FLT) is the umbrella term for all provision below Level 2 that is taken by learners over the age of 14 (ie it includes adult learners). It therefore encompasses what is currently categorised as pre-Entry, Entry level (split into Entry levels 1, 2 and 3) and Level 1.

Phased implementation of the FLT began in August 2007, with an increasing number of providers due to introduce learning programmes until a full complement is reached in 2010.

Learning programmes in FLT will draw on three curriculum areas: personal and social development, vocational/subject-based learning, and key and basic skills. The functional skills, once developed, will replace the key and basic skills.

For details about the Foundation Learning Tier, see www.qca.org.uk/flt.

Apprenticeships

Although final decisions have not yet been made about the role of functional skills in apprenticeships, the expectation is that they will replace key skills Communication, Application of Number and ICT at Levels 1 and 2. Level 3 key skills and the wider key skills are likely to remain in frameworks, or could be introduced.

It is anticipated that key skills and Skills for Life will continue to be available for registration until 2010.

Resources

Functional skills standards: mathematics

The standards (June 2007 version: QCA/07/3166) can be downloaded from the QCA website at www.qca.org.uk/qca_6006.aspx

Amplification of the functional mathematics standards (QCA)

This document gives fuller explanations of the standards, explains relevant terminology, and includes progression tables and a glossary. Available from QCA.

Functional skills mathematics exemplification (QCA)

This gives some examples of purposeful activities for developing learners' functional mathematics. Available from QCA.

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Teaching and learning functional mathematics

Overview

'Teaching and learning functional mathematics' is intended to support teachers of mathematics as they prepare courses that lead to qualifications that include functional mathematics. There are six sections.

The first section, the Introduction, sets out what functional mathematics is, what is expected to change as a result of the Government's vision for functional mathematics, and how teachers should use the Qualifications and Curriculum Authority (QCA) document: *Functional skills standards: mathematics* (version dated June 2007).

The second section, 'The problem solving process', describes how to introduce the problem solving process into mathematics lessons. It provides users with guidance on how to teach through problems so that learners can become more functional in their mathematics. It includes many examples of suitable problems.

'Writing your own contextualised activities', the third section, gives strategies for building your own activities to support learners in becoming more functional in using their mathematics. It explains and exemplifies how to devise and use activities that are based in real-world contexts. This will help teachers to promote motivation in their learners by increasing the relevance and authenticity of the tasks they devise.

The fourth section, 'Cross-curricular activities', gives examples of a range of suitable activities that are set in a wide range of contexts and can be used or adapted to support the problem solving process.

This is followed by a section called 'Assessment, progression and mastery' that sets out how teachers should assess their learners' progress in functional mathematics. This section considers how to assess process skills and how to use the QCA standards to support work in this area.

The final section, 'Resources' lists a large number of relevant resources and sources of information.

1. Introduction

Contents

1.1 What is functional mathematics?

The generic definition of functional skills given by the DfES notes that functional skills will:

> 'provide an individual with the essential knowledge, skills and understanding that will enable them to operate confidently, effectively and independently in life and at work. Individuals of whatever age who possess these skills will be able to participate and progress in education, training and employment as well as develop and secure the broader range of aptitudes, attitudes and behaviours that will enable them to make a positive contribution to the communities in which they live and work.'

The vision described is of learners:

- developing the practical applied skills needed for success in work, learning and life
- tackling the skills gap, improving productivity, enterprise and competitiveness
- becoming more confident in their studies in further and higher education
- becoming more confident in interaction with people in their lives.

Functional mathematics will contribute to this agenda. Learners who are functional in mathematics are able to use and apply the mathematics they know to address problems that arise in their life and work.

1.2 The vision for functional mathematics

The introduction to *Functional skills standards: mathematics* states that:

> 'The term *functional* should be considered in the broad sense of providing learners with the skills and abilities they need to take an active and responsible role in their communities, in their everyday life, workplace and in educational settings. Functional mathematics requires

> learners to be able to use mathematics in ways that make them effective and involved as citizens, able to operate confidently in life and to work in a wide range of contexts.
>
> The aim of the mathematics standards is to encourage people to demonstrate their mathematical skills in a range of contexts and for various purposes. They are essentially concerned with developing and recognising the ability of learners to apply and transfer skills in ways that are appropriate to their situation.'

It is important to recognise that all mathematics can be used in these ways, and that teachers cannot know what mathematics their learners will use as they move through their lives. This means that we cannot identify a curriculum core that every learner will use. Instead, and much more powerfully, learners should be taught to use and apply the mathematics that they know and have learned, and to recognise when they need to develop additional skills.

It is essential to think of learners becoming functional in their mathematics, rather than thinking there is a vital body of mathematical material, known as functional mathematics.

1.3 Teaching functional mathematics

For teachers, helping learners to become functional in mathematics means helping them to:

- recognise situations in which mathematics can be used
- make sense of these situations
- describe the situations using mathematics
- analyse the mathematics, obtaining results and solutions
- interpret the mathematical outcomes in terms of the situation
- communicate results and conclusions.

This will mean that learners should experience sessions that have a significantly new emphasis and focus on problems of sufficient scope to permit these processes to flourish. Learners need to demonstrate the ability to use and apply straightforward mathematical skills in complex contexts. This is different from much mathematics teaching in which learners often use challenging mathematics in very simple contexts, or entirely out of context.

The problems that learners meet in sessions with this new emphasis may sometimes be complicated and extensive. If this is the case, the problems will need to be solvable using mathematics that the learners have already encountered some time before.

It is important that learners are not told, at the time a problem is set, which of the mathematical tools they have at their disposal will actually be needed.

Selecting the right tools is a core aspect of becoming functional in mathematics.

The problems should also be plainly relevant to learners, appealing to them by being motivating, interesting and realistic. Mathematics teaching should reveal how mathematics is used in life, enabling learners to gain experience of the breadth of applications of the subject. It is important for specialist mathematics teachers to liaise with colleagues to identify and maximise the opportunities to embed functional mathematics in other curriculum areas.

Part of the push towards relevance and motivation depends on making the use of ICT integral to teaching and learning mathematics. When encouraging learners to become functional in mathematics, ICT should be given an important role that reflects its significance in life and in the workplace as well as its potential to enhance and motivate mathematics learning. Indeed, it is good practice to give learners opportunities to use all three functional skills when tackling problems, as is often the case in real life.

The implications for teaching and learning of the features of functional mathematics described above are significant. They will need to be introduced gradually and thoughtfully but they do not threaten aspects of existing good practice. 'Teaching and learning functional mathematics' sets out some of the ways in which making adjustments to help learners become more functional in mathematics is supported by existing practices including:

- learning through application
- learner-centred approaches
- active learning and a problem-centred approach
- partnership learning
- assessment for learning.

1.4 How to read the standards

Functional mathematics standards have been issued for the first three levels of the National Qualifications Framework – Entry level, Level 1 and Level 2. As usual, Entry level is subdivided into Entry 1, Entry 2 and Entry 3 to reflect the importance of small incremental steps in learning for learners at these levels. For ease of reference, Entry 1 is broadly comparable in demand with National Curriculum level 1, Entry 2 with National Curriculum level 2 and Entry 3 with National Curriculum level 3. Level 1 is comparable with GCSE grades D-G and Level 2 is comparable with GCSE grades A*-C.

The standards are set out in a single document, published by QCA. After a brief introduction, the document sets out the standards in two sections. The first and most important section sets out the underpinning process skills that make it clear what learners have to do to demonstrate that they are functional

in mathematics. The second section indicates ways in which performances at the various levels can be differentiated.

The process skills are fundamental to the standards for mathematics, and do not change as learners progress through the levels. They are the principal learning targets for functional mathematics and are set out in three columns – Representing, Analysing, Interpreting – each with a number of bulleted statements. (See Figure 1.1, page 25.)

These learning targets are not to be interpreted as three distinct areas of study, nor are the bulleted statements separate statements of attainment, to be ticked off as each is achieved. On the contrary, the three column headings and the individual bulleted statements in the process skills must be interpreted as describing aspects of a single larger process. That process, which is akin to problem solving, is the process of being functional in mathematics.

It is helpful to think about how far the mathematics lessons you currently teach or observe focus exclusively on the analysing aspect of the process skills. This can easily happen when there is pressure to teach many mathematical techniques in a limited time. In functional mathematics, it is very important for learners to experience the need to decide for themselves whether a problem can be addressed using mathematics, what mathematics might help, and how the problem should be set out mathematically (represented). An example of such a problem is to find a way to help someone who lives in a town to visualise the size of an acre or a hectare.

It is also important for learners that they are asked what the mathematical solution means in terms of the initial situation. This is what is meant by ‘interpreting the solution’. For example, the calculation $30 \div 4 = 7.5$ is interpreted quite differently when deciding how many four-seater cars are needed to transport 30 people from the way it is interpreted when deciding how many sweets each of four people can have from a bag of 30 sweets, shared equally. Employees in the workplace will frequently be required to provide a mathematically clear account of how a solution was found and interpreted.

Figure 1.1 The process skills

Representing Making sense of situations and representing them	**Analysing** Processing and using the mathematics	**Interpreting** Interpreting and communicating the results of the analysis
A learner can: • recognise that a situation has aspects that can be represented using mathematics • make an initial model of a situation using suitable forms of representation • decide on the methods, operations and tools, including ICT, to use in a situation • select the mathematical information to use	A learner can: • use appropriate mathematical procedures • examine patterns and relationships • change values and assumptions or adjust relationships to see the effects on answers in the model • find results and solutions	A learner can: • interpret results and solutions • draw conclusions in the light of the situation • consider the appropriateness and accuracy of the results and conclusions • choose appropriate language and forms of presentation to communicate results and conclusions

1.5 Level differentiation

The second section of the standards ('Level differentiation') describes performance at the different levels. It begins by listing ways in which problems that can be solved using mathematics can differ in their demands on learners. The four features identified are:

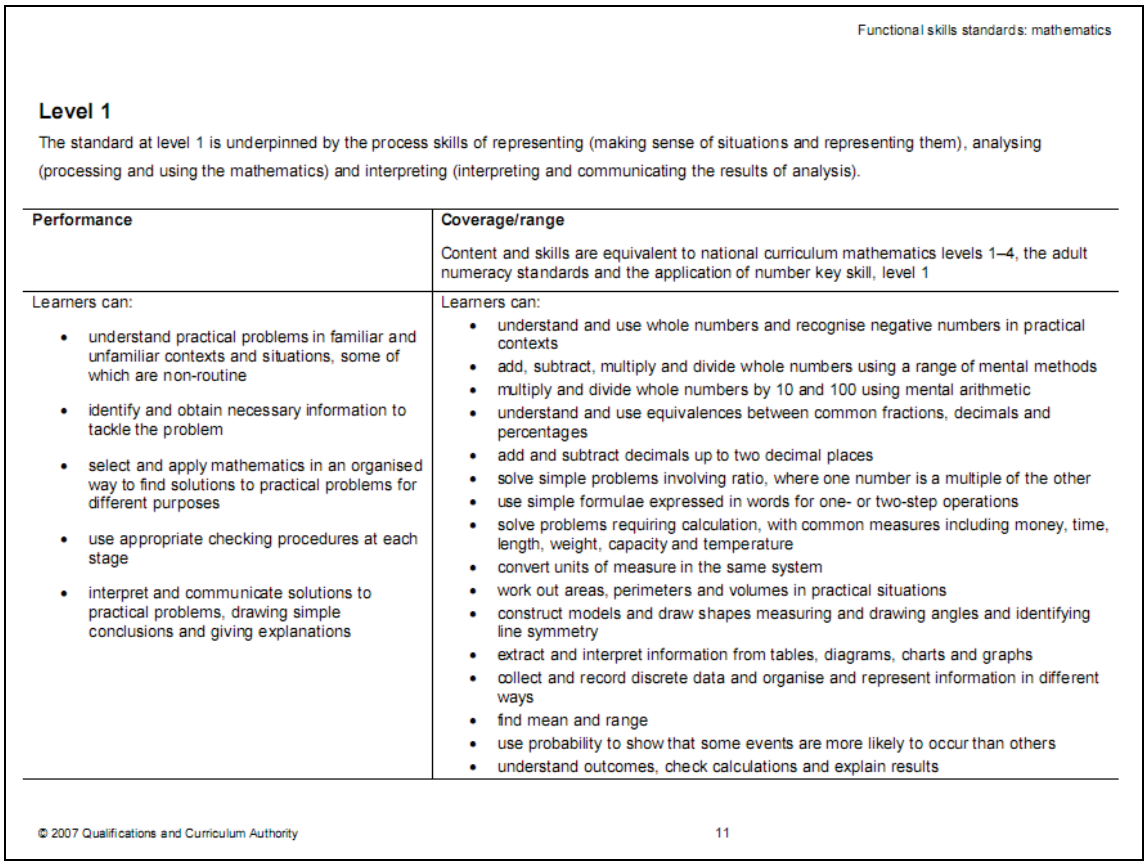
- the complexity of the situation or problem
- the familiarity to the learner of the situation or problem
- the technical demand of the mathematics required
- the independence of the learner in tackling the situation or problem.

These four features of problems could be regarded as dimensions of difficulty. Plainly, a more complex situation will be more challenging to understand and represent mathematically. Conversely, a learner given extra support will find a problem more approachable. In many mathematics lessons the focus is on mathematical techniques, and the difficulty of the techniques determines the difficulty of the work. In functional mathematics, however, it is important to recognise that many real-world problems are complex and unfamiliar. Dealing

with such problems could become too challenging if the technical demand of the mathematics were also at the limit of the learner's capability.

In this second section of the standards, there is a page for each level. These pages give information about performance and coverage/range, and contribute to describing performance at a particular level. Figure 1.2 shows this for Level 1.

Figure 1.2



Functional skills standards: mathematics

Level 1

The standard at level 1 is underpinned by the process skills of representing (making sense of situations and representing them), analysing (processing and using the mathematics) and interpreting (interpreting and communicating the results of analysis).

Performance	Coverage/range
	Content and skills are equivalent to national curriculum mathematics levels 1–4, the adult numeracy standards and the application of number key skill, level 1
Learners can: • understand practical problems in familiar and unfamiliar contexts and situations, some of which are non-routine • identify and obtain necessary information to tackle the problem • select and apply mathematics in an organised way to find solutions to practical problems for different purposes • use appropriate checking procedures at each stage • interpret and communicate solutions to practical problems, drawing simple conclusions and giving explanations	Learners can: • understand and use whole numbers and recognise negative numbers in practical contexts • add, subtract, multiply and divide whole numbers using a range of mental methods • multiply and divide whole numbers by 10 and 100 using mental arithmetic • understand and use equivalences between common fractions, decimals and percentages • add and subtract decimals up to two decimal places • solve simple problems involving ratio, where one number is a multiple of the other • use simple formulae expressed in words for one- or two-step operations • solve problems requiring calculation, with common measures including money, time, length, weight, capacity and temperature • convert units of measure in the same system • work out areas, perimeters and volumes in practical situations • construct models and draw shapes measuring and drawing angles and identifying line symmetry • extract and interpret information from tables, diagrams, charts and graphs • collect and record discrete data and organise and represent information in different ways • find mean and range • use probability to show that some events are more likely to occur than others • understand outcomes, check calculations and explain results

The 'Performance' part gives an illustration of what teachers may expect of learners in relation to the issues of complexity, familiarity and learners' independence at the level. The performance statements should be regarded as indicating one way among many possible ways in which the difficulty of a problem may be expressed at the relevant level. A different problem with greater complexity but involving less independence, for example, could be of equivalent difficulty.

The 'Coverage/range' part indicates the technical demand of the mathematical skills and techniques that are likely to be used by learners performing at that level. The curriculum that may be relevant is not set out in full but is indicated by the references below the heading. These state that the listed content and skills should be regarded as equivalent to particular levels of the National Curriculum, the related adult numeracy standard, and the related application of number key skill standard (levels 1 and 2 only). The coverage/range

statements indicate some of the mathematical skills and techniques that are likely to be used by learners performing at that level. They are not a complete list, so other skills and techniques from the overall curriculum are equally valid for learners to use in achieving the level. It is vitally important that teachers do not regard the coverage/range statements as the list of skills and techniques that learners must show they can use to achieve mastery at the level.

Rather, mastery of the level must be judged in relation to the process skills. Learners must have demonstrated a sufficient grasp of the whole process at any level to be regarded as working at that level. The performance and coverage/range statements can be used to give teachers confidence that the problems solved by learners were of sufficient demand to describe their performance as achieving a particular level. There is more information about this in section 5, ‘Assessment, progression and mastery’ (page 111).

2. The problem solving process

Contents

This section is designed to help you develop your learners' problem solving skills. The ideas are built around functional skills but they can be applied to any aspect of mathematics at any level. The more experience learners have of working in this way, the better they will become at reflecting and thinking critically about their work. They are also likely to improve their learning across the mathematics curriculum and to develop more positive attitudes to the subject.

Mathematical problems require decisions to be made about the mathematics needed and the strategies to be used. Problems come in all shapes and sizes from single-stage closed textbook questions to open-ended investigations. The context can be purely mathematical or can be taken from real life, including contexts from other subjects. All have their challenges but if learners only experience textbook-style questions that are based on one topic and a method that has recently been taught, they will struggle to tackle problems that require the process skills of functional mathematics.

To be able to tackle problems that are more open-ended, learners need to ask questions about the context of the problem, for example: What is this telling me? Would it make any difference if…? They should be able to sort and organise information, including deciding what is relevant and what is redundant by seeing the problem and solution as a whole rather than as a lot of small pieces. This will encourage learners to look for and spot patterns and relationships, and generalise from them where appropriate.

Learners have to realise that there is not necessarily one correct way of tackling a problem and not necessarily only one correct answer to a problem. Choices have to be made but they need to be justified.

This section includes a range of ideas and activities that will encourage learners to develop these skills. They are not written as stand-alone sessions but as ideas to incorporate into 'normal' teaching and learning. They can be adapted for different levels and different topics. Some examples have been included to illustrate how this can be achieved, although it has not been possible to include the whole range of possible contexts and settings. The activities start by moving standard textbook problems from a very closed context into a more open one and encouraging learners to ask questions. Learners consider a range of appropriate contexts in which mathematics may be used, thus helping them gain ownership over the mathematics.

The activities are most effective when learners are working in pairs or groups. This encourages discussion, thinking and explanation. Explaining to others focuses the learner's attention on the various features of the problem that influence its difficulty. This in turn helps learners to explore the situation more fully. The problems can be solved collaboratively using large sheets of paper and coloured felt-tipped pens so that all learners in the group are encouraged to be involved in a creative way.

Note: For a detailed discussion of this approach to teaching mathematics, see 'Improving learning in mathematics: challenges and strategies'. This is included in *Improving learning in mathematics* (the 'Standards Unit box') published by the DfES in 2005 and available from QIA. For details, see section 6, 'Paper-based materials', page 131.

2.1 Why a problem solving approach is especially relevant to functional mathematics

As explained in the Introduction, helping learners to become functional in mathematics means helping them to:

- recognise situations in which mathematics can be used
- make sense of these situations
- describe the situations using mathematics
- analyse the mathematics, obtaining results and solutions
- interpret the mathematical outcomes in terms of the situation
- communicate results and conclusions.

Learners will need to experience lessons with an emphasis on activities that have sufficient scope to permit all these processes to flourish. A problem solving approach permits learners to develop all the process skills in *Functional skills standards: mathematics*, because these process skills are, essentially, problem solving skills. Preparing learners in functional mathematics means helping them to develop problem solving process skills.

For mathematics, this is likely to involve considerable change in the curriculum for many learners. This is because many teachers concentrate on ensuring that their learners have been introduced to all the curriculum content (thus addressing the skill that the standards call 'analysing') without the 'representing' and 'interpreting' skills, and many examinations such as GCSE mathematics reward such an approach by giving little credit for representing and interpreting.

However, in the world outside mathematics lessons, we rarely know at the time a problem is posed whether or how mathematics will help solve it and, if so, what mathematics is needed. To solve problems in the wider curriculum, in life and in the workplace it is often necessary to go through the processes outlined in the standards.

Being functional in mathematics requires learners to demonstrate that they can represent situations using mathematics and interpret mathematical results in terms of the original situation. These process skills are best developed by learning to deal with substantial problems.

'Representing' is about being able to describe a situation mathematically. Some problems are represented by very commonplace methods, such as addition. This kind of representation can become so natural that we no longer notice ourselves deciding to use it. There are situations, however, that require more complicated representations, such as the following problem about chocolate eggs.

> Mrs Newman has five children.
> Three of them are girls. Two of them are boys.
> The children buy chocolate eggs to give to each other.
> Each girl gives each boy a red egg.
> Each boy gives each girl a yellow egg.
> Each girl gives each of the other girls a blue egg.
> Each boy gives each of the other boys a green egg.
>
> 1. How many eggs of each colour do the children buy?
> Show how you get your answer.
>
> The children who live next door use the same rules for giving eggs.
> They buy 8 red eggs, 8 yellow eggs, 2 blue eggs and 12 green eggs.
>
> 2. How many girls and how many boys live next door?
> Show how you get your answer.

(Problem designed by Rita Crust and the MARS/Shell Centre team at the universities of Nottingham and Durham. Published in *Developing problem solving – representing: using diagrams, tables and graphs* (2005) nferNelson, ISBN 0-7087-1490-0)

The 'Solving the eggs' problem requires an approach to representing the information that is likely to be unfamiliar to almost all learners. Learning to deal with this kind of challenge is essential to becoming functional in mathematics.

However, even after the relationships in the problem have been clarified and represented, and the mathematical problem has been solved, the answer has still not been found. This final stage requires learners to interpret their work so that the mathematical result can be expressed in terms of numbers of eggs and numbers of girls and boys.

Similarly, learners will need to become experienced in thinking about the mathematics they need to use to solve a problem. This can be illustrated by a simple example that includes three problems.

> Joe buys a six-pack of cola for £3 to share among his friends. How much should he charge for each bottle?
>
> If it takes 40 minutes to bake five potatoes in the oven, how long will it take to bake one potato?
>
> If King Henry VIII had six wives, how many wives had King Henry IV?

In current curricula, all the problems in a typical chapter on proportional reasoning will be like the first one listed; the learner does not have to choose an appropriate mathematical model. For mathematics to be functional it must include a substantial amount of modelling.

(Adapted from: Burkhardt, H., Bell, A., Pead, D. and Swan, M. (2006) *Making functional mathematics happen*, p. 14. Nottingham: Shell Centre Publications)

In all the examples in this section, learners are required to think for themselves. This is an experience that will stand them in good stead when they come across problems in the wider curriculum, in life or in the workplace and decide that a mathematical approach is needed.

2.2 Asking questions

This approach takes standard textbook or practice questions and requires learners to think beyond the question and its answer – they have to focus on the context of the question and investigate that. This kind of activity is about making sense of situations and representing them, as well as processing and using mathematics.

After learners have answered the original question, they could be asked ‘What other questions could be asked about this situation?’. These ideas can be collated and discussed by the group before being answered. Alternatively, specific questions could be asked first and then followed by the further question.

Question 1

It takes 1.75 metres of denim to make a pair of jeans. Denim costs £3.50 per metre.

(a) How much will the material for the jeans cost?

(b) If the price of denim rises by 5%, how much will the material cost?

What other questions could you ask about this situation?

- If the denim can only be bought in an exact number of metres, how much extra will you pay for the denim you do not use?
- How many pairs would you need to make to ensure that there is no wastage of denim?
- What is inflation at the moment? What would happen if you used that figure instead of 5%?
- How much discount would you need to get the price back to where it was before the price increase?
- What would the discount need to be if the increase was 10%, or 20%?
- Can you generalise from these examples?
- The actual price of the jeans is double the cost of the denim because of trimmings, labour and profit. How much will the maker charge for the jeans?
- Would you ever choose to have jeans especially made for you? If so, why, and if not, why not?
- How do you decide where to buy your jeans?

Question 2

Jenny goes shopping and buys two CDs priced at £6.99 each and three T-shirts costing a total of £13.50. She took £40 with her into town.

How much change will she have from her purchases?

What other questions could you ask about this situation?

- How much was each T-shirt? How do you know? Give some examples of possible prices.
- Is she likely to come home with all her change?
- How did she get home?
- What else might she spend her money on?

- Estimate her other expenditure.
- What would you spend the money on if you took £40 into town on Saturday?

Question 3

The monthly charge for a mobile phone is £25. This includes 300 minutes of free calls. After that there is a charge of 5p per minute.

Calculate the cost of using the phone for 540 minutes in one month.

What other questions could you ask about this situation?

- What other information would you want to know about the charges for this phone before you decide to buy it?
- What difference is it likely to make to the bill if calls after 6.00 pm are only 3p per minute?
- What is the method of payment of your mobile phone? (If you have not got a phone, ask a friend about theirs.)
- Would you consider changing to the phone in the question? Explain your reason.
- Why do some people have 'pay as you go' but others have a monthly rental?

Question 4

Claire wants to record four programmes on a video tape that is three hours long. The lengths of the programmes that she wants to record are 30 minutes, 45 minutes, 50 minutes and 40 minutes.

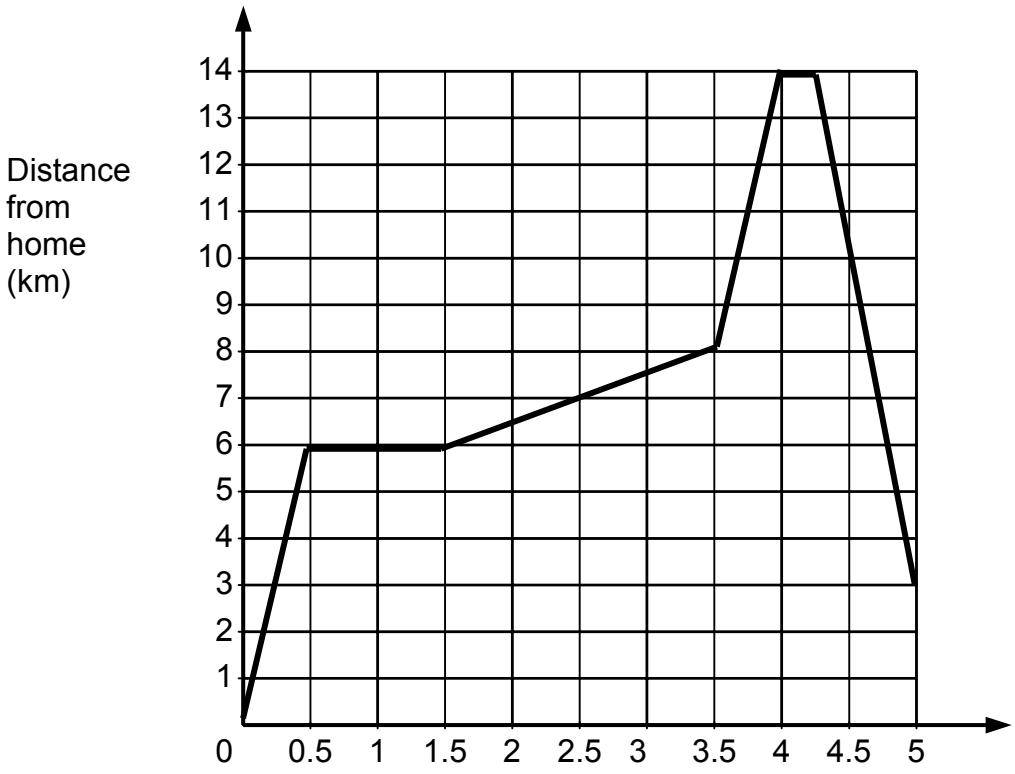
How much time will she have left on her tape when she has recorded them?

What other questions could you ask about this situation?

- What do you think the programmes are?
- How much of the time do you think is adverts?
- If Claire started watching the video at 6.00 pm when will she finish watching?
- What time do you think she will finish if she uses fast-forward when the adverts are on?
- What programmes would you like to record this week? How long will they last altogether?

Similarly, if a problem involves a graph as the solution or as part of the problem, learners can ask questions about the graph.

Question 5



Andrew sets off on a cycle ride as shown on the graph above. What is his average speed for the whole journey?

What other questions could you ask about this situation?

- Where did he fall off his bike?
- What happened at the end? Why do you think he did not go home?
- When was he riding at his fastest?
- Why do you think he was going fast on this part of the journey?
- What could have been happening after 3½ hours of the ride?
- Describe the whole journey in words.
- How would the graph have been different if he had got a puncture somewhere and had to walk the rest of the way?
- How could you change the graph so that his average speed is 4 km h^{-1}? Or 6 km h^{-1}?

- Is the graph realistic? If not why not? What assumptions have been made? How could you make it more realistic?

Even 'simple' questions from an exercise can be developed into more complex problems.

Question 6

Calculate 20 + 16 × 5

Ask learners to create a story or scenario that this calculation might represent. Once the story has been created the questions that can be asked about the context are limitless. Any sort of calculation problem can be used in this way (eg 34 × 1.05, or 4500 × 3 + 2510 × 2).

2.3 Adapting questions to other contexts

Question 1 (page 33) could be adapted to other contexts by changing the focus of the activity from buying material for a pair of jeans to, for example, ordering ingredients to make a recipe in a catering context, as shown in the following adaptation.

Question 1 Catering

To make 50 bread rolls takes 1.6 kg of strong white flour, which costs £1.95 per kilogram.

(a) How much will the flour cost?

(b) If the price of flour rises by 5%, how much will the flour cost?

The other questions can also be adapted to the new context, for example in the catering context, as follows.

- If the flour can only be bought in an exact number of kilograms, how much extra will you pay for the flour you do not use?
- How many bread rolls would you need to bake so that there is no wastage of flour?
- What is inflation at the moment? What would happen if you used that figure instead of 5%?
- How much discount would you need to get the price back to where it was before the price increase?
- What would the discount need to be if the increase was 10%, or 20%?
- Can you generalise from these figures?

- The actual price of the bread rolls is double the cost of the flour because of the yeast, butter and sugar needed and the baker's profit. How much will the baker charge for the bread rolls?
- Does the type of bread roll make a difference to the cost? Are brown bread rolls more expensive than white bread rolls? If so, why might that be, and if not, why not?
- How do you decide where to buy your bread rolls?
- What other questions could be asked about this situation?

This approach to adapting questions for learners can be applied to many learning and work contexts. Question 2 (page 33) could be adapted to a social care context, as follows, where care workers in a residential home are often asked to shop for residents.

Question 2 Social care

Jenny goes shopping for Ada, one of the residents, who wants four Lucky Dips at £1 each, a magazine that costs £1.30, two pairs of support tights that cost £6.15 a pair and two boxes of tissues at £0.75 a box. She gives Jenny £20 to buy everything.

How much change will Jenny have to give back to Ada?

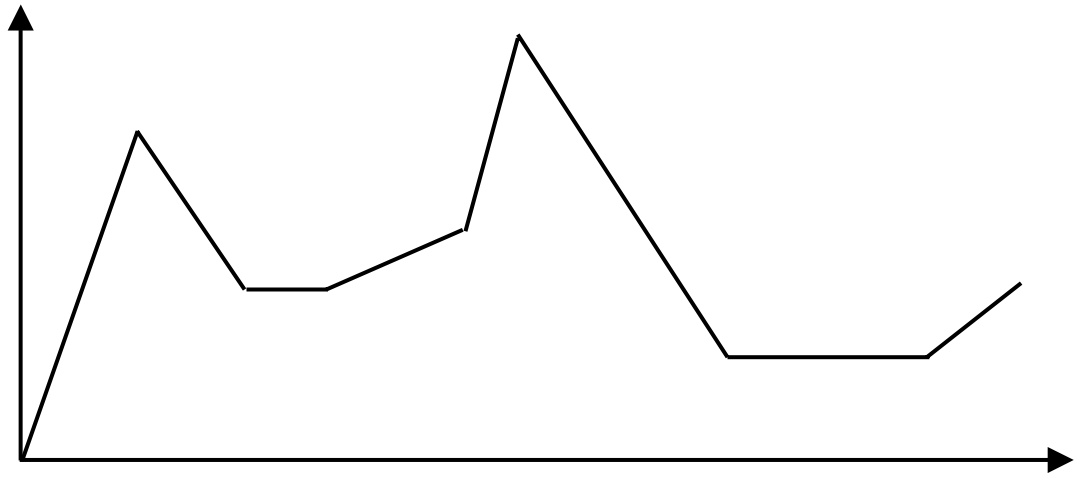
The further questions would need to be adapted, but could include asking learners to decide how much extra change Jenny would have if the tissues were on special offer at £1.35 for two boxes, or what she could do if the tights had gone up in price by 50p a pair.

This approach can be applied to any problem that has a context relevant to the learners, including problems from other subject areas. Learners could, for example, tackle a problem about population from geography or one about the laws of motion from physics. These problems can be extended in the same way by asking further questions and extending the context.

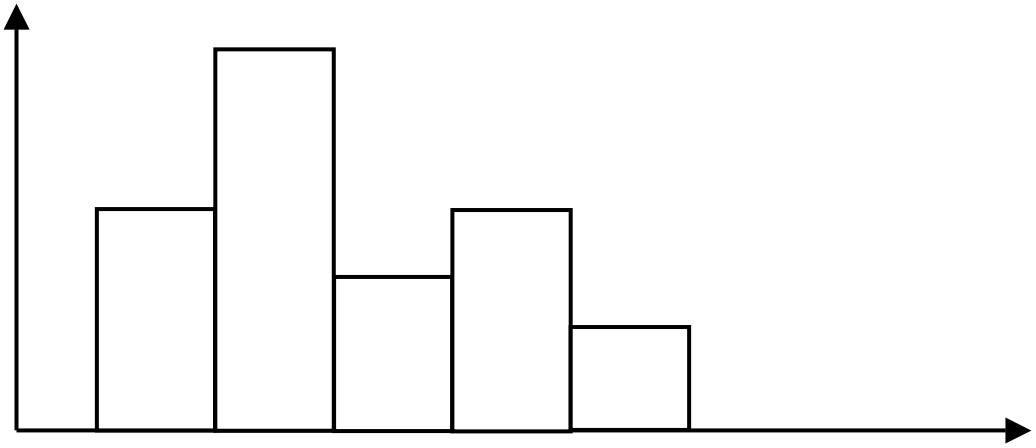
2.4 Creating a story

It can also be interesting to ask learners to create a story about a graph or chart that has no labels on the axes. A graph or chart that is to be used as part of a question in an exercise problem could first be shown with its labels removed. This will make learners examine the graph carefully and think about the significance of each of its parts.

For example:



Or:



Adapting to other contexts

Similar graphs and charts could be used in learners' own contexts to challenge them to think about their possible meaning in that context.

For example, the chart might represent sales of certain items in a retail setting, or the types of treatments requested in a beauty therapy salon. Charts and graphs are regularly used in many other curriculum areas, for example history, geography, physical education and science. Learners could be asked to interpret the graph or chart in the context of one of their other curriculum subjects.

2.5 Looking for the mathematics

Learners sometimes struggle to identify what mathematics is needed to solve a particular problem. Ask them to identify the mathematics in a range of everyday events by suggesting questions that could be asked about them.

The questions do not have to be answered but creating them and discussing them will encourage learners to decide what mathematics is involved in particular situations. They may be surprised at how much mathematics they can find.

Encourage learners to ask as many different questions as they can and then, as a class or as a small group, write problems that require some or all of these questions to be answered.

Learners could also be asked to create a problem about each scenario that does not require any mathematics to answer it. Other learners can then try to identify some relevant mathematical questions that can be asked. Some of the problems may be trivial but it is all part of the process of sorting out whether or not a problem lends itself to mathematics. In this way, learners will get used to 'looking for the mathematics' so that, when they are faced with a problem to solve, they will be able to give a sensible decision as to whether it requires mathematics to solve it.

This can be extended by giving learners particular problems that need solving and asking them what, if any, mathematics they need to solve the problem. This is particularly appropriate if problems from other curricular areas are used. Learners can firstly identify all the mathematics that there is in the context of the problem, possibly by considering what questions can be asked, and then decide whether any of it is relevant to tackling that particular problem.

This will encourage learners to think about all the mathematics involved in any problem and whether or not it is appropriate to use mathematics to solve the problem.

The following are examples of scenarios that could be used.

What mathematical questions could be asked about:

- a bus journey to work?
- making a cup of coffee?
- watching a DVD?
- going to watch a football match?
- booking a client for treatment, for example in a beauty salon?
- painting the skirting board of a room?
- planning a holiday?
- today's weather?
- the London Marathon?
- the moon?

Alternatively, learners could be shown a visual image or information that is relevant to them and asked to 'look for the mathematics'. The image or information could come from their vocational area, the local environment, or other curricular subjects, for example a map from geography, a graph from chemistry, a source from history, a design from technology or a formula from physics.

Examples

What mathematical questions could be asked about the information below?

Final results for 2006–07

Hull City	**Sunderland**
21st in the Championship	1st in the Championship
Played 46	Played 46
Won 13; drawn 10; lost 23	Won 27; drawn 7; lost 12
Goals for 51; goals against 67	Goals for 76; goals against 47
Goal difference: –16	Goal difference: +29
Points: 49	Points: 88

What mathematical questions could be asked about this picture?

What mathematical questions could be asked about this picture?

2.6 What is the same? What is different?

This continues the idea of encouraging learners to look carefully at the detail in the information they are given and asking questions about it. This time, learners compare and contrast and are encouraged to use mathematical language to express their observations. They can be as creative and original in their answers as they want to be.

For example, learners are given two diagrams or scenarios that are based on similar contexts. They have to contrast and compare them. They do this by dividing a large sheet of paper into two columns and heading one column 'Same' and the other column 'Different'. They write down every detail they can find that is the same or different about the two diagrams or scenarios, whether it is trivial or fundamental. They then compare their lists with other groups and add properties that they have missed. This can be used as an introduction to a new topic or idea to see what learners notice for themselves or to assess what prior learning they have.

Figures 2.1 to 2.4 show a pair of shapes, a pair of charts, a pair of graphs, and a pair of stories. It is helpful to use up-to-date stories, graphs or charts from the media, for example newspaper articles that include facts and figures about something in the news that is relevant for a particular group of learners.

There are many other possible contexts for this kind of activity. For example, the graphs in Figure 2.3 that represent the charges on a mobile phone could instead represent the fluid intake of two residents in a residential home in a social care context. With judicious changes to the labelling and data on the axes, the graphs could represent a range of situations and contexts.

Figure 2.1

What is the same and what is different about these shapes?

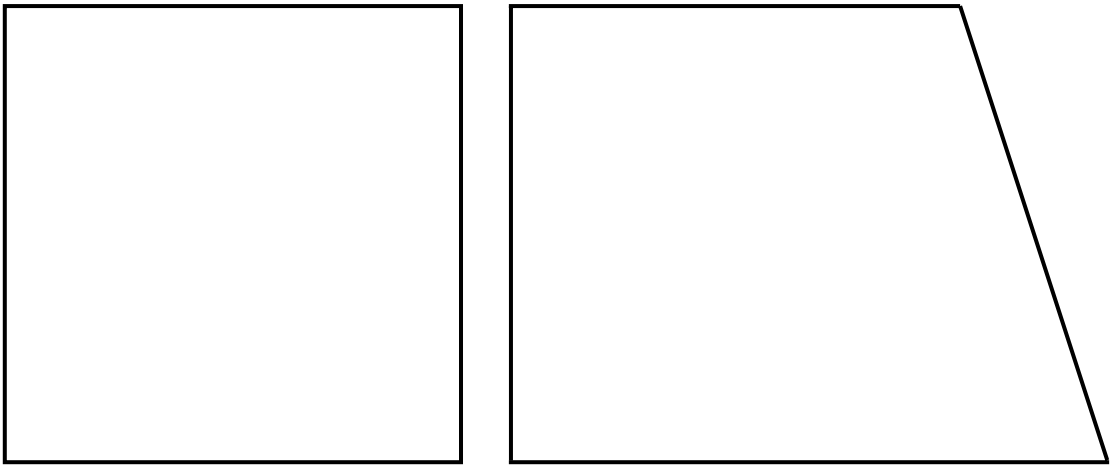


Figure 2.2

What is the same and what is different about these charts?

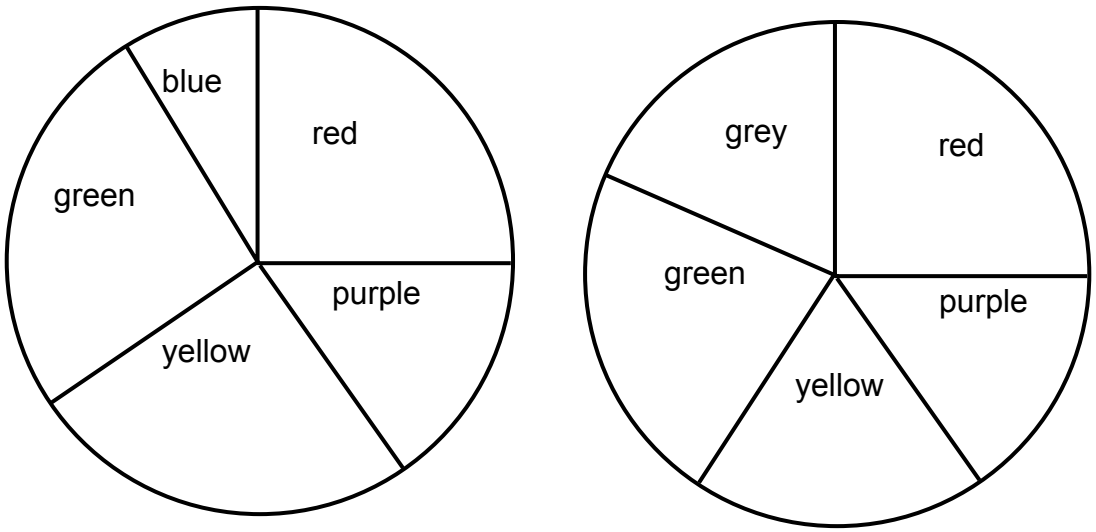
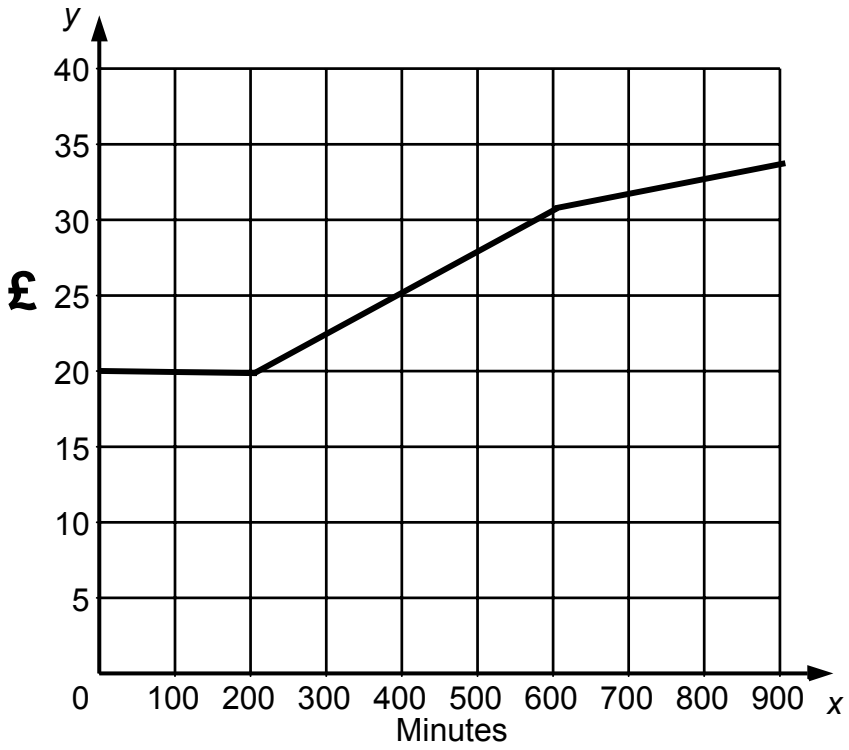


Figure 2.3

What is the same and what is different about these graphs?

They both represent the charges on a mobile phone but they are from two different providers.



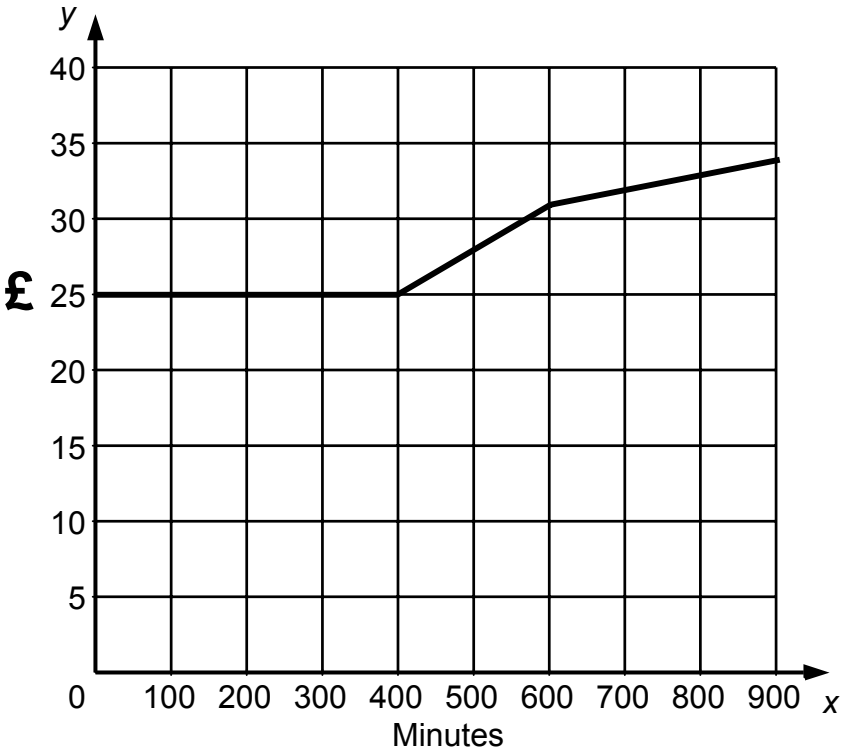


Figure 2.4

What is the same and what is different about these stories?

Story 1

Got up at 7.15 am.

Missed breakfast.

Ran 200 m for the bus.

Caught it with a minute to spare.

Got to work for 08:13 after 22 minutes on the bus.

After a hard day's work arrived home at 17:40.

Tea ready for me when I got home.

Ate tea at 17:55.

Then watched television for 1 hour 50 minutes starting at 6.25 pm.

Read a book and listened to music until bedtime at 20:50.

Story 2

Alarm went off at ten to seven in the morning.

Got up 25 minutes later.

Arrived at bus stop at 07:40 after eating breakfast.

Waited until 07:51 for the bus.

Bus journey lasted 35 minutes.

Worked late that evening and didn't arrive home until 19:45.

Flopped in front of the television for 30 minutes eating fish and chips bought on the way home.

Watched a DVD for 2 hours 25 minutes.

Went to bed.

Asking learners questions for which there is no exact answer encourages them to develop strategies for solving problems for which there is not one correct method. Learners then begin to recognise that there are alternative paths through a problem and they develop their own chain of reasoning.

These problems can be trivial, fun and chosen to be relevant to learners' everyday lives or related to a workplace, vocational or other curriculum subject context.

Examples:

- What is the surface area of a banana?
- How many chips have you eaten in your life?
- How many raisins would fit into this room?
- How many bags of cement would you need to concrete the floor of the stands in the new Wembley Stadium?
- How many cans of hairspray would you need to use for all the learners in the college?
- How many times has your heart beaten in your lifetime?
- How many leaves are there on a tree?
- How many words are there in all of Shakespeare's works?
- How long would it take to run from Hull to London?
- For how many hours did it rain last year?

Asking open questions as often as possible is another way of encouraging learners to develop thinking and reasoning skills.

Examples:

- Can you give me a data set that has a mean of 5 and a median of 6?
- The perimeter is 20 cm. Can you suggest a possible shape?
- Give me an example of a shape that has one line of symmetry and one right angle.
- The area is 60 cm^2. Give me a possible shape.
- What can you tell me about the number 3.4?
- The answer is 12. What was the question?

These questions can be answered individually and then shared and discussed as a group, or answered in groups. This activity works even better when learners are using mini-whiteboards to display their answers.

2.7 Justifying decisions

In problem solving there is often no such thing as one right answer, particularly for more open questions. It is the answer plus the justification that is important. If the justification is appropriate, sufficient and valid, then the answer is correct. Even if the question is closed, justification is needed. Learners sometimes find this a difficult idea to grasp but, once they learn to compare and discuss alternative solution strategies to problems, their confidence and flexibility in using mathematics increase. In activities of this

kind, learners will be analysing mathematics and interpreting solutions, as required by the functional mathematics standards.

The 'Agree or disagree' activities suggested on pages 47–48 can be carried out as a class discussion or with pairs of learners sticking the statements onto large sheets of paper and adding their justification in writing. These activities or problems can be used to start a session or to review the learning at the end of a session. There is an opportunity here to encourage learners to express their reasoning clearly and logically using appropriate mathematics.

These activities or problems require learners to justify and give reasons for their decisions and so encourage their capacity to explain and convince. Initially the 'Agree or disagree' examples are closed, in the sense that the statement is either true or false. However, learners have to provide justification for their decision for each one; how they do that is up to them.

The examples given contain common errors and misconceptions and so are likely to provoke interesting and useful discussions which, it is hoped, will result in a decision that is clearly and carefully justified. The examples cover a range of mathematics but each one could be developed into a set about one particular aspect of mathematics. They could be replaced with examples containing statements from a range of vocational contexts that include common errors and misconceptions.

The 'Statements to evaluate' on page 49 are more provocative and learners have to give an opinion backed up with justification. They are intended to move learners on beyond the idea that there is always only one answer to a problem.

In 'Sometimes, always, never' on page 50 learners are given statements that they have to evaluate. They have to test the statements out using appropriate specific cases to decide which category each statement is in. As they go deeper into sorting out the problem, they may be able to generalise and explain their decision rather than only using examples and counter-examples.

In 'Odd one out' on pages 51–52 each card shows three similar mathematical objects. Each one of the three could be the odd one out. Learners have to justify each one being the odd one out in as many ways as they can.

Ideas that develop learners' ability to explain, convince and prove can be devised at any level of difficulty and for any topic. They are particularly effective if they force learners to confront common difficulties and misconceptions in a context that is relevant to them. All the above ideas could be replaced with examples from a vocational context or from other curricular areas. For example, the statement about train fares on page 48 could be adapted to a construction context using a construction-related item and VAT instead of a percentage increase. It might then read:

> The cost of a window frame was £250 exclusive of VAT. I managed to negotiate a 17.5% discount, so I only had to pay £250.

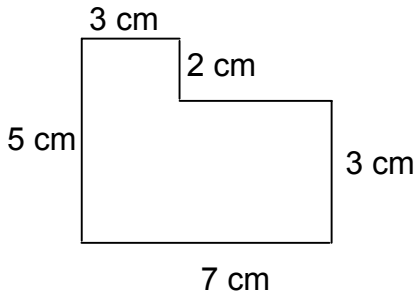
This approach can be used to develop similar, contextualised statements for many of the activities suggested in this section.

Agree or disagree

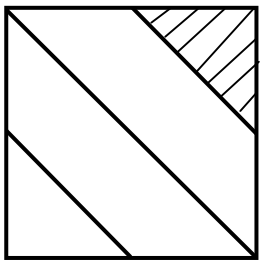
Sort the following statements into those you agree with and those you disagree with. Give reasons for your decisions.

$\frac{2}{3}$ is bigger than $\frac{3}{5}$
$3 + 7(2 + 9) = 80$
0.4 is the same as 40%
$3.74 \times 10 = 3.740$
$0.3 \times 0.2 = 0.6$
$\frac{1}{2} + \frac{1}{3} = \frac{5}{6}$

The perimeter is 20 cm.



$\frac{1}{4}$ of the square is shaded.



My train fare to London was £84. The fares went up by 10% but then I managed to get a discount of 10%. So now I am back to £84.

There are three possible outcomes for any football match. A team can win, draw or lose a match.

Therefore the probability of winning is $\frac{1}{3}$.

Statements to evaluate

Girls' scores %: 34, 53, 21, 48, 97, 65, 76, 93, 56, 85, 71, 24, 31, 47, 55, 63, 50

Boys' scores %: 45, 67, 86, 43, 55, 58, 12, 89, 67, 78, 43, 59, 67, 34, 54, 41, 81

Girls are better at maths than boys because two girls got over 90% and no boys did. Also the lowest score was from a boy.

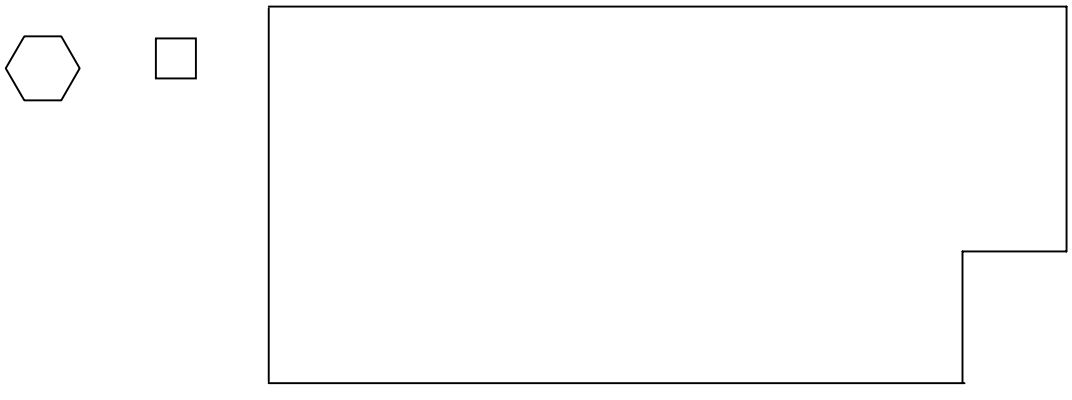
Wages from firm A:	Wages from firm B:
£74 000	£47 000
£53 000	£38 000
£21 000	£25 000
£19 000	£25 000
£19 000	£25 000
£19 000	£25 000
£19 000	£25 000

Mean wage from firm A is £32 000.

Mean wage from firm B is £30 000.

Therefore it is best to have a job with firm A.

The shapes are scale drawings of a floor and two types of floor tiles.
It would be best to use hexagonal ones as they are bigger so you will need fewer of them.

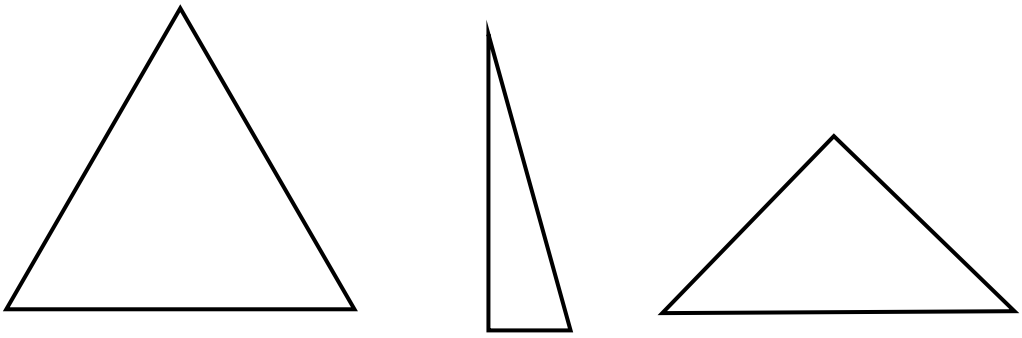
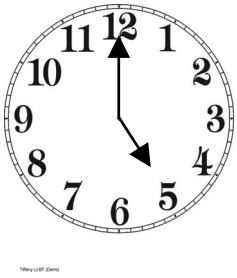


Sometimes, always, never

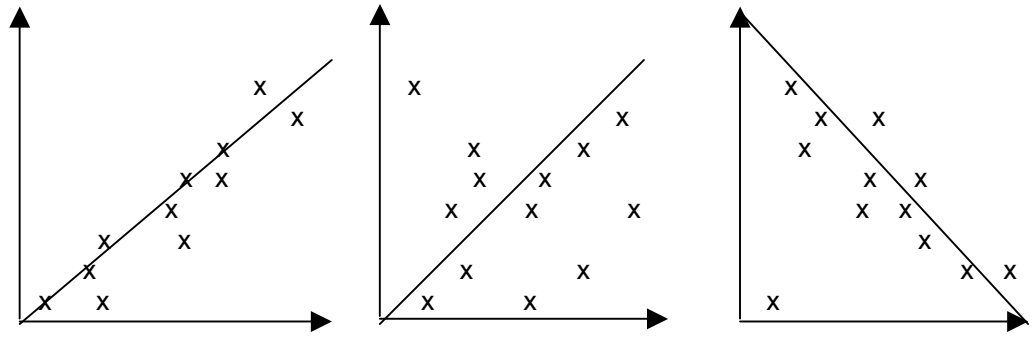
A trapezium does not have a line of symmetry
The more digits a number has, the bigger the number
Adding two numbers together results in a number that is bigger than either of the original numbers
Finding a fraction of something makes it smaller
Numbers ending in a 5 or a 0 are divisible by 5
Doubling each number in a set of data doubles the mean
Doubling the length of each side of a rectangle doubles the area
The sum of the exterior angles of a polygon is 360°

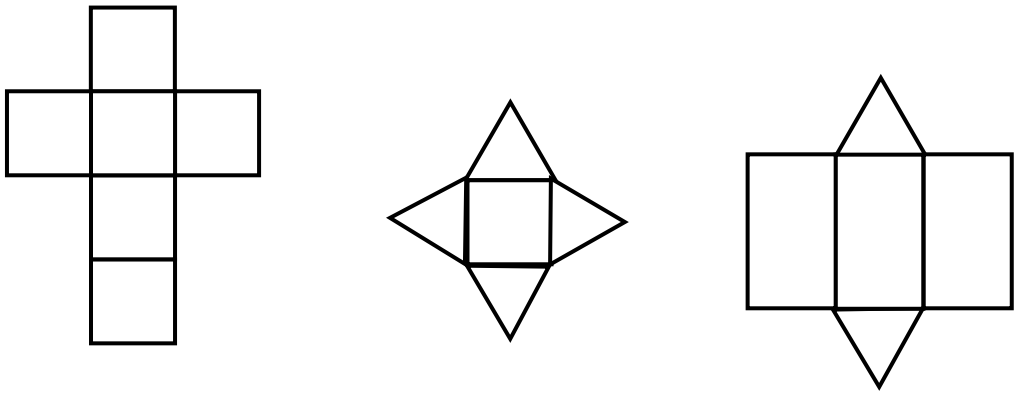
Odd one out

Justify each item on a card being the odd one out in as many ways as you can.

32	36	45
		
	15:00	5.00 pm

$\frac{1}{4}$ $\frac{3}{6}$ $\frac{2}{3}$





2.8 Classifying, ordering and sorting

All problems involve information that needs to be sorted. To encourage learners to make their own decisions about classifying, they can be given a set of cards or data and asked simply to sort them according to a criterion they have thought of. This can lead to interesting class discussions about the different criteria used. The process can be continued by asking learners to sort again using a different criterion. This can be done with a set of numbers, shapes, pictures or graphs. It encourages learners to discriminate carefully, recognise the properties of objects, and develop mathematical language and definitions. In activities of this kind, learners will be analysing mathematics and interpreting solutions, as required by the process skills in the functional mathematics standards.

Ordering can be a closed activity, for example 'sort a set of measurements into order starting with the smallest'. However, to encourage problem solving skills it is better to have open criteria. Ordering according to opinion can provoke discussion and be adapted to many different levels. At Entry level, learners can be given a set of cards each with details of an individual, for example:

- Angela has two children aged three and six.
- Colin is a granddad and supports Manchester United.
- Andrew is a nurse and has lived in his current house for 20 years.
- Tim is a teacher and is planning to get married next year.
- Kelly has had three jobs since leaving school and is now training to be a hairdresser.

Learners have to arrange the cards in order of age, decide on an age for each person, say when they were born, and justify their decisions. There is no right answer but some answers are more appropriate than others, depending on the amount of detail given on the cards. The details of the characters used can be adapted to relate to the learners in the group.

Two examples at other levels are given here. The first, 'Choosing the can' (page 55) involves different costs of cans of drink. Start by setting the scenario that someone is feeling thirsty and wants to buy a can of drink. It is important to make sure that learners understand that it is only one person wanting a can (so it is not necessarily the cheapest that will be most appropriate). Learners have to put the cards on 'Choosing the can' in order as to which is the most appropriate purchase in the circumstances. You could adapt this to other contexts such as cans of spray paint in a motor vehicle setting or cans of hairspray in a hairdressing context. You could change the cans to other types of container for a range of contexts, for example tubes of mastic in a construction setting or bottles of fertiliser in a horticulture setting. The scenario can be varied to provide criteria such as metallic paint as

opposed to flat paint in a motor vehicle context, or whether the item is for use in the workplace or at home.

The second example (page 56) uses probabilities. Learners are given events on cards and have to put them in order of how likely they are to happen. This could be done on a line showing the range from 0 (completely impossible) to 1 (certain). If different groups of learners order the cards, the orders can be compared. Each group has to justify any differences with other groups. This is more interesting and provocative if current events that are relevant to the learners or their environment are used.

Working with comparisons and preferences encourages discussion and the use of mathematical language, as personal choices have to be justified. Another example would be to use advertisements for second-hand cars from a local newspaper. Each group of learners has a set of advertisements with details of the cars for sale. They have to put the advertisements in order starting with the car they would most like to buy. They must give valid reasons for their decisions. This could also be done using advertisements for mobile phones.

Alternatively, each group of learners could be given the details of a customer and have to choose what they consider to be the most suitable car or phone for that customer and give reasons. This can be followed by lots of class discussion but everyone is right so long as they can justify their choice.

Similarly, this idea could be used for holidays or journeys. Using some holidays from a holiday brochure, learners have to decide which is the ‘best’ holiday for them and justify their decisions using the information given.

Different characters could also be used. Each learner or pair of learners takes on a different character or set of characters, for example a family of four with two small children, a group of teenagers, a retired couple or a single 20-year-old. Learners have to consider how their idea of ‘best’ might change when they take on the role of one of these characters. Journeys could involve different types of transport, so different costs, and also different routes. Any commodity that is relevant to the learners either from their vocational context or other curricular subjects or from their everyday lives can be used.

Choosing the can

Pack of 4 x 330 ml cans costing £1.80	Original price for a 330 ml can is 60p Current offer is 10% off
One individual 330 ml can for 50p	One 550 ml can costing 78p
One 330 ml can costing 58p with the offer 'Buy one, get one free'	One individual 550 ml can costing 55p with the offer '50p off next purchase'

Probabilities

How probable is it that: It will rain tomorrow ?	How probable is it that: England will win their next cricket game ?
How probable is it that: It will snow on Christmas Day this year ?	How probable is it that: The moon will be visible tonight ?
How probable is it that: Coronation Street will finish next year ?	How probable is it that: Income tax will be abolished in the next budget ?
How probable is it that: The winning lottery numbers this Saturday will be 1, 2, 3, 4, 5, 6 ?	How probable is it that: Chelsea will win their next football match ?
How probable is it that: The M25 will be mentioned on the next traffic news ?	How probable is it that: There will be a new number one in the pop charts this week ?

Managing information

Learners can sometimes be overwhelmed by being given a lot of information at the beginning of the problem solving process. They do not know where to start or how to organise the information. Giving learners sets of cards that have a range of information about a problem can help them appreciate the need to read all the information carefully, select what is relevant, discard what is not, and organise the information into a useful format.

Problems can be given in all sorts of contexts. The two on pages 58 and 59 are about travelling to college and voting. The travel problem could be changed to be about travelling to school or work. The voting problem could be set in the context of 'Big Brother' or 'The X Factor', with the letters being replaced by current or recent names on these programmes, or it could be adapted to other topics, such as commission earned in a retail context where this can be a significant part of the wages received, as shown in the example on page 60.

The set of cards contain the problem and a range of related information. Learners work in groups of two or more, each with a set of cards. First, they have to identify the problem. They then sort out which cards contain information that will be needed to solve the problem and which are redundant. They then solve the problem by connecting the ideas on the cards. Using large sheets of paper and felt-tipped pens will help learners track their thoughts and make connections that support the process.

Travelling to college

I can walk at 5 mph	The speed limit is 30 mph
The car never exceeds the speed limit	The bus stop is 0.5 miles from my house
There is a bus stop outside college	Bus journeys usually take 9 minutes
I can cycle at 12 mph	The bus is number 32
Buses come every 15 minutes	It usually takes me 24 minutes to walk
If I get a lift in a car my journey time is half the time it takes me to cycle	Footpaths through the estate cut the walking journey distance by 1 mile
I hate cycling when it is windy	The car goes faster than the bus
The bus fare is 50p with a pass	Each day I cycle, walk, go by bus or get a lift to college. How long is each journey time?
Usually I wait at the bus stop for 5 minutes	How far is college from my house?

Voting

A got 10% more votes than B	B's number of votes was ⅞ of the number of votes that E got
C got 30 000 fewer votes than E	The ratio of the number of votes for D to the number of votes for E was 4 : 3
D got the second highest number of votes	B got 50 000 more votes than F
G only got 15% of the number of votes that A got	H got more votes than F
Who won?	The total number of votes was the highest ever recorded
How many votes did each participant get?	H's share of the vote was halfway between F's and E's
F did not win	E got more votes than B
E got 240 000 votes	B got fewer votes than A

Retail commission

A earned 10% more commission than B	B's commission was ⅞ of the commission that E earned
C earned £3 less commission than E	The ratio of the commission earned by D to the commission earned by E was 4:3
D earned the second highest amount of commission	B earned £5 more commission than F
G only earned 15% of the commission that A earned	H earned more commission than F
Who earned the most commission?	The total amount of commission earned was the highest ever awarded
How much commission did each sales person earn?	H's amount of commission was halfway between F's and E's
F did not earn the most commission	E earned more commission than B
E earned £24 commission	B earned less commission than A

2.9 Analysing solutions

Asking learners to mark their own work or that of another learner is a powerful way of encouraging them to think beyond the answer to a problem and to become reflective and self-critical. This can be done on any piece of work that learners complete, from a practice exercise to a complex problem. When assessing, learners should be invited to write advice to the person who has tackled the problem. This puts the learner in a critical, advisory role. In activities of this kind, learners will be interpreting solutions.

Once learners are used to self-assessing and peer assessing, they can be given more substantial problems to assess such as the ones on pages 61–67. These problems contain some good ideas, some poor ideas and some superfluous ideas. Learners should be encouraged to identify the three types. It may be that not all learners will come up with the same opinions but, so long as they can justify them, all opinions are accepted. This again reinforces the idea that not all solutions to complex problems will necessarily follow the same route.

When asking learners to assess made-up solutions such as these, it is a good opportunity to introduce common misconceptions and errors. For example, in problem 2 (page 64), the solution takes the route that many learners do when doing a statistical analysis, ie starting by drawing bar and pie charts and calculating all averages whether or not they are appropriate.

Problem 1

Design a box for 30 chocolates. Each chocolate is cylindrical with diameter 1.5 cm and height 1 cm.

Without including any flaps, how much card will the design need?

Possible solution

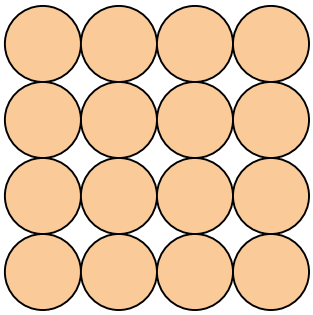
I am going to design a square-based pyramid shape.

Volume of each chocolate $= \pi r^2 h = \pi \times 0.75 \times 0.75 \times 1$
$= 1.34\ cm^3$

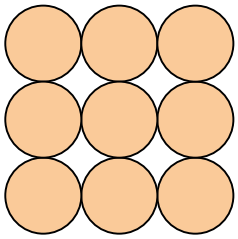
The volume of space needed for each chocolate $= 1.5 \times 1.5 \times 1\ cm^3$
$= 2.25\ cm^3$

Arrange them like:

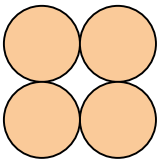
Bottom layer:



Second layer:



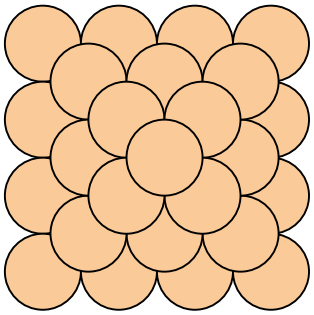
Third layer:



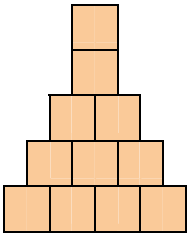
Fourth layer:

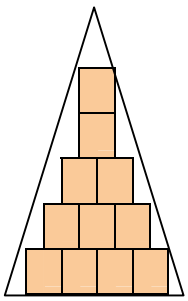
Top layer:

From the top this will look like:



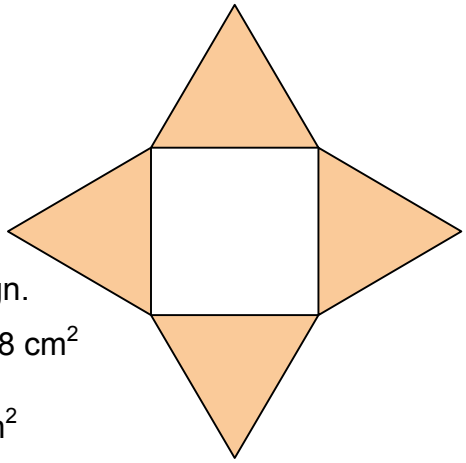
From the side it will look like:





Choose dimensions of triangle to be: base: 8 cm
height: 7 cm

Using Pythagoras:
$8^2 + 3.5^2 = 76.25$
$\sqrt{76.25} = 8.73$ cm



This is the net of my final design.

Area of triangle = $\frac{1}{2} \times 8 \times 7 = 28$ cm^2

Area of square = $8 \times 8 = 64$ cm^2

Area of card needed = 92 cm^2

Ask learners to look through this solution to the problem. Ask them to comment on it and give opinions on these issues.

- Which calculations are appropriate and which are not appropriate, and why?
- Are the diagrams helpful?
- Does the design work?
- Are the decisions clearly explained?
- Could you suggest ways in which to improve how the solution has been presented?
- Could you improve the design?

Problem 2

Use the information below to investigate women's earnings in relation to men's earnings.

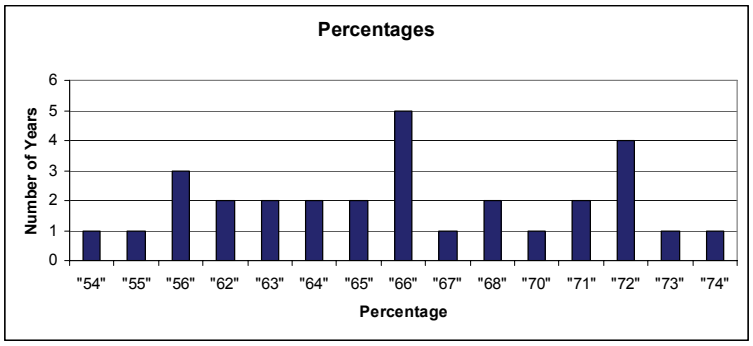
Women's earnings as a percentage of men's in Great Britain

Year	Percentage	Year	Percentage
1970	54	1985	66
1971	56	1986	66
1972	56	1987	66
1973	55	1988	67
1974	56	1989	68
1975	62	1990	68
1976	64	1991	70
1977	65	1992	71
1978	63	1993	71
1979	62	1994	72
1980	63	1995	72
1981	65	1996	72
1982	64	1997	73
1983	66	1998	72
1984	66	1999	74

Source: ONS Social Trends

Possible solution

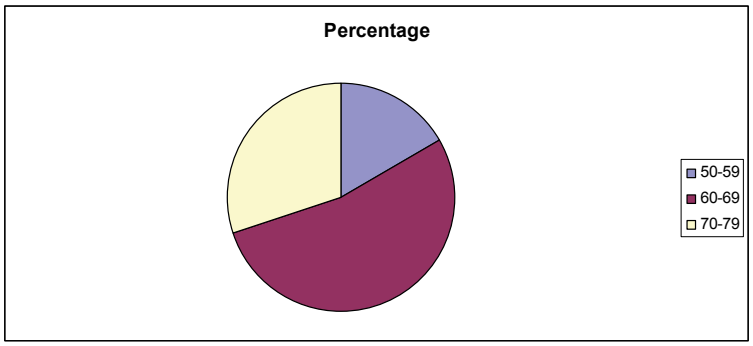
I am going to draw a bar chart of the percentages.



66% was the most common percentage.

A lot of percentages only happened once.

I am going to group the percentages and draw a pie chart.



There were more percentages in the 60s than in the 50s or 70s. The 70s had the second most.

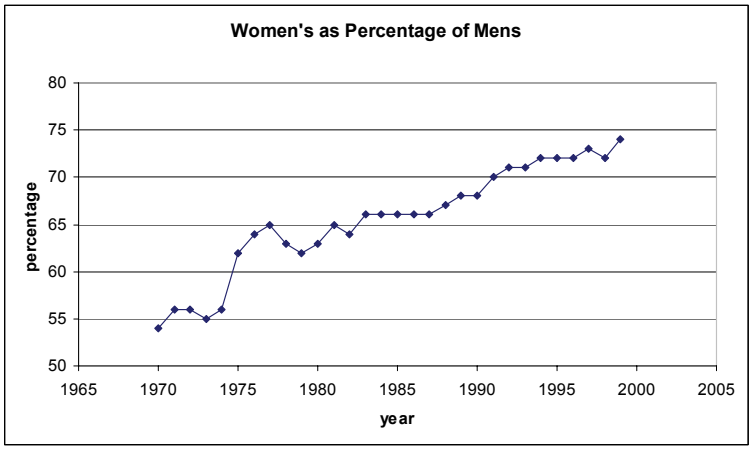
I am going to calculate the mean, mode and median of the percentages.

Mean = 1965 ÷ 30 = 65.5%
Mode = 66%
Median = 66%

The mean percentage over the period was 65.5%.

There were more 66% than any other percentage.

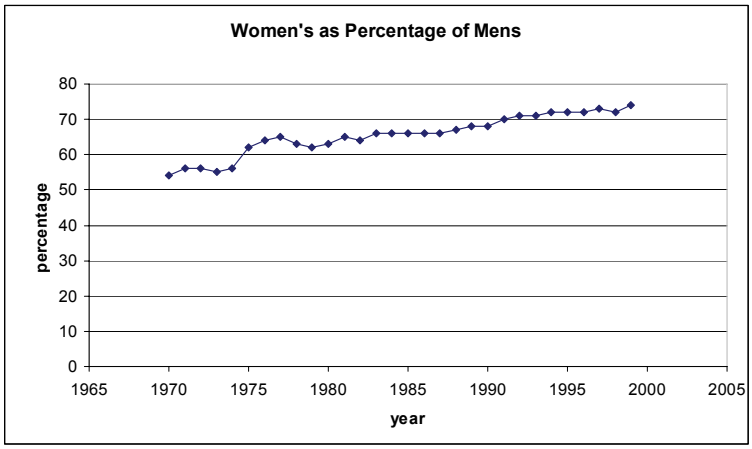
I am going to plot a line graph to show the trend over time.



There was a relatively huge rise between 1974 and 1977.

I think this graph is a bit misleading because it implies that there were a lot of big changes whereas the changes were only in single figures.

I am going to redraw it with different axes.



The trend is upwards.

Overall the percentage has risen by 20% over 20 years.

The percentage has risen at an average rate of 1% per year.

Average wages have risen a lot in this period of time therefore there is still a big gap between men's and women's wages.

More women are career women now and there are more women in top jobs. Therefore there must be still a lot of women at the bottom end who are very poorly paid.

Maternity leave was not available in 1970. More women are now going back to work after having children and continuing with their career.

Equal opportunities legislation has helped women get a better deal.

More women than men have part-time jobs and they tend to be poorly paid.

Ask learners to look through the solution to this problem. Ask them to comment on it and give opinions on:

- Which bits of analysis are not appropriate and why?
- Which statistical techniques are appropriate and why?
- Are there any other statistical techniques that would have been appropriate?
- Comment on the interpretation and conclusion.
- How could you improve the solution?

This activity could be adapted to any relevant context using data from the particular sector and adapting the solution presented.

2.10 Language problems

Some learners will have difficulty understanding what a question is asking for. This difficulty can be at a basic level of not knowing whether to add, multiply, subtract or divide when faced with a simple problem expressed in words, or at a more advanced level and with more complex problems.

Giving learners problems and answers to mark can encourage them to think more carefully about which operation is correct. Asking learners to write their own problems to fit a particular operation can be effective in identifying any difficulties they have. In activities of this kind, learners will principally be analysing mathematics, though some of their thinking is likely to involve representing situations (for example in Problem 1).

Problem 1

Jennifer needs £15. Claire gives her £9. How much more does she need?

15 × 9
15 + 9
15 – 9
15 ÷ 9

Which calculation would be correct for answering the problem?

Write problems that require the other three calculations to answer them.

Problem 2

There is a sale on at the shop selling digital video players. Tom wants to buy a model that is selling at £129.99 after a discount of 15%. How much was it before the discount? Which of these calculations would be correct for answering the problem?

129.99 × 0.85
129.99 × 1.15
129.99 ÷ 0.85
129.9 ÷ 1.15

Write problems that require the other three calculations to answer them.

Learners can be given a range of word problems set in an everyday context that require different operations (+, -, ÷, ×). They have to sort these according to which operation they need. When they have sorted them, learners can be asked to identify which word or phrase in the problem indicates the operation needed. Learners can then be asked to make up as many additional problems as they can for each different word or operation, or be asked how they would change the wording in some of the problems to change the required operation. Problems that learners have written can be passed on to other learners for sorting and discussion can take place over any disagreements.

This can be applied to other types of calculations, for example percentage problems.

Using grids that do not have one set solution is also a useful way to encourage learners to think about the language used in mathematics. The example on pages 69–70 uses simple word problems based on (+, -, ÷, ×) but problems can cover a wide range of topics and levels. Learners have to place number cards in each box of the statements grid so that they fit the criteria. All boxes giving statements must be covered. When they have placed a few

cards, learners often find that they have to move cards around to cover all the boxes. As a result, they are responding to the same words several times and so reinforcing their meanings. Follow-up class discussion about which numbers could fit each criterion can also reinforce the use of language.

The sum of these numbers is 23	The difference of these numbers is 7	The total of these numbers is 29	The product of these numbers is 54
These numbers multiply together to make 24	One of these numbers divided by the other gives 3	One of these numbers is 9 more than the other number	One of these numbers is twice as big as the other number
Subtract these numbers to get 15	One of these numbers shared between the other gives 2	One number is three times the other number	One of these numbers is 15 less than the other

25	9	1	2
10	24	5	6
8	3	36	27
19	30	12	20
4	11	16	31
7	13	14	15
22	21	18	45

3. Writing your own contextualised activities

Contents

Ideally, learning activities for functional skills should develop 'naturally' from the contexts in which the learner is working. Some examples of this are given in section 4. However, it is often the case, especially when focusing on the 'skills-building' phase, that you will need to develop and write activities that concentrate on a particular aspect of the process skills or of coverage/range. It is important that these activities are realistic and relevant to your learners, support the problem solving approach and contextualise mathematics in wider learning. This section will help you to develop such activities.

3.1 Introduction

Compare Problem A with Problem B (page 72).

Problem A

i.	Calculate the percentage decrease from 589 to 556.
ii.	Calculate the values of a 12.5% decrease from 589, a 20% decrease from 589, and a 60% decrease from 589.

Problem B: Kyoto and beyond

Scenario

Carbon dioxide is the main greenhouse gas, accounting for about 85 per cent of greenhouse gas emissions in 2005.

The carbon dioxide emissions for the period 1990 to 2005 in the UK are shown in the following table.

	million tonnes (carbon dioxide equivalent)					
	1990	1995	2000	2003	2004	2005
Total	589	549	549	556	557	556

To meet its commitment to the Kyoto Protocol, the UK has agreed to reduce total greenhouse gas emissions by 12.5% relative to the base year, 1990, over the period 2008–2012.

The UK aims to move beyond its Kyoto target (reducing emissions of carbon dioxide by 20% below 1990 levels) by 2010, and to put itself on a path to reduce carbon dioxide emissions by 60% by 2050.

Task

How well is the UK doing towards meeting these targets?

Source:
www.defra.gov.uk/environment/statistics/globatmos/gagccukem.htm

Problem A is presented as a traditional ‘sum’ to which the answers must be found.

You will have recognised that Problem B requires the same mathematical techniques to be used but they are set in a context that is relevant to all learners and will be of real interest to many, especially any who are studying geography, some aspects of engineering, environmental sciences or related subjects.

Crucially, Problem B allows learners to apply their process skills and mathematical techniques in context and, from identifying the initial problem to providing an appropriate presentation of their results and conclusions, to use their functional mathematics process skills to arrive at the answer.

Making sense of situations and representing them

Learners ask themselves:

- Is the UK on course to meet the 12.5% or 20% targets for carbon dioxide emission reduction? (This involves percentages and decreases in quantities.)
- What information from the table do I need to use? What does it tell me? What other information do I need?
- Reducing carbon emissions means a decrease. What do I know about percentage decrease and how do I calculate it? Can I do it with a calculator, or could I use a spreadsheet?

Processing and using the mathematics (analysis)

- I can use my mathematical techniques to determine what the solution might be and test my results, for example: do the results show a decrease and, if so, by how much? Do my results make sense? How do I check them?
- What would happen if the UK continued to decrease carbon dioxide emissions at the same rate over time?

Interpreting and communicating the results of the analysis

- What do my answers tell me? Has the UK reduced carbon dioxide emissions over this period? Is the UK likely to meet its targets based on the current reduction rate of carbon dioxide emissions and why (or why not)?
- Would a chart or graph show the reduction in carbon emissions over time? Is there another way to present the information? Who is this information for? Will readers understand the information if I use a chart or graph?

Note: Section 1, pages 21–27, explains the process skills in detail.

Using these process skills, and applying them to problems in a range of contexts, allows learners to secure their understanding and work towards mastery of the skills. This will enable them to apply and transfer these skills to a range of problems in different contexts such as other subjects in their education or training programme, or in day-to-day work and life.

3.2 Planning activities for your learners

Mathematics learning activities can be designed or adapted to ensure that they incorporate the development of functional skills by setting them in contexts that are meaningful and relevant to learners. These contexts include those that are related to:

- a course of study, for example GCSE or NVQ
- employment, for example budget forecasts, production times
- other aspects of life, for example consumer knowledge, citizenship, sport.

Effective functional mathematics activities:

- encourage a more active approach to learning mathematics
- provide opportunities to develop, demonstrate and master functional mathematics skills
- encourage critical thinking and reflective learning
- develop application of the process skills in a range of meaningful contexts
- demonstrate the relevance of functional mathematics skills
- raise the standard of learners' work
- enable learners to see the links between their mathematical skills and the subjects they are studying, their work and life in general.

Activities that enable learners to use and apply their mathematical skills and techniques should be:

- purposeful
- set in a realistic context that is relevant to learners
- achievable
- at the right level
- engaging and motivating.

Purposeful

Purposeful problem-centred activities have both an aim and a reason for tackling the problem. Activities need to give a satisfactory answer to the learner's question 'Why am I doing this?'.

In the 'Kyoto and beyond' example on page 72, the aim is to determine whether there has been a reduction in carbon dioxide emissions between 1990 and 2005 and, if so, what the carbon dioxide emission is likely to be if it continues to reduce at the same rate for the next few years. The reason for

doing this is to decide whether the UK will meet the targets for carbon dioxide emission reduction to which it is committed.

Purposeful activities contribute to the learners' main subject of study or are directly related to their interests. Learners can see the point of engaging with the activity as it provides a direct link with their wider learning.

Set in a realistic context that is relevant to the learner

Functional activities provide opportunities for learners to use their mathematical skills in relevant and realistic contexts. In such activities, learners would have to use all the process skills (represent, analyse, interpret) to find a solution to the problem.

The two examples given from page 71 highlight the difference between applied and non-applied activities. Although the mathematical techniques required are very similar, the applied 'Kyoto and beyond' activity sets the problem in an environmental setting, demanding that the learner finds and represents the information, analyses the information, and interprets the outcomes in a way that is appropriate for the intended audience.

Achievable

Functional mathematics activities must be achievable. It is demoralising for learners to attempt an activity that they cannot do either because they do not have the skills, or cannot access the appropriate tools, strategies and information they need. On the other hand, teachers should have high expectations of their learners and use a bank of strategies and activities that will challenge learners across the levels.

It is therefore important to know each learner's strengths and weaknesses in relation to functional mathematics. The assessment of learners' mathematics may be based on their previous achievement, for example at Key Stage 3, on ongoing assessment for learning, or, in a further education or training provider setting, on initial and diagnostic assessment. This information will help to inform the planning for problem-centred activities, and identify the support some learners may need as they tackle the task. However, it is important that the assessment of the current skills of individual learners takes a holistic view that includes assessment of their process skills as well as of their mathematical abilities.

At the right level

The right level of an activity is one that challenges the learner but is nevertheless achievable. The key dimensions of 'levelness' are: complexity, familiarity, technical demand and independence. See section 1 for details.

In the next activity, it will be the outcome (the results and solutions) and how they have been arrived at (the processes used) that will determine the level of functional skills required and demonstrated.

Digitally challenged

Scenario

Your teacher has asked your group to investigate the purchase of a digital camera to take photographs to support your coursework.

Task

The budget is limited and you want to get best value for money, so you will need to compare cameras according to cost and how far they meet your requirements.

Present your findings to your teacher.

In determining the level of demand of a functional mathematics activity you will need to consider the following points.

- How complex is the activity? Are the steps to solve the problem too challenging for Entry level learners, or can the activity be completed at different levels according to the ability to apply the mathematical skills at each level of the standards?
- How familiar is the context to the learner? Entry level learners are likely to be working in familiar contexts. They may have been working with this type of activity before and be secure in the mathematical skills needed, or they may need support to transfer the mathematical and process skills they have already developed to a new context. Higher-level learners would need to use their mathematics skills and apply them to new contexts, and consider how these skills can be adapted to complete the activity.
- What is the technical demand of the activity? At Entry level, learners could work with simple costs, for example whole pounds, or simple capacity, for example whole megapixels, rather than decimal numbers. At a higher level, the task might require learners to compare information, using and presenting their comparison as statistical data, charts or graphs.
- How autonomous will learners be in completing the activity? If learners are at Entry level more support could be given. This support may be the provision of appropriate sources of material or data, for example, or the one-to-one support a teaching assistant can provide. In the 'Digitally challenged' activity, data on cost and functionality could be provided in a catalogue, website printout or other media.

Understanding the 'levelness' of an activity, and knowing your learners' mathematical skills levels, will enable you to personalise the learning by differentiating the task. This will ensure that it is accessible to all learners, but also stretch those who are more able.

Section 5 on assessment and progression provides more information about functional skills levels and progression.

Having identified the process skills required to complete the activities, and your learners' functional mathematics skill levels, you may decide that learners need to develop some aspect of their mathematics skills or their application. It would therefore be helpful to prepare learners for the task with an activity that develops these skills, thus enabling learners to approach the task with greater confidence. For example, if you were planning to use the 'Digitally challenged' activity with learners, you might feel that it would be helpful to revise decimals, as learners will need to do calculations with decimal money.

Note: The materials developed in the *Improving learning in mathematics* and *Thinking through mathematics* projects (see section 6, 'Resources' on page 131), and the approaches in section 2 will promote active number learning by engaging learners in discussion and group work.

Engaging and motivating

Active, problem-centred activities encourage learners to get involved and to try things out for themselves. Learners are more likely to remember what they have done and to learn from their experiences – particularly when things do not work out quite as planned.

Using a range of teaching and learning strategies to develop and practise skills can engage and motivate learners. Section 2, 'The problem solving process', outlines many different approaches to the teaching and learning of problem solving skills. There are many other resources available through websites and from other sources that can provide materials to generate ideas. Some of these are listed in section 6.

3.3 Building towards mastery

> 'The man who removes a mountain begins by carrying away small stones.'
>
> (Chinese proverb)

If learners are to become secure in their mathematical skills, they will need opportunities to practise and apply the skills in a range of contexts, sometimes by consolidating the functional mathematics skills in manageable bites of learning. It may be that, before learners can tackle a big problem, they need to practise on smaller, more focused problems first.

To complete the following activity, learners need to apply their process skills and use a range of mathematical skills and techniques.

Running a car

Scenario

Running a car is an expensive business. According to the RAC, the average cost of running a new car in 2006 was more than £5,500 a year, of which about £2,400 was depreciation. Nevertheless, many people, especially young people, plan to buy and run a car.

Task

Investigate the cost of running a car. Compare it with your budget, or what you think your budget may be in the future.

Learners would need to consider the many costs involved, including insurance, tax, petrol, repairs, servicing and MOT costs, etc. While a complex problem such as this can motivate and enthuse some learners, some may need to tackle it step by step. More focused activities would help learners who tackle it step by step to develop and practise their process skills, and enable them to build the skills needed to complete the activity.

The following activity focuses on one aspect of running a car – the cost of insurance. This will enable learners to practise the process skills in a less technically demanding activity. Learners could be given support by being provided with data or with the sources where information can be found.

Should you take the risk?

Scenario

A major cost of running a car is the insurance premium you have to pay. You are planning to buy a car (or to change your present car).

Task

Choose three cars that you would like to buy. Make sure they vary in price, age and engine size. Get quotes for insurance on each, with you as the named driver, from different sources, for example using the internet, or by telephone.

Activities that provide opportunities to build skills in small steps will develop learners' autonomy in applying functional mathematics, enabling them to tackle more demanding activities as they become more confident.

Learners will also need opportunities to transfer their skills and apply them in other contexts. Problem-centred activities could be developed that will enable learners to make the links between a familiar context and one that is less familiar, as shown in the example 'Temperatures for tender plants' below. This activity requires learners to use their functional mathematics skills to inform decision making.

Temperatures for tender plants

Scenario

In February, March, April and May you have some tender plants in the greenhouse at the garden centre where you work. You need to have heating on if the overnight temperature is likely to fall below 4°C.

Task

Using information about temperatures in previous years, investigate the key periods when overnight heating is likely to be required in the greenhouse.

It is important that, at the end of each session, you encourage learners to identify the mathematical processes and skills they have used, and check that they understand how these can be applied in wider contexts. Learners will need to become familiar with the language used to describe the processes of problem solving in mathematics; they will need repeated opportunities to reflect on their practices and to develop their skills in describing these, using appropriate language. Eventually, learners should be so competent in recognising similarities and differences between the processes in different contexts that they are able to select suitable approaches for new situations. This is a necessary stepping stone to transferability.

Using formative assessment in this way will enable you to determine the next step for your learners, whether this is to consolidate the skills developed in a session through further activities that transfer to other contexts, or to plan for progression. Progression can be either horizontal, where the skills are practised until learners are secure in their application, or it could be vertical, where the skills are developed further towards the next level of functionality.

The following activity provides learners with the opportunity to apply their functional mathematics skills in a more challenging context. Learners are expected to be more autonomous about identifying the relevant information required, the mathematical techniques are likely to be more technically demanding and, although the context may be familiar, learners are less likely to be familiar with the task.

What a waste!

Scenario

Britain is Europe's worst waster of energy, with bad habits – such as leaving appliances on standby – set to cost households £11 billion by 2010, a study has claimed. (BBC News, October 2006, http://news.bbc.co.uk/1/hi/uk/6076658.stm)

You have seen many similar stories in the media and think that it should be possible to save energy in your home.

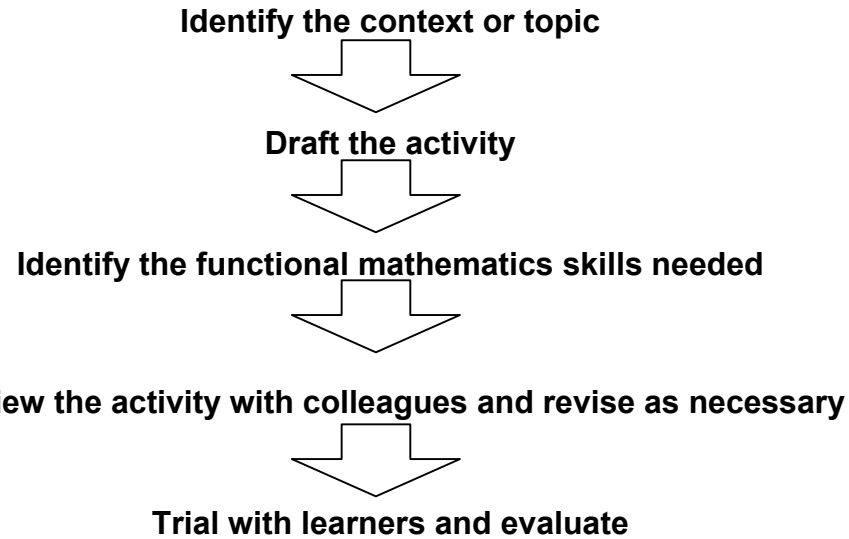
Task

Investigate ways you could reduce the use of energy in your home, and estimate some of the possible savings on fuel bills.

3.4 Writing problem-centred activities

> 'Knowing mathematics is doing mathematics. We need to create situations where students can be active, creative, and responsive to the physical world. I believe that to learn mathematics, students must construct it for themselves. They can only do that by exploring, justifying, representing, discussing, using, describing, investigating, predicting, in short by being active in the world.'
>
> Countryman, J. (1992) *Writing to learn mathematics* (p.2) Portsmouth, NH: Heinemann.

There are several stages in writing problem-centred activities that provide opportunities for learners to develop, practise and apply their functional mathematics skills.



Identify the context or topic

Identifying a context or topic that is realistic and purposeful is the first and critical stage in writing problem-centred activities.

A subject teacher, working alone, may be able to identify contexts where functional mathematics opportunities occur naturally and can be used to contribute to the main subject learning. However, it can be very effective for a subject teacher and a functional mathematics expert to work in partnership to identify contexts and develop authoritative problems. This combination of knowledge and expertise will produce activities that achieve both aims: subject focus and mathematics process.

The following activity was devised by an electrical engineering supervisor and a functional mathematics teacher working together. While soundly rooted in the vocational context, it has been designed to ensure that learners have the opportunity to practise and apply their functional mathematics skills.

Resistance and temperature

Scenario

Your supervisor has given you the job of rewiring a house that has been heavily insulated in the loft. The resistance of wire increases with temperature. In the height of summer, the temperature in the loft can reach 50°C.

Task

Investigate whether the 2.5 mm² annealed copper wire usually used for this purpose will be suitable for this particular job.

It is unlikely that many functional mathematics teachers will have the knowledge of the engineering context to be able to develop this activity on their own. The expertise of the engineering supervisor is critical to ensuring that the context is authentic but they will need guidance from the functional mathematics teacher if they are to get the level right.

Partnership teaching, where the subject specialist and the functional mathematics teacher work together to plan, prepare and deliver the lessons, can also be highly effective. This collaborative working enables the functional mathematics teacher to identify the mathematical skills that underpin the subject content and devise relevant activities that will provide opportunities for learners to practise and apply their functional mathematics. This, in turn, will help learners to achieve their core learning aims.

In other provision, the activity can be led by the learners' expressed interests. The following activity has been devised to encourage a learner with a keen interest in competitive weightlifting to develop and apply mathematical skills.

Weightlifting competition

Scenario

You are taking part in a weightlifting competition in 12 weeks' time and have high hopes of winning a trophy. You know that you will need to prepare a detailed programme of training for the coming weeks.

Task

Using the template provided*, plan a programme of training for the 12 weeks that will ensure that you are at peak fitness for the competition.

*a template for the weightlifting programme should follow the accepted format for such programmes in the real world.

The activity could be adapted for a learner who is keen on another sport.

Another way to challenge learners to apply their functional mathematics skills is to suggest that they develop an activity for another learner. This will enable them to identify and demonstrate their knowledge and understanding of the functional mathematics skills as well as using a range of other skills.

Sources of ideas and contexts

There is an almost limitless supply of ideas and sources for activities. Examples follow.

- A current news item, opinion polls, or data from National Statistics Online (www.statistics.gov.uk) can be used to develop a functional skills activity, for example national statistics about health, crime, and other issues can be compared with regional and local data, as in the example following.

Texting

Scenario

> 'Adults aged 55 and over are most likely to have a mobile phone for use in an emergency; those aged under 25 are most likely to have a mobile phone to text their friends and family. In 2005, 94 per cent of adults aged from 16 to 24 had sent a text message compared with 17 per cent of those aged 65 and over.'
>
> *Focus on the Digital Age*, Office for National Statistics, www.statistics.gov.uk/focuson/digitalage/

Your English teacher has read this report about the use of mobile phones for text messaging. She feels that it is an underestimate for the 16–24 age group.

Task

Research how people in your school, college or workplace use mobile phones for texting. Decide if the data you collect reflects the national statistics and present your findings to your teacher.

- Subject-specific topics can provide functional mathematics opportunities, for example interpreting plans in a construction course and deciding on the resources required; predicting inheritance to advise on potential cross-breeding.

Dimensions and deviations

Scenario

Many thousands of bricks are used every day in the UK construction industry. Bricks should be made to British Standard 3921:1985*, which outlines the coordinating size and work size of bricks and the dimensional deviation allowed.

Task

In your workplace, test a sample of bricks to determine if they meet the British Standard.

*You would need to ensure that learners are aware of and have access to the relevant British Standard. This type of activity could be usefully introduced after learners have covered the knowledge about brick sizes and British Standards in their subject learning.

- Everyday topics that are of interest to learners can be used as a basis for activities, for example deciding on the best buy from a range of options; fundraising to support a local environmental issue; finding the cost of a holiday for four.

New home for newts

Scenario

An article in your local paper highlights the threat to the population of newts in the park near your home due to the rubbish being dumped by visitors. You decide to enlist the help of friends to raise £100 to clean up the pond and make it environmentally safe for the newts.

Task

Consider the different ways you could raise the money and decide on the best option to put to your friends.

- Learners themselves can provide ideas for functional mathematics. Many learners will have an interest that can be harnessed to provide a scenario for an activity, for example sports, hobbies, leisure pursuits, cars. The following activity was devised for a learner who had a keen interest in Formula One motor racing.

Formula One

Scenario

Formula One is a very expensive sport. It is important that a team does well in the Constructors' Championship if their sponsors are to continue to provide the money to run the team.

Task

Investigate how the different teams in Formula One have performed over the last ten years. Present your findings to a group of your fellow students. Decide which team you would advise a sponsor to support next year and explain your reasons.

Many purposeful activities will enable learners to use a range of functional skills, not just in mathematics. In many of the activities in this section there are opportunities for learners to develop and practise ICT skills, for example searching the internet, producing a graph to present data, and English skills, such as writing a questionnaire, producing a report, engaging in discussion.

In the real world, functional skills are not used in isolation. Making the links with other functional skills will increase learners' opportunities to use and apply the skills in a range of contexts.

Draft the activity

Having decided on the context or topic, you will need to consider:

- the purpose of the activity
- the scenario
- what learners will be expected to do
- what results learners should produce
- how the functional mathematics process skills of representing, analysing and interpreting can be used to complete the activity.

Presentation and the use of language are important. Activities should be concise and should be written in language that learners will understand. Structure, style and readability are all important.

Structure

If you are developing a number of activities, it will help learners in the early stages if they all contain the same elements and follow the same format; learners will know what to expect. However, as learners become more confident in their mathematical skills, it may be appropriate to devise activities that are less structured, allowing learners to use a greater degree of autonomy to determine the processes and information required. This is particularly relevant for higher-level learners, but it is worth noting that real-world problems tend not to come in a structured format, so learners at every level will benefit from being provided with activities that vary in the degree of structure.

A structured activity should include:

- the title – short and informative, but exciting the interest of the learner
- an overview – this may be through a scenario, but should set the scene for the activity and outline the context
- the task or tasks – what the learner has to do
- the outcome – what the end result should be; what the learner should produce
- resources – any materials required to complete the activity, or guidance as to where they can be found, as appropriate to the level of the learner
- the timescale for delivery of the completed task.

It may also be useful to show the links to main subjects, if appropriate.

Writing style

Key points for good style include the following.

- Address the learner directly in your writing – use 'you'.
- Avoid the passive wherever possible.
- Avoid ambiguity. It is easy to make assumptions – you know what is involved but learners may not.
- Keep paragraphs short and to the point.
- Use simple direct words rather than complex or formal language.
- Use short sentences.
- Use words that learners are likely to know and understand. Define any new technical terms at the first time of use.
- Use bullets or numbered lists as appropriate.

Readability

An activity should be clear, easy to read and attractive to learners. Here are some Do's and Don'ts to keep in mind.

- Don't try to fit too much on a page.
- Do avoid clutter; use lots of white space.
- Do use a typeface that is easy to read.
- Don't use lots of different typefaces.
- Do use headings where appropriate, but don't use unnecessary capital letters.
- Don't use images that are not relevant to the activity.

(Adapted from *Good practice guide – writing assignments*, KSSP, and *Using and developing key skills assignments – guide to good practice*, KSSP, 'Learning for work')

This good practice extends to any source material you might develop to support the activity.

Identify the functional mathematics skills needed

As explained in section 1, the functional mathematics process skills apply at all levels. For an explanation of differentiation between the levels, see pages 25–27.

A task or activity should be considered in terms of its level of demand in relation to its complexity, familiarity, technical demand and the independence required of the learner.

An activity can be differentiated for different levels and, where appropriate, to meet the needs of individual learners. For example, activities could provide more or less learner support. For lower-level learners this might mean providing additional guidance in the form of resources, more teacher input, or breaking down the task into smaller chunks. For higher-level learners it could mean more demanding outcomes, greater complexity in the tasks required, and multi-stage interrelated tasks.

This stage also provides an opportunity to identify links with other functional skills. The following activity requires functional mathematics, but learners will be able to approach the activity with more confidence if they are able to apply functional English and ICT skills as well.

Travelling on the job

Scenario

You have just got a new job in the London area as a computer technician. It will mean regular travel by car to offices in Central London (SW1), Slough, Epsom, Bexley, Chigwell and Watford.

Task

Your employer has promised to help with the removal costs to relocate from Newcastle if you can provide an estimate. Where would be the best place to live, taking into account the travel costs and time taken?

The activity can be adapted to make it more relevant for learners by using local places and contexts.

Learners could use their functional ICT skills to search for and determine the mileages between the offices using a route planner. They could also use their functional ICT and functional English skills to present the final estimate to the employer.

With all problem-centred activities, it is important to give effective formative feedback, as this will enable learners to confirm their skills and identify areas for further development. It is worth identifying opportunities for formative assessment at this stage of the writing process.

Review the activity with colleagues and revise as necessary

You should ask colleagues for comment on the relevance, accessibility and authenticity of draft activities. Involving them in this way will also widen support and ownership of activities, and generate ideas for further development. It is easy to be limited by your own knowledge and interests when writing activities for learners, and new ideas and suggestions should always be welcomed.

Developing a checklist for reviewing activities, alone or as a team, will prompt everyone involved in writing activities to look for the same key points. This is a starting point for your checklist.

- Is the activity purposeful?
- Is the activity relevant and interesting?
- Is the task clear and explicit?
- Is the activity achievable for learners?
- Is the language used appropriate to the level?
- Is the context authentic and realistic?
- Are the supporting materials (if any) appropriate and sufficient?
- Will the activity enable learners to develop, practise or apply functional mathematics skills?
- Are there any health and safety issues?
- Does the activity afford equal opportunities for all learners?

(Adapted from *Good Practice Guide – Writing assignments*, KSSP)

Finally, you can revise the activity, if needed, and move on to trialling it with learners.

Trial with learners and evaluate

Learners' feedback on an activity will help to tell you whether it was effective, although you will need to be clear about the type of feedback you want. You could ask learners for their opinion of an activity informally through group discussion, or formally through a short questionnaire.

With support and encouragement, learners are usually keen to express their views. Key areas you might want to ask them about include the following.

- Did you find the activity easy to understand?
- Did you have or could you find all the source material you needed to complete the activity?
- What skills did you use to complete the activity?
- What did you like about the activity?
- Was there anything you didn't like or found difficult?
- What did you learn from the activity?

This feedback will enable you to revise or adapt the activity to meet different learners' needs and interests. It may also generate further ideas for activities and engage learners in the development process. In fact, you could add a final question asking learners for suggestions that could be used for writing future activities.

Top tips

- Be open to finding sources of ideas and activities in the most unlikely places.
- Listen to learners – they may provide ideas or topics of interest that you can develop.
- Be aware of links with other functional skills and other subjects, courses and programmes.
- Working in partnership with a colleague can enhance the process of writing activities and increase the stock of ideas.

4. Cross-curricular activities

Contents

Learners who are functional in their mathematics can transfer their mathematical skills to a wide range of contexts. They can select the appropriate techniques and carry out calculations to solve different problems. They can use mathematics in their everyday lives, including in their work at school or college, in their jobs, in making shopping decisions, or in managing their personal finances.

This section contains example activities set in a range of contexts and at various levels. Some contain opportunities to develop learners' functional skills in ICT and in English in the context of mathematics.

As a specialist teacher of functional mathematics, it is part of your role to promote the embedding of functional mathematics across the whole curriculum. It is essential that learners come to recognise that 'mathematics is everywhere' and that it is not just 'what people do in maths lessons'. This section offers some suggestions and ideas for you to discuss with subject-specialist colleagues so that you can work together to embed mathematics across the curriculum. You should try to ensure that your colleagues use the correct terminology when discussing functional mathematics with learners.

In some of these examples, such as the activities that use and develop functional mathematics in GCSEs, the demand of the mathematical process skills and techniques are suitable for learners at Level 1 or 2. Other examples are more appropriate for Entry level learners. Most are suitable for groups of learners with a range of ability levels and some hints are given to meet the needs of differentiation within a group or for different groups of learners.

Where possible, there is an indication of how activities can be adapted to use in different contexts. For example, a customer service survey could be used in a range of different situations, and an example involving the cost of supporting a football team would be equally suitable for a team in any sport.

Every care has been taken to ensure that the activities do not discriminate against any group of learners because of differences in gender or cultural background.

4.1 Functional mathematics in GCSEs

Most GCSE subjects have opportunities to develop functional mathematics. If we identify these opportunities and make the most of them, mathematics becomes a contextualised part of the whole learning experience and not just something that is 'done in maths lessons'.

Applied art and design – working to project briefs

In this unit, learners are required to meet a project brief for a client. The specification states that this must take into account the constraints of cost and time. Mathematical techniques are clearly involved here and can be addressed in a way that emphasises the financial and time implications of meeting a customer's requirements.

Applied business – business finance

Preparation for this unit will require learners to develop a whole range of mathematical techniques associated with finance and as such cover different types of calculations and the use of formulae at levels 1 and 2. There are also excellent opportunities to develop the use of IT for accounts and financial forecasting.

If the problems are set in context, learners will have opportunities to develop the functional mathematics process skills as well as the mathematical techniques that they need to demonstrate both for the unit and for their functional skills.

Suitable activities would include:

- covering costs of a new product or service
- creating a cash flow forecast
- creating a budget
- calculating the break-even point
- calculating profit and loss.

Applied ICT

Learners will have opportunities to develop some mathematical techniques when they study the use of spreadsheets in units 1 and 2, carrying out simple calculations and producing graphs and charts. This can be taken further if they study how spreadsheets are used in a business context.

Applied science

There are opportunities to develop functional mathematics techniques and processes in all the applied science units, but the unit 'Science at work' appears to be particularly rich. The portfolio of evidence is an ideal place to

demonstrate functional mathematics skills at either Level 1 or 2, depending on the individual learners and their application of the process skills and coverage.

The portfolio investigations will develop mathematical techniques that involve extracting and interpreting information, and applying the four operations to solving problems associated with yield, mass, cost, force and work efficiency. They may involve the use of formulae, and manipulating statistical information. There are also opportunities to check the accuracy of the results and present the information in appropriate ways.

Business

Different awarding bodies offer different units, but many topics lend themselves to developing functional mathematics, including the following.

Accounting and finance

Learners can develop and use their skills of representing, analysing and interpreting information in activities with budgets, cash flow forecasts, costs, break-even analysis and final accounts. They are also asked to calculate and interpret ratios to assess business performance. Any activity in these fields is likely to provide opportunities to develop functional mathematics process skills and techniques such as carrying out calculations using decimals in practical contexts, using formulae and interpreting results.

Marketing

There may be opportunities in this module to plan and carry out market research for a company or product. This type of activity will develop the process skills and the techniques of data handling to collect, represent and interpret data and to use statistical methods to investigate situations. It is also likely to involve the use of ICT.

Design and technology – designing and making

The options in design and technology offer a variety of opportunities to develop and practise functional mathematics processes skills and techniques. The ‘Designing and making’ component offers the best opportunity to follow through the process skills and apply the appropriate mathematical techniques as learners are required to carry out product analysis, model their findings, use a range of mathematical techniques and select effective methods of presentation, including the use of ICT as appropriate.

Engineering – design and graphical communication

This requires learners to develop a solution from a client design brief.

The specification requires the following elements:

- analysing client design briefs
- developing design specifications and solutions

- applying scientific principles
- producing and reading engineering drawings
- selecting appropriate drawing techniques
- communicating a design solution
- presenting the portfolio and prototype to the client.

To develop design ideas learners must be able to use the techniques of:

- research and analysis of information and data
- generation of ideas and solutions
- evaluation of ideas, solutions, testing and subsequent modifications
- two-dimensional and three-dimensional drawing and sketching techniques
- modelling techniques.

The GCSE engineering website provides a wealth of information and a number of assignments to support this unit. See www.gcseinengineering.com.

All these assignments, and any other task that meets the requirements of the unit, will provide an ideal model to develop and evidence functional mathematics at Level 1 or Level 2. The elements relate to the process skills and the mathematical techniques will be appropriate to the coverage/range. It is likely that an assignment that meets GCSE grade A*-C will be suitable for Level 2 functional mathematics.

Geography

The geography curriculum is a rich source of opportunities to develop and practise functional mathematics. The study of physical, human and economic geography involves learners in research, processing data and presenting their findings. Broadly speaking, the coursework projects are graded on the process skills of functional mathematics and include:

- collecting and selecting primary and secondary data
- representing data
- analysing and interpreting findings
- drawing conclusions.

The study of population, settlement, economic activities and energy are a few of the appropriate examples. Learners will use all aspects of the functional mathematics techniques, including statistical analysis, different types of calculation, and a variety of different methods of presenting their findings, including the use of ICT, as identified in the coverage/range statements in the functional mathematics standards.

Health and social care – promoting health and well-being

When learners carry out their investigations for this unit, they are likely to develop a variety of mathematical techniques associated with interpreting measurements such as blood pressure, peak flow, body mass index and pulse readings using graphical and other formats. They will probably carry out calculations involving weight and height, pulse rate and diet, use a formula to calculate body mass index and use ratios of, for example, smokers to non-smokers in a particular group of people. They may do some statistical analysis, perhaps comparing data from a group of people with the national statistics on obesity or incidence of heart disease. They will present their findings as part of their final report.

ICT

Coursework projects involving the use of spreadsheet software are likely to provide opportunities for learners to develop and practise their functional mathematics process skills and techniques. They may involve planning, making initial models of situations and deciding on methods and mathematical information to use. The processing and analysis of the data and interpretation and communication of results will include the use of ICT to carry out calculations and present findings.

Leisure and tourism – marketing in leisure and tourism

Although it is not required, learners may choose to carry out some research, compare their findings with marketing information, and present the result in a statistical format. This would give learners opportunities to develop their functional mathematics process skills and techniques. They may also use ratios to compare the marketing mix of their sample with the ideal mix. This may develop skills and techniques at Level 1 or 2.

Manufacturing

GCSE manufacturing is rich in opportunities to develop functional mathematics process skills and techniques at Levels 1 and 2 through:

- making sense of situations and representing them
- processing and using mathematics
- interpreting and communicating the results of analyses.

Activities are set in both familiar and unfamiliar contexts, the calculations are set at an appropriate level of difficulty, and learners are required to select and adapt their own models to arrive at a solution. There are opportunities to develop the full range of mathematical techniques at Level 1 or Level 2 as appropriate to the learner and the context.

Unit 1 – Designing products for manufacture

Learners are required to consider production details and constraints, properties of materials, scales of production and costs as part of developing a design solution. They will carry out a range of calculations associated with raw materials or ingredients, labour costs, product dimensions, tolerances, scale models, quality control, probabilities and use of formulae. They will present the results as part of a design solution.

Unit 2 – Manufactured products

In this unit learners will interpret technical information about components, ingredients, materials, etc. from a production plan, calculate and maintain levels of resources, identify correct calibrations on machines, work with dimensions, quality control, probabilities and formulae, and present the findings in a production schedule.

Unit 3 – Application of technology

Unit 3 involves investigating a manufactured product and the impact of new technology, interpreting technical information, carrying out a range of calculations involving dimensions, quantities and scale, using formulae and statistics about, for example, market share, range of products and energy consumption.

The GCSE manufacturing website offers a wealth of suggestions and teacher support materials. See www.gcseinmanufacturing.com

Mathematics

Learners will usually develop their functional mathematics techniques in specialist mathematics lessons but they will also need opportunities to develop all their functional 'process' skills. If the problems that learners tackle in mathematics lessons are limited to the development of mathematical techniques (the analysis part of the process), they will have little opportunity to use the representing and interpretation skills that are also core to functional mathematics.

Learners will have opportunities to develop and practise all the functional mathematics process skills if they are given more open-ended activities that require a problem solving approach such as that described in section 2.

Physical education

Learners will have opportunities to develop and practise their functional mathematics process skills and techniques as part of their physical education course. They may be required to collect primary and secondary data, analyse performance, including making comparisons against benchmark data, and present their findings using ICT as appropriate.

Science

There will be opportunities for learners to develop and practise their functional mathematics skills throughout their GCSE science programme. They are likely to have opportunities to plan and carry out experiments and analyse and present the results, do research and compare results to benchmark data, using formulae to calculate results. Presenting learners with open-ended tasks will help them to develop their functional mathematics process skills alongside their scientific knowledge and techniques.

4.2 Functional mathematics in work experience

Analysing how time is spent

This activity could be carried out on work experience or applied to full-time, part-time or holiday jobs. It gives learners the opportunity to develop the three process skills, using their mathematical techniques at the appropriate level.

> **How did I spend my time?**
>
> Your task is to do an analysis of how you spend your time during work experience. You should include all the activities you carry out as part of your work, including breaks and the different jobs that you have done each day.
>
> You will need to decide how you will record the information, what calculations you will do and how you will present the findings.

The task appears straightforward at first glance, but the learner will have to make a number of decisions about collecting the information, such as what they will need to record and how they will record it.

They have been asked to 'analyse' their time, which should make them think about using statistical methods. At levels 1 and 2 they could be using a range of statistical techniques to analyse and compare their use of time. Level 2 responses would include justification as to why they have used particular techniques.

Learners are required to present their findings in a way that is suitable for the audience, which might consist of fellow-learners, a group of teachers, managers at the workplace, or any other group that you nominate. The findings might be presented as a written report or as an oral presentation with visual aids. Learners may use ICT for both the calculations and the presentation, and will possibly use appropriate graphics, such as pie charts. This will enable them to practise their functional ICT skills.

The activity also gives learners an opportunity to practise and develop their functional English skills, perhaps by giving a presentation (speaking and listening) or in a written report.

Adapting the activity

This activity is appropriate to learners at different levels from any cultural background and in any vocational context that includes recording time. For example, at Entry 3 learners may keep a record of appointments in a diary at a hairdressing salon, making sure that they leave enough time for each type of treatment and that there are not too many clients in at any one time.

Learners can be given more support at the lower levels, for example by providing templates, additional information or more structured guidance. This will enable learners to approach challenging problem-centred activities with more confidence.

Changing the level

Entry 2	Learners write down the time they start and finish activities on a recording sheet you have provided.
Entry 3	Learners estimate the time it will take to carry out a task (in minutes). They use a diary or other recording sheet to write down the start and finish time and check the time taken against the estimate. They compare times taken to do different tasks.
Level 1	Learners at this level may need some guidance, but the final decisions about how they carry out the task should be their own. These decisions include what to record of their daily activities and how to do this, what calculations they will use and how they will present their findings. They may not carry out a wide range of different tasks. The analysis may include calculations of mean and range for their different activities and the use of appropriate charts to draw some straightforward conclusions about how they have used their time.

Customer service

This activity requires learners to plan and carry out a survey about the canteen or restaurant in their school, college, training centre or place of work.

Your opinion matters!

Some of your friends have been complaining about the food and service in the canteen. They say that everyone is fed up, the food costs too much and the service is poor. Are they right?

Find out what other people think about the canteen. Plan how you will do this, analyse your data, and present your findings to the canteen manager.

Here are some things for you to consider:

- You may want to ask about prices, menus, cleanliness and service in general.
- Will you give people a questionnaire to fill in or will you interview individuals and record their answers?
- What calculations will you need to do?
- How will you present your results?
- Will you need to use IT facilities?

This is presented as a Level 1 activity with a list of hints to help the learners to plan and carry out the survey. The coverage/range of mathematical techniques at this level includes collecting and recording discrete data and finding the mean and range.

Adapting the activity

Data handling techniques are included in the coverage/range at levels 1 and 2 although the process skills required may be higher or lower than this. Practising the process skills for this type of activity will help learners to develop their skills in real contexts.

A customer satisfaction survey can be adapted to use in any café, restaurant or canteen in a garden centre, shop, leisure centre, retirement home, etc. It could also be adapted for other service industries, such as a survey of customer satisfaction in a hairdressing salon (including questions about prices, treatments, cleanliness, courtesy), estate agent (courtesy, accuracy of house details), garage (customer care, speed of service).

Changing the level

Level 2

For Level 2 learners it would be more appropriate to omit the advice and suggestions. This would give learners more scope to develop their process skills at the appropriate level.

At Level 2 you would expect a wider range of data handling techniques, and justifications for the methods used and the results. Learners may decide to compare customer numbers and waiting times at peak and off-peak periods, the range of food available at different times of the day, average spend per customer, and other relevant information. They may also decide to interview the canteen manager to find out the other side of the story – costs, staffing, etc. – which would show that they are representing and analysing the situation more effectively. You would also expect the report to show signs of clear thinking in terms of interpreting the findings and appropriate use of the mathematical analysis.

Mixed level groups

You could present the task to all learners in the group without the list of hints. Those who need more guidance to demonstrate their process skills at Level 1 could then be given the extra information to help them with their planning.

4.3 Functional mathematics in the workplace

Most jobs include activities that can be used to develop and practise functional mathematics processes and techniques. In catering, hairdressing, horticulture and care, for example, there are situations where learners are required to plan and carry out activities that involve weighing and measuring, using ratio to mix colours or chemicals and scaling quantities up and down. Measuring areas, quantities and volumes is fundamental to the construction industry. Calculations involving money are essential to retail and service industries.

Monitoring stock

All retail businesses have to monitor sales, stock levels and wastage. The activity could be to study how the process of stock control is carried out in a particular work environment or to develop a stock control system for a business. At Entry level, learners may help with stock-taking and plan how they will count and record the stock. They may be asked to fill in their findings on a standard form. Learners at Level 1 may be asked to calculate the value of stock in a section of the stores. This activity could be adapted to any context that involves control of stores, for example residential care, or the hospitality and catering industry, looking at packaging, storage, wastage, costs, etc. in a restaurant, sandwich shop or canteen.

Measuring up or costing a job

Measuring up a job, working out the materials needed and working out the cost is an essential task in all areas of the construction industry and can be adapted to many other contexts, for example planning hard landscaping or planting in horticulture, designing and costing a set for a drama production.

Design and layout

Planning the layout of a reception area in a hairdresser or other business, a play area in a nursery, the day room in a care home or day centre, or car parking, all involve measuring, calculating and considering a range of options. This could be extended to taking into account the cost of a number of alternatives.

Planning a route

In the context of a business that makes deliveries, the activity will involve using maps to plan a route, with mileage and approximate timings for the van or lorry driver, to minimise journey times and mileage and inform customers of approximate delivery times. It could be adapted to any context where someone has to travel from place to place during their working day, such as contexts for health visitors, TV repair engineers or couriers.

4.4 Functional mathematics in citizenship

There are many opportunities to apply functional mathematics in citizenship. Surveys and investigations into local and national crime figures, central government and local council spending, and issues such as sustainability, recycling, local business trends and many more can be used to embed mathematical processes and skills.

Crime statistics

This activity will allow learners to practise their research skills to find information at both national and local level and relate their findings to their own experience.

How likely am I to be a victim?

This activity involves a study of local and national crime statistics.

The local and national press and TV are full of stories about violent crime. They sometimes give the impression that it is not safe to walk the streets.

But what is the real situation? Are things really that bad? Are they worse in some areas than others? Are some groups of people more at risk than others?

What do the official statistics of crime tell you?

Setting the level

In this case, the level has been left open so that the activity can be used at a range of different levels.

Level 2	Learners would probably be able to approach this activity with very little guidance, especially if they have well-developed process skills. They may search the crime statistics on the internet, for example starting with www.crimestatistics.org.uk, and compare the local and national figures. They may also make a study of the local events by studying back issues of the local paper.
Level 1	At this level it may be necessary to give learners some help with planning their activity, pointers to finding the information they may need and more support as they carry out the process and complete their analysis of the situation.
Entry level	Learners may be given some simple statistics, perhaps in the form of a table, pick out the relevant information, and draw some conclusions.

Council spending

This is another activity that could be used as part of a citizenship programme as well as an opportunity to practise processes and techniques in functional mathematics. It is an investigation of how the local council raises money and what the council spends it on. It will give opportunities to use IT to search for information, carry out calculations and present results in a variety of different ways.

> **So what do they do with our council tax anyway?**
>
> Have you ever wondered what council tax is spent on? Now is your chance to find out.
>
> Check out the range of local services that the council provides in your area and see what you can find out about how they are funded and where the money comes from.

Adapting the activity

It would be possible to adapt this activity to investigate other forms of public funding, such as health spending or, on a smaller scale, the funding for a school or college. Alternatively learners could look at the finances of a charity, for example how the income is raised and how it is spent.

Changing the level

This is another open-ended activity which could be used by learners at different levels and by mixed-ability groups.

Level 2	The teacher presents the activity as given here.
Level 1	Learners may need more support – perhaps a list of hints and some ideas to get them started.
Entry level	Learners could be given a council tax bill and perhaps the local council information sheet or newsletter to find out as much as they can about how much money is raised, where it comes from and how it is spent. The amount of information and support given will depend on the ability level, but learners should be given opportunities to practise the process skills as well as the performance and coverage/range for their level.

In the news

This activity focuses on some issue of global importance, such as global warming or child poverty. Learners would be given some stimulus, for example a newspaper article, a podcast, an item from the BBC news website or a recording of an item on the national or local news. Their task would be to find appropriate statistics and compare their findings to the news items. This

may be useful as a group activity, where learners compare the results of searching for information from different sources.

4.5 Functional mathematics in personal finance

Financial matters are of interest to all learners of all ages at all levels. From the simple 'Have I got enough money to buy a cup of tea and a bun?', to the slightly more difficult 'If I catch the bus home and have chips at lunchtime, will I have enough money left to go to see a film this evening?', to 'Can I really afford to buy and run a car or should I get a motorbike?'

Several financial institutions have websites and resources that can be used for financial literacy topics and there are opportunities to develop and practise the processes and techniques that learners need to develop their financial awareness. An internet search on 'Financial literacy' will bring up a number of sites to check, for example:

'NatWest Face2Face with Finance' on www.natwestf2f.com is designed for use by learners aged from 11 to 18 years.

'Money matters to me' is a website developed by NIACE and supported by Prudential plc that focuses on family finances. See www.moneymatterstome.co.uk

'Support for learning, Financial education' provides dozens of links to websites about all aspects of personal finance. See www.support4learning.org.uk/money/financial_education.cfm

The following activities address spending, borrowing, saving and investing.

Spending

The following activity may be useful for Entry level learners to develop and practise their functional mathematics process skills and techniques. It is based on a shopping activity and focuses on finding the best value for money.

What is the best buy?

When you go shopping for food, do you look out for bargains? Next time you go to the supermarket or local shop, see how many things on your shopping list are on special offer and check how much you could save on the normal price. Try to find different types of reductions and 'best buys'.

Try to answer the following questions:

- How much have I spent?
- How much have I saved?
- Are 'offers' always cheaper?

Which reduced items did you find that you didn't buy? Why didn't you buy them?

This activity has some guidance to support Entry level learners. It may be useful to start the work with a discussion about when and why goods are reduced, for example when they are near their sell-by date or because they are not popular. Other points to discuss may be the cost of large sizes – are they always cheaper? If buying a large size of a food product, can you use it all before it is past its best?

There are some useful materials, for example in the *Skills for Life materials for embedded learning – social care,* module 4 'Figure it out' which may be useful for learners to practise the mathematical techniques and help with discussions in preparation for the activity. See www.dfes.gov.uk/readwriteplus/embeddedlearning/

Adapting the activity

Although aimed at personal shopping in a supermarket, the activity could be adapted for a range of contexts, including the social care example mentioned above.

Changing the level

Level 2	Learners could be given a budget and a scenario such as catering for a large party at the end of a course, an important birthday, or a family celebration. If they are in work, an opportunity may arise for a leaving 'do' or retirement party.
Level 1	As Level 2, with more guidance.

Borrowing

Can I afford this?

Store cards can be a tempting way to secure a discount on your shopping but shoppers often end up paying extra through high interest charges.

Imagine that you're at the checkout, weighed down with purchases, and the assistant at the till offers you a 10% discount on everything – if only you'll sign up to use the shop's handy store card.

Are you really being offered something for nothing, a nice discount and an opportunity to buy now and pay later? What is the catch?

Here are some things to think about.

- Research different store card charges and then compare the alternatives, such as paying cash, using a credit card or getting a bank loan.
- Base your calculations on the cost of buying something that you really want – perhaps a new outfit, a flat-screen TV with DVD player, a bike or something else.

This activity has been written for Level 1 learners, hence the 'Here are some things to think about' section. The activity still allows considerable scope for applying the process skills and selecting appropriate mathematical techniques.

Adapting the activity

The activity could be adapted to look at other methods of personal borrowing, with the emphasis on credit cards, bank loans, finance deals to buy a car, or 'buy now, pay later' schemes that are popular with electrical and furniture retailers.

This could also become a group activity. There are other ways of borrowing money and perhaps learners could investigate as many schemes as they can find, looking at the 'pros and cons' such as interest rates, secured and unsecured loans, credit ratings, maximum and minimum amounts for advances, etc, and ranking them based on a set of criteria that they have decided as a group. An investigation of this kind would be open-ended and decided by the group, with each individual playing their part. It could be appropriate to include mixed-ability learners in the group.

Changing the level

Level 2	Remove the 'Here are some things to think about' section to give learners control of the process and the mathematical techniques that they will use.
Level 1	Use as provided.
Entry level	Learners can investigate leaflets or other advertising for store cards and credit cards. They could use examples of store card and credit card bills and identify the purchases, amount of interest and the interest rate.

Savings

Learners can compare different types of savings, including National Savings, premium bonds, deposit accounts, ISAs, etc. This may involve looking at interest rates, regular savings, minimum balances and loss of interest for withdrawals. Learners could also consider aspects such as how safe the money is.

Investments

This activity looks at investing money.

Groups of learners investigate different types of investment, develop and track their investment portfolio, and keep within a set budget. The activity could be set up as a competition with small groups selecting different types of companies and investments to compare performance over a set period.

This type of activity is suited to learners on business courses or those with an interest in investments and the stock market. It provides an excellent opportunity to develop Level 2 functional mathematics process skills in a realistic though simulated activity which is carried out over a period of time.

For those who want to take this activity further, the 'ifs School of Finance' includes the 'Student Investor Challenge' and 'Uni Investor Challenge'. See www.ifslearning.com/financial_capability.

4.6 Functional mathematics in hobbies and interests

Most learners will be able to identify with activities associated with their hobbies and interests and may be more willing to work with such a topic, rather than following a set task. There are functional mathematics implications in most hobbies. Decisions associated with costs of materials, equipment, travelling, membership fees, etc are often important when deciding to take on a new hobby.

Following sport

Are they worth it? The cost of being a supporter

Do you support a particular football team? Do you go to home games? Do you follow your team to away games? Do you buy the team's merchandise?

Have you thought about the total cost of supporting your team for a whole season?

This very open-ended activity gives learners an opportunity to work out exactly how much they spend on supporting their team.

Adapting the activity

The activity could be adapted to look at following other sports, perhaps motorbike racing, ice hockey or athletics. It may be interesting to consider the cost of following a favourite band. In a wider context, all hobbies have cost implications such as travel expenses, equipment, materials, special clothing, entrance fees, membership fees, etc. Learners may like to look at the cost of taking up a new hobby or pastime.

Changing the level

Level 2	As it stands, this activity would give Level 2 learners scope to develop and practise their process skills and techniques for functional mathematics. They can compare the cost of different options for travelling, buying a season ticket, joining a supporters' club, etc.
Level 1	Learners may need some extra guidance to get started on this activity.
Entry level	Learners can investigate prices of tickets and work out the cost of going to all the home games. They could look at travelling to a particular away game and sort out times of trains or buses and the cost of tickets.

Cooking a meal for friends

This would involve planning a menu, working out quantities for recipes (scaling up or down), and associated costs. The activity could be adapted for different levels of learners. Starting with a recipe for a main course for four people and a price list for a range of desserts, an Entry level learner could be asked to plan a meal for two people and find some prices. For Level 1 or Level 2 learners, this may entail being given a budget, recipes and other information and asked to plan a larger event, maybe for nine or ten people.

Downloading music

Learners may be interested in a technical investigation associated with speed, bandwidth and memory size.

5. Assessment, progression and mastery

Contents

This section will help practitioners to assess and support their learners as they become more confident and make progress in functional mathematics. It is intended to support teachers in using assessment for learning in relation to functional mathematics.

The section has four key messages.

- Assessment in functional mathematics should relate to the process skills set out in the standards – representing, analysing, interpreting.
- Learners may have spiky profiles in these process skills, ie they may have made more progress in relation to one or two of the skills than in the other(s).
- Progression in relation to the process skills relates to the degree of challenge of the problems solved – this includes their complexity, their familiarity, the difficulty of the mathematical techniques employed, and the degree of independence given to learners.
- Judging when learners have achieved a level involves assessing their work in relation to the performance statements and the coverage/range statements in the standards.

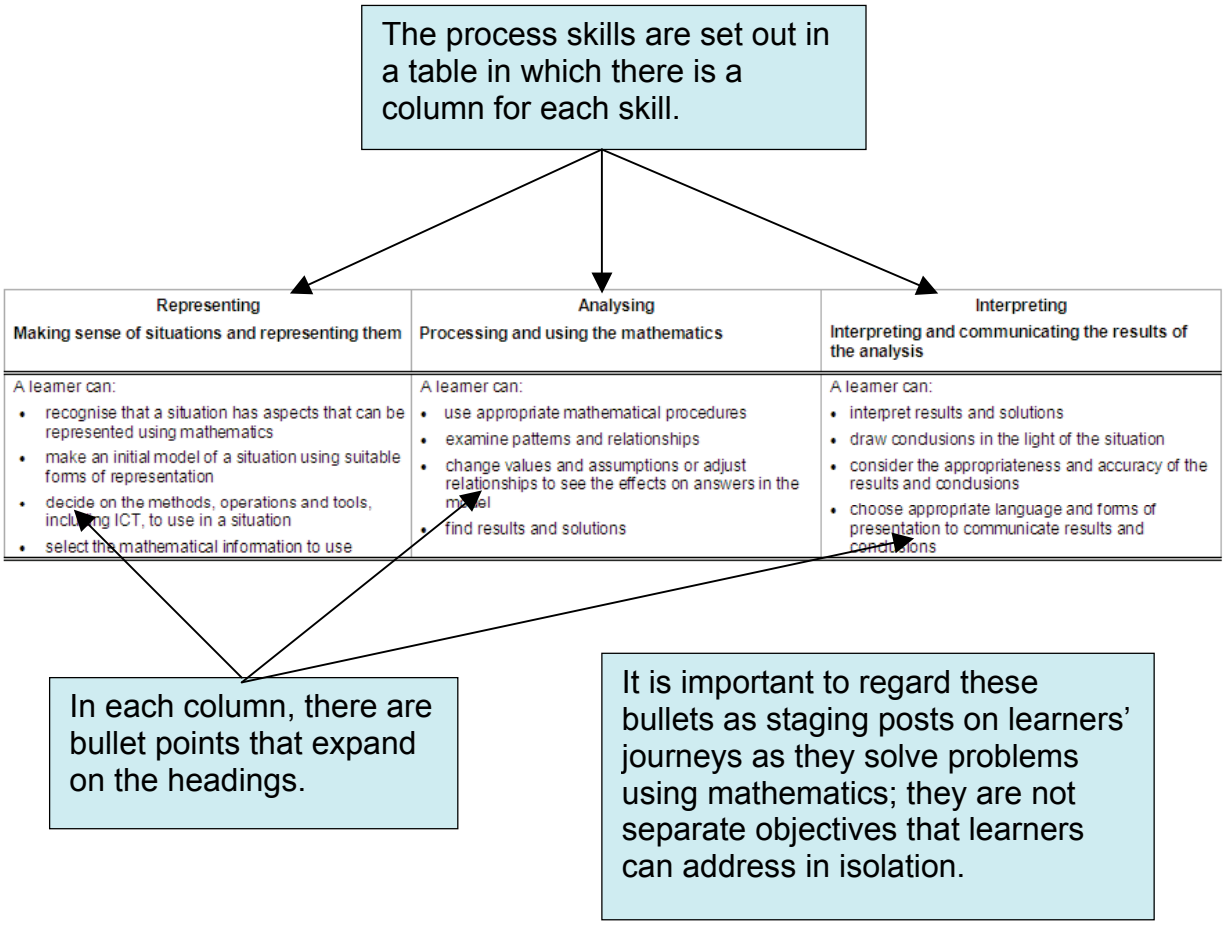
5.1 Assessment relates to the process skills

Assessments of progress in functional mathematics are about the extent to which learners have managed to:

- make sense of situations and **represent** them using mathematics
- **analyse** situations by processing the mathematics
- **interpret** and communicate the results of the analysis.

The standards set out these skills in a table with a column for each skill, as shown in Figure 5.1. Bullet points listed under each skill expand on the headings. These bullets are staging posts on learners' journeys as they solve problems using mathematics.

Figure 5.1



The process skills are therefore parts of a single overall process – solving problems using mathematics. In carrying through this process, most of the skills represented by the individual bullets will need to be used every time; often, all the skills will be needed.

Assessing the process skills

Being functional in mathematics means being able to use these process skills to solve problems. It follows that assessing progress towards becoming functional in mathematics means making judgements about the extent to which a learner is able to use the process skills. How well the learner's response answers the real-world problem is more important than the mathematical techniques employed. That said, a key question for teachers is: 'How should I make these assessment judgements?'

The answer is that you should make judgements about performance in the three process skills – representing, analysing and interpreting – in terms of the individual bullet points listed under that skill. The purpose of these assessments is to inform the next steps in your teaching; for example you

may decide that more activities requiring representing or interpreting skills are needed.

There is no need to assign a level to learners' performance in each of the three skills. Moreover, you should not need to make an overall judgement that a learner's work in functional mathematics is at a particular level. This summative assessment will be made in tasks set by an awarding body at the end of the course.

However, you may wish to make records based on your professional judgements. Such records of learners' performance should be kept to a sensible minimum.

Learners may have spiky profiles in process skills

Sometimes a learner's performance in representing, analysing and interpreting will be at a different level for each skill. Indeed, it is quite likely that learners will demonstrate different levels of performance across the three process skills, as they describe quite different capabilities. For example, a learner might demonstrate high-level representing and interpreting skills, but be much less capable at analysing. Similarly, a learner's spiky profile is likely to vary according to the context of the problem or task, for example they will be more confident, and hence show more independence, in some contexts than in others.

Showing different levels of performance in relation to these key aspects of assessment is what is meant by a learner having a spiky profile.

5.2 Assessment and progression

Because the basis of assessment is the same at all levels, assessment judgements are made based on the extent to which learners have demonstrated success in using the process skills. Within the process skills themselves, there is no ladder of achievement that indicates how to recognise the steps learners make as they progress – all the process skills can be used at a low level, if the problem is simple enough.

However, while the process skills are specified in a way that is appropriate for all levels, the standards do differentiate between:

- problems at different levels
- learners' performance at different levels
- the mathematical techniques likely to be used at each level.

The standards list ways in which problems that can be solved using mathematics can differ in their demands on learners, depending on:

- their complexity
- their familiarity to the learner
- their technical (mathematical) demand
- the degree of independence given to the learner.

These four dimensions of difficulty impact on the overall demand of a task.

In many mathematics lessons, the focus is on mathematical techniques; the technical demand of the techniques determines the difficulty of the work. In functional mathematics, by contrast, a more demanding task is one that, overall, has a greater demand in terms of all four dimensions. A task in functional mathematics must therefore include:

- a degree of complexity
- low familiarity
- a degree of independence required to solve it.

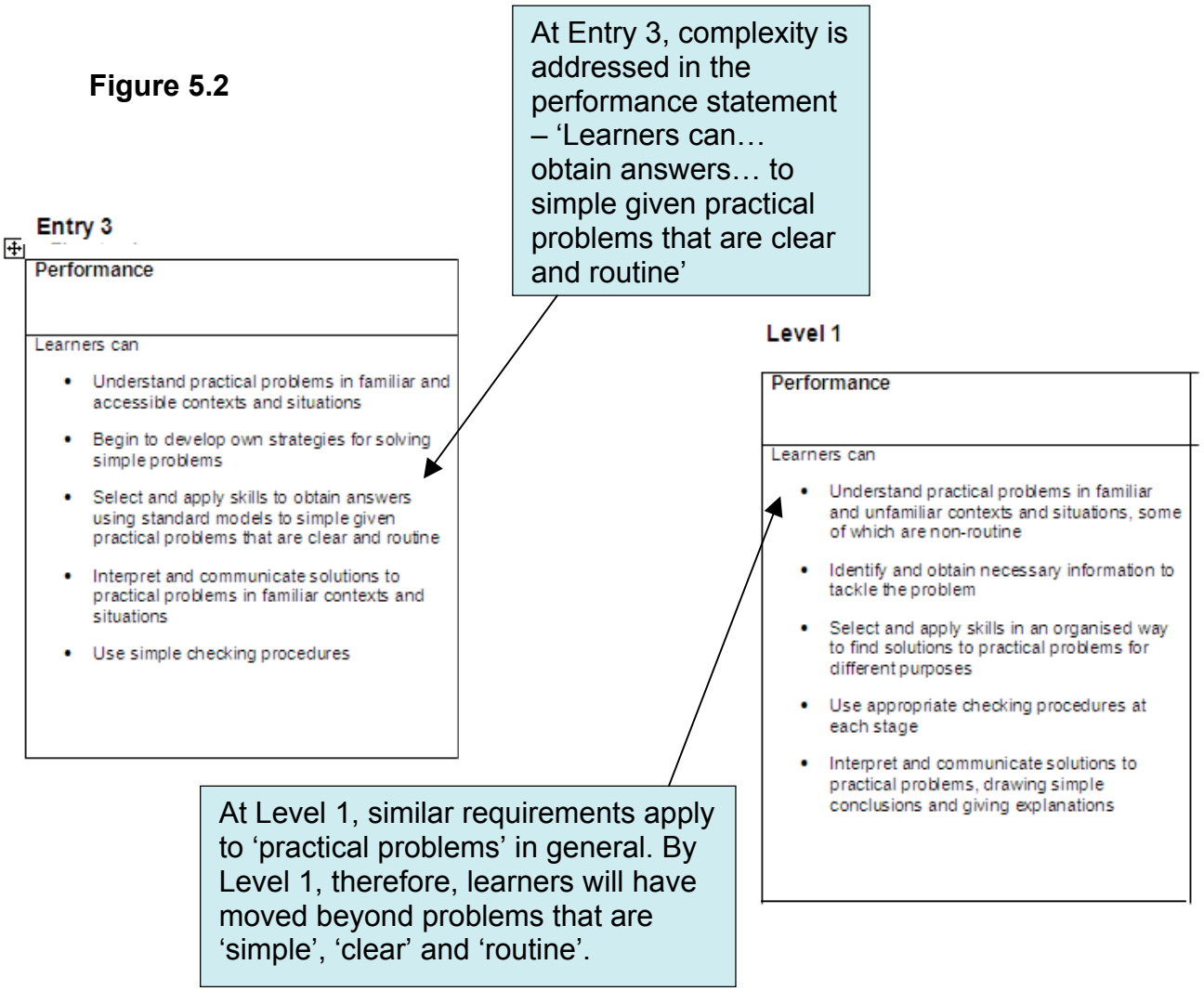
These requirements are expressed in the performance statements.

Using the performance statements to support assessment

The performance statements in the standards describe what teachers may expect of learners in relation to the issues of the complexity and familiarity of the task, and learner independence, at each level. For example, see Figure 5.2: at Entry 3, complexity is addressed in the performance statement 'learners can… obtain answers to… simple given practical problems that are clear and routine'. At Level 1 similar requirements apply to 'practical problems' in general. By Level 1, therefore, learners will have moved beyond problems that are 'simple', 'clear' and 'routine'.

However, different balances of complexity, familiarity and learner independence can produce tasks that allow responses at any level. For example, a task with Level 2 complexity, or that demands a fuller analysis of the problem, may use only Level 1 mathematical techniques. Such a task might be equivalent in demand to a familiar problem that requires straightforward uses of Level 2 mathematical techniques.

Figure 5.2



Similarly, the learner's independence is relevant in, for example, the Entry 1 requirement that 'learners can… use given methods', while at Entry 3 'learners can… begin to develop own strategies' and, at Level 2, 'learners can identify the… problem and the mathematical methods needed to tackle it'. Here too, the performance statements indicate a ladder of progression that learners are expected to move up. For functionality to relate to the real world, a substantial proportion of the assessment tasks should be non-routine, ie not imitations of something the learner has been shown how to solve. Thinking through a problem with unfamiliar aspects is essential.

Familiarity is also mentioned at, for example, Entry 3 where 'learners can… understand practical problems in familiar… contexts' and at Level 1, where 'learners can… understand practical problems in familiar and unfamiliar… contexts'.

The implication for assessment is clear – learners can be regarded as performing at Level 1 only after they have solved at least some problems in unfamiliar contexts.

Using the coverage/range statements to support assessment

The coverage/range statements describe the technical demand of appropriate problems at a level. They indicate the mathematical skills and techniques that are likely to be used by learners performing at that level.

It is important to note that the relevant skills are not set out in full. The content that is listed should be regarded as equivalent to and standing for content at particular levels of the National Curriculum, the related adult numeracy standard, and the related application of number standard (at Levels 1 and 2 only).

The mathematical techniques at each level set out the mathematics that could be used by learners, or that teachers who are setting problems can assume to be available to learners. It is not appropriate to require any particular technique to be used in solving a problem; as process skills improve, a problem might be solved using less demanding mathematics. For example, a learner at Level 2 may deal with a problem that involves calculating a price including VAT at 17.5%, by first calculating the price, then finding 17.5% of this amount, and finally adding the two quantities. This does not demonstrate the full Level 2 appreciation that multiplying the price by 1.175 is the simplest method.

Teachers should note that almost all the techniques listed in the coverage/ range statements in the standards apply to the analysing aspect of the process skills. It follows that these statements give little help in supporting judgements about the representing and interpreting aspects.

5.3 Knowing when a learner has achieved mastery

A learner has achieved mastery of a level in functional mathematics when that learner demonstrates the ability to use the process skills in ways that satisfy the performance and the coverage/range statements at that level. As already indicated, the performance statements illustrate the challenge of problems at the level; this challenge must be fully satisfied for the level to be achieved. The coverage/range statements indicate the difficulty of the mathematical techniques that can be expected; a level may be achieved if the coverage/ range statements for the level are a better match with the mathematical techniques demonstrated by the learner than those of any other level.

In practice, this means, for example, that a learner working towards Entry 3 must clearly demonstrate success in tasks that are of the difficulty indicated by the five performance statements in the Entry 3 standard. On the other hand, the same learner, working towards Entry 3, need not demonstrate all the coverage/range statements in the Entry 3 standard. Rather, it is sufficient for this learner to demonstrate enough of the Entry 3 coverage/range statements (or mathematical techniques of equivalent difficulty from the

National Curriculum or adult numeracy standards) to make them a better description of the techniques used in the learner's work than the coverage/range statements at the levels above or below Entry 3.

The soundest measure of the level of complexity of a task is the difficulty it presents to learners, when compared with straightforward exercises in mathematical techniques. As teachers become more familiar with functional mathematics, they will develop a capacity to recognise the level of difficulty of tasks in functional mathematics and to compare this with the difficulty of the standard mathematical exercises with which they are more familiar.

Bearing these two scales of difficulty in mind, it follows that, if a complex 'functional' task is of the same level of difficulty as a 'standard' Entry 2 exercise on mathematical content, it is Entry 2 for functional mathematics.

5.4 Exemplification of evidence at Levels 1 and 2

We give below some exemplification of learners' work at Levels 1 and 2. The two learners have tackled the same problem – investigating the use of mobile phones.

Level 1 – Learner A

Problem: Investigate the use of mobile phones

I am going to ask 30 people about their mobile phones. I am going to ask my friends and family. I think that most people will own a mobile phone. I think that people will use it most to send texts.

The questions I am going to ask are:

- Do you have a mobile phone?
- Is it on a pay-as-you-go or monthly rental scheme?
- How many texts do you send each day?
- How many phone calls do you make each day?

I will collect my data using tally charts and then show my results on charts and use averages.

Results

1. Yes 26
   No 4

2. Pay-as-you-go 11
   Rental 15

3. Texts:

0	1	2	3	4	5	6	7	8	9
3	0	0	1	0	2	1	0	4	0

10	11	12	13	14	15	16	17	18	19
8	0	3	0	0	1	0	0	0	0

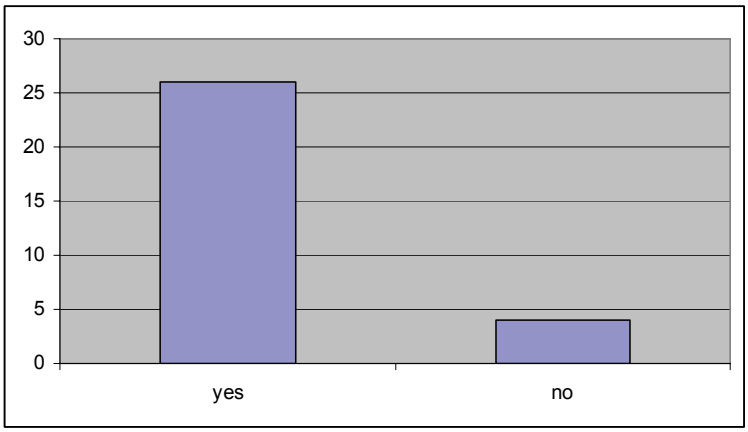
20	21	22	23	24	25
2	0	0	0	0	1

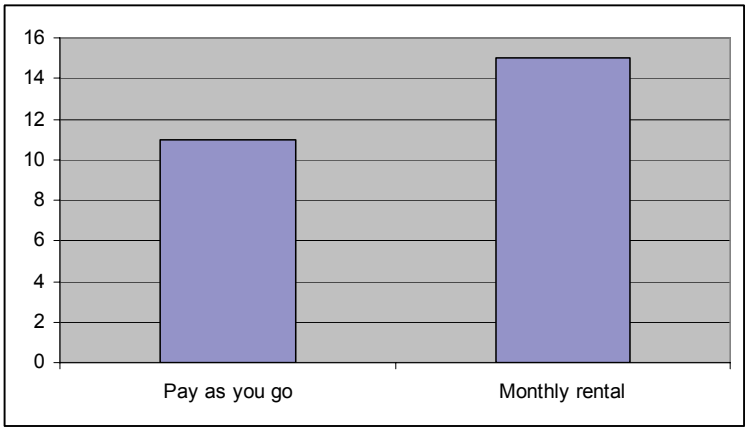
4. Calls:

0	1	2	3	4	5	6	7	8	9
1	0	5	0	4	4	3	3	2	0

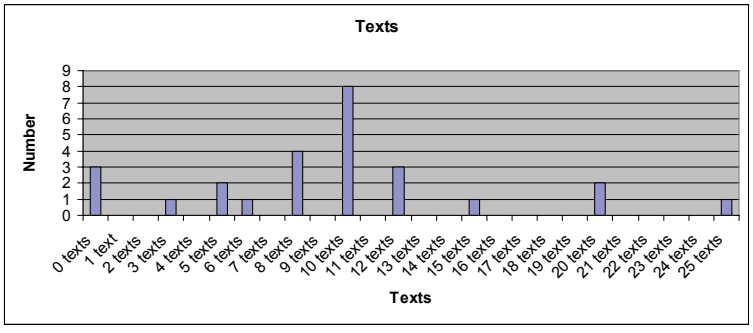
10
4

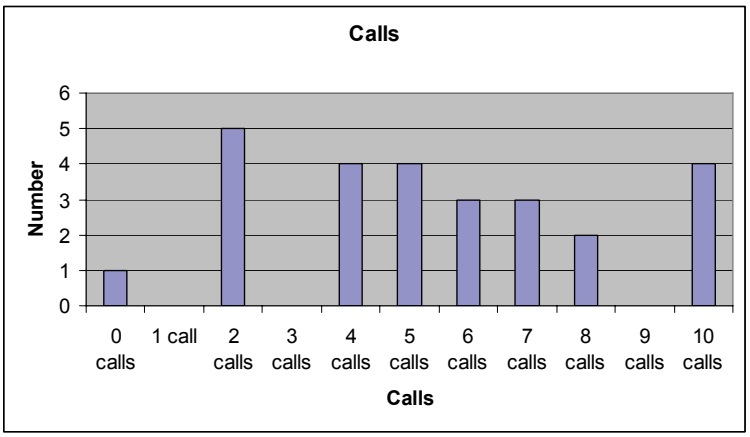
I am going to show these results on bar charts.



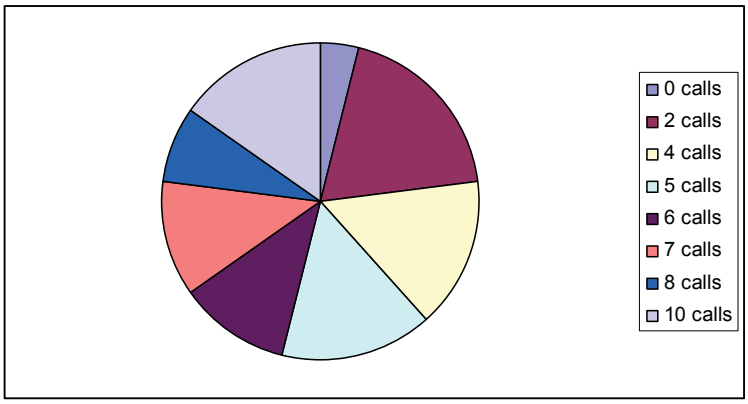


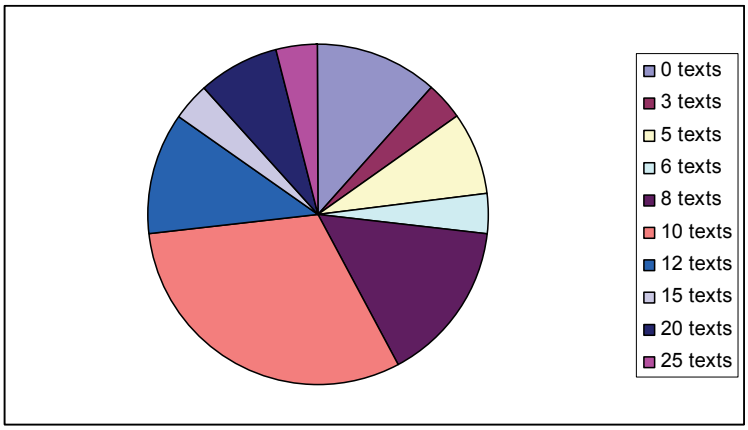
These charts show that I was right and most people have a mobile phone. Most have monthly rental.





The bar charts on texts and calls are not very good. There are too many gaps so I am going to use pie charts instead.





10 was the most popular number of texts.

2 was the most popular number of calls. The range for calls was 10 and the range for texts was 25. So the range for texts was bigger.

I am going to work out some averages.

Texts

0	3	0 × 3 = 0
3	1	3 × 1 = 3
5	2	5 × 2 = 10
6	1	6 × 1 = 6
8	4	8 × 4 = 32
10	8	10 × 8 = 80
12	3	12 × 3 = 36
15	1	15 × 1 = 15
20	2	20 × 2 = 40
25	1	25 × 1 = 25
Total: 26		247

Mean = 247 ÷ 26 = 9.5

Calls

0	1	0 × 1 = 0
2	5	2 × 5 = 10
4	4	4 × 4 = 16
5	4	5 × 4 = 20
6	3	6 × 3 = 18
7	3	7 × 3 = 21
8	2	8 × 2 = 16
10	4	10 × 4 = 40
Total: 26		141

Mean = 141 ÷ 26 = 5.4

The mean of the texts is bigger than the mean of the calls so I was right.

Conclusion

I have found that most people have mobile phones and they send more texts than calls. This might be because lots of people get free texts on their phones.

If I was to do this again I would improve it by asking more people.

Commentary on Learner A's work

This solution is somewhere in the middle of Level 1. It uses Level 1 coverage and performance but, more particularly, the process skills are at that level. More of the same would not move the work towards Level 2. For Level 2 there needs to be a more complex approach.

To explain this judgement more fully, we set out below some of the evidence that teachers would normally assess 'in their heads'. There is no need to keep records at this level of detail.

1. Representing

In this problem, representing is about the planning of the data collection: deciding what aspects to investigate, making hypotheses, writing the questionnaire, and deciding who to ask. In this piece of work the learner has made some hypotheses. They are relevant and appropriate. The learner has recognised that the problem can be represented using mathematics and has decided on the methods to use. In designing the questionnaire, the learner has made an initial model of the situation using suitable forms of representation. The plan demonstrates that the learner has selected the mathematical information to use. These points demonstrate that Level 1 has been achieved.

However, the hypotheses are separate statements and no attempt is made to link them. They also leave some important questions unanswered, for example: What age is the user? A more coherent approach, which sees the problem as a single problem rather than a series of mini-problems, would move the work towards Level 2.

A wide range of people may have been asked but the impression is given that the sampling was opportunistic only. To reach Level 2 some thought should be given to obtaining a representative sample.

For the questionnaire, grouped boxes for some of the responses would have been more appropriate. This would be expected for Level 2.

2. Analysing

In processing and using mathematics the learner has chosen bar charts to represent the data; this is consistent with working at Level 1. There was some awareness that the bar charts were not always the most appropriate representation and two were replaced by pie charts. This is moving towards the thinking expected at Level 2, but in this case the replacement did not improve the analysis very much and this was not commented on.

However, no explanation was given for the choices of charts. For Level 2 some discussion about the choices of charts and/or statistical techniques and their suitability would be expected.

The calculation of means was an appropriate mathematical procedure and the comparison was useful. The comparisons move the work towards Level 2.

In calculating the means, there was no realisation that people had probably estimated the number of calls and texts (thus explaining the frequency of 10 or 15 while never having an instance of 13). The data was accepted at face value without any real thought about its accuracy. Some realisation that the data was probably based on estimates would be expected for a Level 2 piece of work. This may appear by using grouped data boxes in the questionnaire or as part of the analysis.

3. Interpreting

In this solution, each chart and calculation has been interpreted and there is a simple comparison. There is a very basic commentary linking the work together. The overall results of the analysis are communicated briefly in the conclusion and there is a valid suggestion about the reason for the results. This is sufficient to achieve a Level 1.

To reach Level 2 the interpretations would need to be more detailed and linked together with more commentary. The conclusion should be written with reference to the data collection, for example: were there any reasons why the findings might not be valid? Could any bias have crept in due to sampling?

At Level 2 more detailed reasons for the results relating to a real-life context would be expected.

Level 2 – Learner B

Problem: Investigate the use of mobile phones

I am going to ask 40 people about their mobile phones. I am going to ask my friends, family and other people that I know. I am going to make sure that I ask at least 5 from each of the age groups:

15–20; 21–30; 31–40; over 40

I think that most people will own a mobile phone and I think that the ones that do not will be over 40.

I think that people will use it most to send texts but I think that most of the texts will be from the people under 30. I think that people over 30 are more likely to use it for calls. This is because they have not grown up with a mobile phone and some of them do not know how to use one properly.

The questions I am going to ask are:

Do you have a mobile phone?

On average how many texts do you usually send each day? Is it:

0 1–5 6–10 11–20 over 20

How many phone calls do you usually make each day? Is it:

0 1–5 6–10 11–20 over 20

What age are you?

15–20 21–25 26–30 31–35 36–40 over 40

I am going to group my data for the number of texts and calls as I do not think people will be able to remember accurately exactly how many texts and calls they make and it might not be the same each day.

Results

1. Yes 32
   No 8

2. Texts:

0	1–5	6–10	11–20	over 20
4	7	13	6	2

3. Calls:

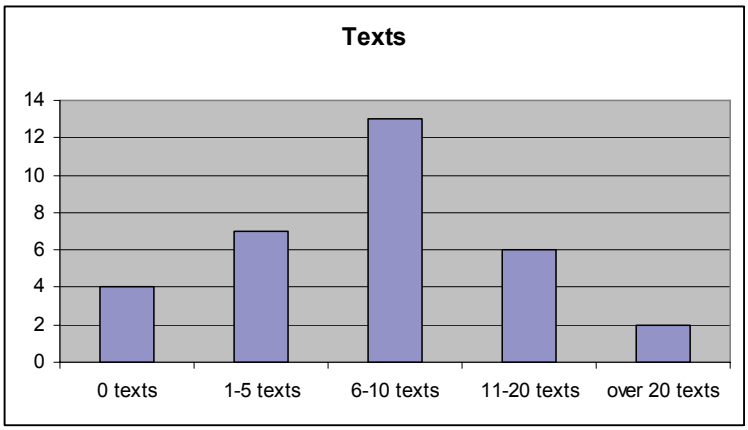
0	1–5	6–10	11–20	over 20
6	14	7	5	0

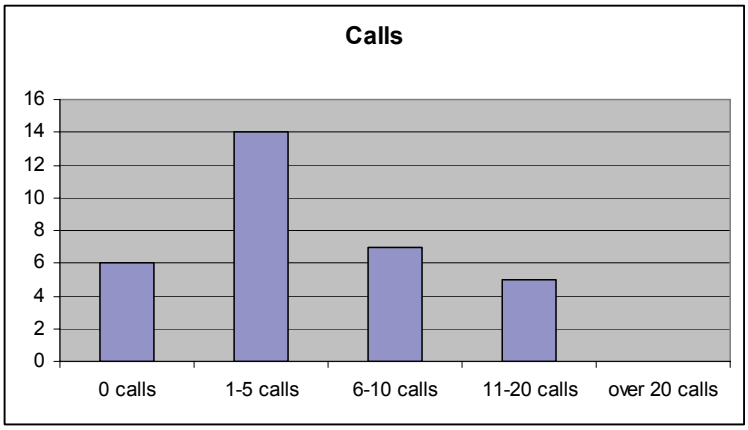
4.

15–20	21–25	26–30	31–35	36–40	over 40
15	9	2	3	4	7

Only 8 out of 40 did not have a phone. Of these 3 were over 40 and the other 5 were all in the 26–30 age group. I was surprised by this.

I am going to show the texts and calls on bar charts so they can be compared.





These show that people make more texts than calls.

I am going to work out an estimate of the mean for each to see how big the difference is.

Texts:	0	1–5	6–10	11–20	over 20
Midpoint	0	3	8	15.5	25
	4	7	13	6	2
Totals	0	21	104	93	50

Mean = 268 ÷ 32 = 8.375

I used 25 for the midpoint of the last group because it seemed sensible.

Calls:	0	1–5	6–10	11–20	over 20
Midpoint	0	3	8	15.5	
	6	14	7	5	0
Totals	0	42	56	77.5	0

Mean = 175.5 ÷ 32 = 5.484

On average people make about 3 more texts than they do calls.

I want to know if there is a difference between old and young so I am going to split the data. I will look at the age groups for 30 and under and for over 30.

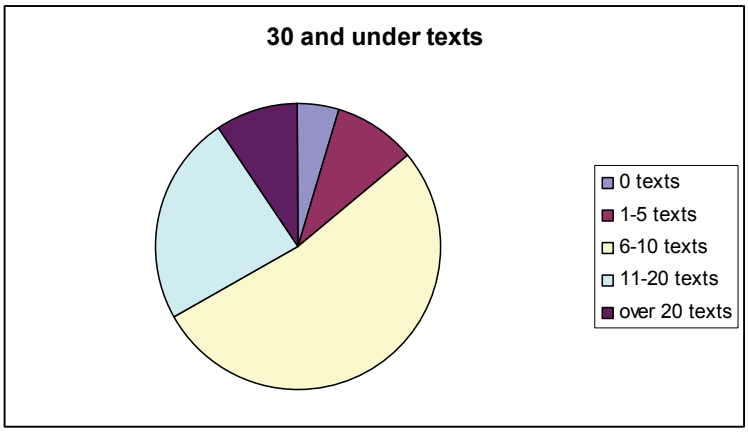
30 and under:

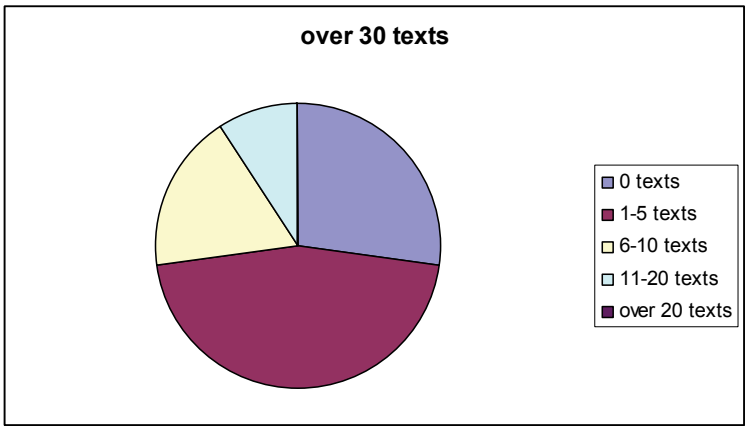
Texts:	0	1–5	6–10	11–20	over 20
	1	2	11	5	2
Calls:	0	1–5	6–10	11–20	over 20
	3	9	5	4	0

Over 30:

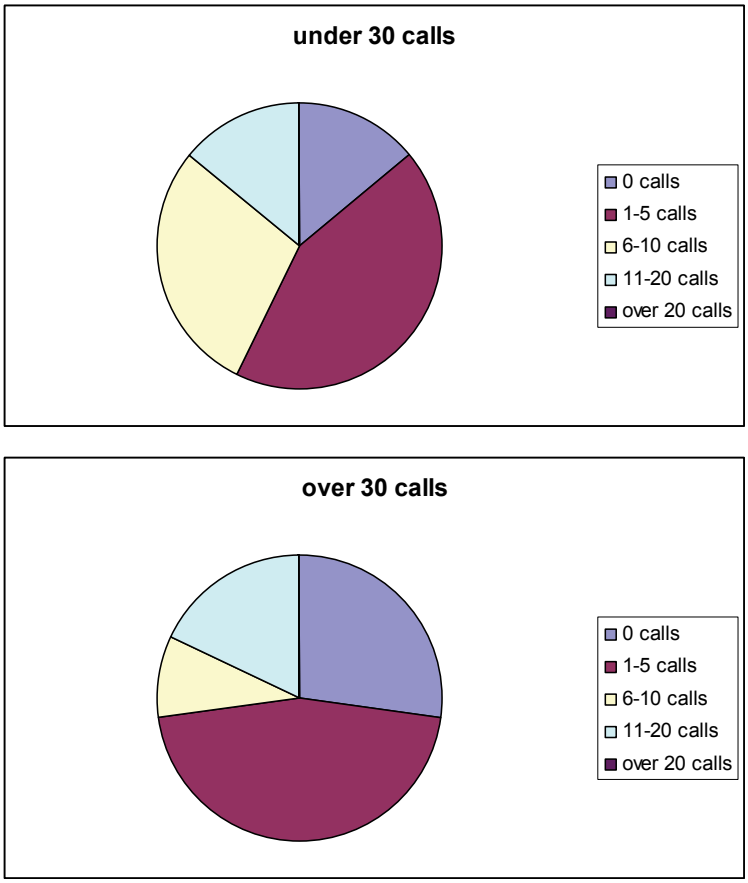
Texts:	0	1–5	6–10	11–20	over 20
	3	5	2	1	0
Calls:	0	1–5	6–10	11–20	over 20
	3	5	2	1	0

I am going to use pie charts because there are a different number of people in each group.





These charts show that the over 30s do a lot less texting than the younger ones. About three quarters of the over 30s text either 0 or between 1 and 5 times a day. Of the older ones about three quarters text 6 times or more a day.



The difference between these charts is that there are a lot more under 30s making between 6 and 10 calls a day compared to the over 30s.

Conclusion

My results show that the majority of people own a mobile phone but my results may not be accurate. I would have to ask more people and maybe more older people to be more sure. I also found that people text more than they make calls.

But it might be that the people that make lots of texts do not make many calls and those that make lots of calls do not make many texts. If I were to do some more work on this I would collect more accurate data about texts and calls and draw a scatter graph to see if this is true.

Older people tend to use calls more than texts compared with the younger people. This might be because they only use their phones to ring people to talk to them and it is mainly teenagers that text a lot because they want to send messages to their friends. It might also be because they have a lot of free texts and calls cost money and they are a bit short of money. If I were to do more work I could find out if the older people who use texts have teenage children who keep them up to date.

I could look up figures on the internet to see if they agree with my findings.

Commentary on Learner B's work

In this solution there are still areas that could be improved on, for example in the interpretation of the pie charts, but the work would still be Level 2. It is not a perfect solution for the level. However, the piece of work reaches Level 2 because the learner has tackled it as a single complex coherent problem, made decisions about data collection and analysis that help make the results more valid, and interpreted the results with reference to a real-life context. The choices made were more appropriate than those made in the Level 1 piece of work and there was a detailed conclusion that drew it together and suggested reasons.

6. Resources

Contents

Most centres will already have a wealth of materials and learning resources. Several recent initiatives have produced free high quality learning and teaching resources for mathematics. Many of these materials provide contextualised opportunities to develop learners' mathematical techniques.

Recent materials include:

- *Improving learning in mathematics* (see below)
- *Thinking through mathematics* (page 132)
- *Materials for embedded learning* (Skills for Life) (page 132)
- *Resources for key skills learning* (KSSP) (page 133).

All these are available free, either as downloads or in hard copy.

There are also many excellent websites that provide both downloads of paper-based materials and online interactive opportunities that can be used for practising and reinforcing techniques.

6.1 Paper-based materials

Improving learning in mathematics

These materials were developed by the DfES Standards Unit and are still commonly known as 'the Standards Unit box'. They are now part of the National Teaching and Learning Change programme and its Professional Training Programme. There may be a subject learning coach in your centre who will be able to help with ideas for using the materials.

The box includes 'Resource files' that contain a wealth of active learning ideas that have proved very successful in developing mathematical techniques and confidence. You will have already met some of these activities in the pages of this document. There is also a box of multimedia resources.

There are a number of other 'Standards Unit boxes', including for construction, engineering, ICT, health and social care, and creative and media. Many of these contain useful ideas for setting mathematics in context and to develop the process skills for applying the techniques. The boxes for construction, engineering, ICT, health and social care, and creative and media are being revised to meet the needs of the diplomas and will be ready for April 2008.

You can access these materials via the 'Excellence Gateway' on the QIA website: www.qia.org.uk or http://excellence.qia.org.uk/

The full set of materials available on the QIA website includes the topics:

- business
- construction
- creative and media
- E2E (Entry to Employment)
- engineering
- health and social care
- Foundation Learning Tier (pre-Entry and Entry level)
- ICT
- land-based
- mathematics
- science.

Thinking through mathematics

Thinking through mathematics has been developed by the Maths4Life team as a continuation of the work begun by the DfES Standards Unit with *Improving learning in mathematics* (see above).

The ring-binder has an introduction to the approaches as well as sections on collaborative professional development and teaching and learning, and includes a DVD and a CD-ROM of all the materials.

You can order a copy from www.maths4life.org.uk or telephone: 01283 227597.

Materials for embedded learning

The blue ring-binders are a familiar sight in many organisations. There are no fewer than 26 titles available, developed by the Skills for Life Quality Initiative and providing a rich resource of contextualised materials for developing both literacy and numeracy. They cover levels from Entry 1 to Level 2 and are therefore suitable for the full range of functional mathematics learners.

Materials can be downloaded or ordered from the 'Embedded Learning Portal' website: www.dfes.gov.uk/readwriteplus/embeddedlearning/index.cfm or from

DfES Publications
PO Box 5050
Sherwood Park
Annesley
Nottingham NG15 0DJ

Telephone: 0845 60 222 60
Fax: 0845 60 333 60
Textphone: 0845 60 555 60
Email: dfes@prolog.uk.com

A new publications list for Skills for Life resources is currently due for publication (August 2007).

Resources for key skills learning

Since 2000 the Key Skills Support Programme (KSSP) has produced a range of publications that can be used to develop the techniques and skills required for functional mathematics.

The *Resources for key skills learning* have been produced primarily for work-based learning and are integrated into different vocational units. Each pack contains teaching and learning materials, 'How to' sheets (for application of number and communication) and assessment tasks. They are at levels 1 and 2 and, although the materials have been written to the key skills standards, they can be used to develop learners' mathematical techniques for functional skills. The sample assessment tasks can be tailored to provide opportunities for developing the process skills.

Packs include 'Engineering', 'Care', 'Child care', 'Hospitality', 'Retail', 'Administration' and many more.

www.ksspforwork.org.uk/resources.php

6.2 Websites

The following websites have been found useful for developing and practising mathematical techniques, process skills and problem solving.

Bear in mind the following notes.

- Some websites disappear or change their web addresses. The URLs given here were active in May 2007.
- In some centres, the network may be set up to block access to certain websites. If this happens, check with your technical support team.
- The list that follows is in alphabetical order of URL and does not imply any ranking by merit or value.

www.bbc.co.uk/schools/gcsebitesize/maths

BBC bitesize is useful for GCSE revision and developing the mathematics techniques required at Levels 1 and 2.

www.bbc.co.uk/keyskills

BBC key skills – Material aimed at key skills but equally useful for developing functional mathematics.

www.bbc.co.uk/skillswise

BBC Skillswise provides downloadable and online interactive materials for both numeracy and literacy. It was developed to support adult basic skills and is very useful to develop and practise mathematical techniques up to Level 1. It contains a wealth of engaging material for learners of all ages.

www.cimt.plymouth.ac.uk/resources/topical/default.htm

Centre for innovation in mathematics teaching

Mainly generic topics but a few that may be adapted to suitable contexts and useful for developing both mathematical and process skills.

www.dfes.gov.uk/readwriteplus/embeddedlearning

The **Embedded Learning Portal** has a full range of Skills for Life learning materials, many of which can be used for developing mathematics techniques for a wide range of learners and levels. There is a list of materials and details of how to obtain free copies.

www.dfes.gov.uk/readwriteplus/Learning_Materials_Main

The **Skills for Life materials** provide resources that are paper-based and available on CD-ROM. They support literacy, numeracy and ESOL learners at Entry levels, and levels 1 and 2. They are referenced to the adult literacy and numeracy core curriculum and contain clear links to Skills for Life and key skills. They are available to download from the website.

www.dfes.gov.uk/readwriteplus/raisingstandards/

The Raising Standards Guides produced by the DfES Skills for Life Strategy Unit, are intended to help practitioners and managers improve the quality of teaching and managing Skills for Life provision by using the five Common Inspection Framework questions for their particular context. They have now been made available as interactive versions, and can be accessed at the URL above.

http://excellence.qia.org.uk/

The **Excellence Gateway** is an online service for post-16 learning and skills providers and the new home for the Learning and Skills Web and Excalibur. There are examples of good practice, networks to support self-improvement, suppliers of improvement services, plus tools and materials to support teaching and learning.

www.itembank.org.uk

'The Item Bank' holds a massive number of key skills and Skills for Life questions that can be used to practise the mathematical techniques at levels 1 and 2.

www.keyskills4u.com/

KeySkills4u is an online resource for application of number, communication and ICT with some excellent materials to develop mathematical techniques at levels 1 and 2. There are a range of materials including interactive learning, self-assessment and application material and interactive games that are useful for developing process skills.

www.keyskills4u.com/tutorguides/

Keyskills4u Tutor guide includes examples of lesson plans.

www.keyskillssupport.net

The Key Skills Support Programme has produced a wealth of materials to support teaching, learning and assessment. Resources have been posted for schools, colleges and vocational (work-based) learning. Many of these will be useful for developing mathematical techniques and process skills. The assignments or tasks may be used to practise process skills in context.

www.keyskillssupport.net/

KSSP materials for application of number can be found here.

www.keyskillssupport.net/supporting/resources/shared/

Here you will find mixed resources to support skills development and contextualised assignments.

www.ksspforwork.org.uk

This is the website of Learning for Work, partners in the Key Skills Support Programme and the functional skills support programme.

www.ksspforwork.org.uk/resources.php

Teaching and Learning resources are offered here, including vocationally specific skills development sheets ('How to...' sheets), assignments and task briefs.

www.maths4life.org

Maths4life is a national project sited in the National Centre for Excellence in Mathematics (see below). The project aims to stimulate a positive approach to teaching and learning in adult numeracy and mathematics. In the resources

section, there are links to materials on teaching and learning, research and a range of resources.

www.moneymatterstome.com

Money Matters to Me (developed by NIACE) provides a detailed suite of material linked to personal finance.

www.move-on.org.uk/index.asp

Move-on offers skills development materials and practice tests for AoN, numeracy and communication and literacy suitable for functional mathematics development,

www.ncetm.org.uk

The **National Centre for Excellence in the Teaching of Mathematics** provides a wide range of support, advice and resources to enhance mathematics teaching. Resource material will be developed over time and added to the existing work there.

www.thenetwork.co.uk/providertoolkit/vault/embedlearn.htm

The Network Vault provides vocationally specific materials.

www.nln.ac.uk

This is the **National Learning Network** website. You need to register on this site but you can then access some numeracy and other mathematics material.

www.nrdc.org.uk

The NRDC **Effective Teaching and Learning** Series: 'Reading', 'Writing', 'Numeracy', 'ESOL', and 'Using ICT' (NRDC, 2006) outlines recommendations about effective approaches to teaching and learning. These can be downloaded from the website.

www.nrich.maths.org/public/index.php

Subtitled 'Enriching mathematics', this website contains a wide range of mathematics problems, games and articles. Each month has a different theme and back issues provide a wealth of material which will repay investigation. Start with the home page, which has links to some interesting activities including the **Millennium Mathematics Project** resource from Cambridge University.

www.raftarget.com/raf

This is the RAF mathematics mission website. Click on the 'Learners area' tab to access the online interactive classroom.

The site also gives access to:

- **'The Mathematics Mission' CD-ROM**

  A CD-ROM containing curriculum-related mathematics activities based around a tour of a virtual RAF base.

- **The RAF Mathematics Workshop Tour**

  An interactive classroom-based mathematics workshop for lower-ability 14–16 year olds which is available to visit UK secondary schools.

www.s-cool.co.uk/default.asp

S-Cool is a revision site for GCSE and A level.

www.skillsworkshop.org/about.htm

The **Skills workshop** on Maggie Harnew's website from Abingdon and Witney College offers shared resources that are principally designed for developing techniques.

www.totallyskilled.org.uk/awardingBody/ab.htm

Totally Skilled, the Embedding Skills for Life and Key Skills in Vocational Qualifications Project website, contains examples of skills audits and task analyses. Resources developed by awarding bodies for this DfES project include support for centres of identifying literacy, language and numeracy skills in vocational courses.

6.3 Resources designed for schools: Key Stages 3 and 4

The resources produced by the Secondary National Strategy, which are available from the DfES Standards site, support the development of functional mathematics. The early resources were designed for Key Stage 3 learners, but are still relevant for those in Key Stage 4.

www.standards.dfes.gov.uk/secondary/keystage3/respub/

The titles listed are a selection from what is available. The order in which they appear here does not imply any ranking by merit or value.

Mathematics planning toolkit CD-ROM: Key Stage 4

This is included in the pack 'Mathematics subject leader development materials, summer 2007, ref 00277-2007PCK-EN. It, and the accompanying handbook 'Mathematics at Key Stage 4: developing your scheme of work, ref 00049-2007BKT-EN. Copies can be ordered from Prolog: tel. 0845 60 222 60

Assessing pupils' progress in mathematics at Key Stage 3

Ref 00007-2007FLR-EN

Copies can be ordered from Prolog: tel. 0845 60 222 60

Progression maps

These are part of a suite of resources to support intervention in secondary schools. They can be accessed at:
www.standards.dfes.gov.uk/secondary/keystage3/all/respub/ws_intvsec

Teaching mental mathematics from level 5 series

Details, downloads and ordering instructions are available at

www.standards.dfes.gov.uk/secondary/keystage3/all/respub/ma_tmml5up

Using ICT to address 'hard to teach' concepts in English and mathematics (June 2007)

ICT offers the potential to transform teaching and learning. This project explores the use of ICT to support the teaching of identified 'hard to teach' concepts in English and mathematics.

The project was started in September 2006 and based on action research in classrooms. The research is presented in a series of case studies linked to relevant resources and descriptions of the journeys taken by the teachers in developing the use of ICT in their classrooms. The work they produced, along with some reflections on the experience of the teachers and their learners, is available from this website.

Mathematics study modules (July 2004)

These are ten mathematics study modules, designed for an individual teacher or group of teachers, which have been produced by the mathematics strand of the Key Stage 3 National Strategy. They are intended for teachers who would like to reinforce, confirm and extend their knowledge of the Key Stage 3 mathematics curriculum and to develop their teaching skills.

Interacting with mathematics in Key Stage 3 – constructing and solving linear equations (May 2004)

This material, designed to be used with the *Framework for teaching mathematics: Years 7, 8 and 9*, provides guidance on developing progression in the teaching of constructing and solving linear equations. Although specific in this focus, it illustrates an approach that is designed to serve the broader purpose of developing the teaching of all aspects of algebra.

Interacting with mathematics in Key Stage 3 – enhancing proportional reasoning (March 2004)

This series of training and school-based materials aims to support mathematics departments in planning for teaching that engages and challenges learners, developing mathematical reasoning and so raise standards of achievement in Key Stage 3.

Interactive Teaching Programs (ITPs) (February 2004)

You will find some mathematics ITPs, created for Key Stage 3 pupils within the National Numeracy Strategy (NNS) programme, and covering a range of mathematical techniques.

Intervention Strategy Key Stage 3 (May 2003)

Intervention is targeted at pupils who are working below national expectations but who have the potential to meet the expectations for their age group if they are given timely support and motivation.

Mathematics vocabulary flashcards (March 2003)

The flashcards have all the words from the vocabulary checklist in section 5 of the *Framework for teaching mathematics: Years 7, 8 and 9*. They are provided in Word format to allow for individual editing and printing. The vocabulary words are grouped by years and in six sections:

- Algebra
- Handling data
- Numbers and number systems
- Shape, space and measures
- Applying mathematics and solving problems
- Calculations.

Interacting with mathematics in Year 9 – geometrical reasoning (Nov 2002)

This series of training and school-based materials aims to support mathematics departments in planning for teaching that engages and challenges learners, developing mathematical reasoning and so raise standards of achievement in Year 9.

Interacting with mathematics in Year 9 – proportional reasoning (Nov 2002)

This unit is a sequel to the Year 8 multiplicative relationships unit. It provides an opportunity to revise, consolidate and extend ideas introduced in Year 8 and to make links to other mathematical strands, particularly shape and space. Making such links, especially with visual contexts, can help learners to understand proportion.

Teaching able, gifted and talented pupils (September 2002)

This series of optional modules aims to help schools evaluate and develop provision for able, gifted and talented learners. Schools and departments can choose to use some or all of the modules within a planned programme of professional development.

Securing improvement – the role of subject leaders (May 2002)

This booklet is intended to support subject leaders, and in particular to identify core tasks and areas for development.

www.censusatschool.ntu.ac.uk

This is a huge site inviting all kinds of statistical work with real data.

www.1000problems.org

This is an interesting site with problems related to mathematics across the curriculum.

6.4 Professional organisations

The Association of Teachers of Mathematics
www.atm.org.uk

The Association for Achievement and Improvement through Assessment
www.aaia.org.uk

The Mathematical Association
www.m-a.org.uk

NANAMIC (National Association for Numeracy and Mathematics in Colleges)
www.nanamic.org.uk

Acronyms

BSA

Basic Skills Agency. The Basic Skills Agency has merged with the National Institute of Adult and Continuing Education (NIACE) and will work in alliance with Tribal. Its full name is now 'The Basic Skills Agency at NIACE'. See www.basic-skills.co.uk

CBI

Confederation of British Industry. A not-for-profit organisation, incorporated by Royal Charter in 1965. It represents the business sector in the UK, provides membership services, conducts research and provides 'a voice for business' at national level. See www.cbi.org.uk

CEL

Centre for Excellence in Leadership. CEL's remit is to foster and support leadership improvement, reform and transformation throughout the sector. It serves the existing and future leaders of all providers through programmes, events, support services and bespoke consulting assignments. See www.centreforexcellence.org.uk

CPD

Continuing professional development.

DCSF

Department for Children, Schools and Families. Established in June 2007; successor organisation to DfES. Responsible for functional skills policy. See www.dcsf.gov.uk

DDP

Diploma Development Partnership. There are 14 Diploma Development Partnerships – one for each line of learning – developing content for each of the Diplomas. See www.qca.org.uk/qca_5400.aspx

DfES

Department for Education and Skills. In June 2007, divided into DCSF and DIUS. See www.dfes.gov.uk

DIUS

Department for Innovation, Universities and Skills. Established in June 2007; successor organisation to DfES. Responsibility for key skills and Skills for Life policy. See www.dius.gov.uk

Entry 1, Entry 2, Entry 3

Entry levels in the adult literacy, adult numeracy, adult ICT and ESOL core curricula.

EFL

English as a Foreign Language.

ESOL

English for Speakers of Other Languages.

FLT

Foundation Learning Tier. The umbrella term for all provision below Level 2 that is taken by learners over the age of 14. It therefore encompasses what is currently categorised as pre-Entry, Entry level (split into Entry levels 1, 2 and 3) and Level 1.

ILP

Individual Learning Plan. Document used to plan and record a student's learning.

Jobcentre Plus

Government agency that provides help and advice on jobs and training for people who can work and financial help for those who cannot; helps employers to fill vacancies. Part of the Department of Work and Pensions (DWP). See www.jobcentreplus.gov.uk/

Key Stage 3

Usually, the first three years of secondary education – Years 7, 8 and 9 – but sometimes condensed.

Key Stage 4

Years 10 and 11 of secondary education.

KSSP

Key Skills Support Programme. Delivered on behalf of QIA by the Learning and Skills Network consortium, consisting of LSN, Learning for Work and CfBT Education Trust. Supports the delivery and implementation of key skills in all post-14 settings. Provides advice, training, information and resources to learners, teachers, trainers and managers. See www.keyskillssupport.net/

LA

Local Authority, the education function of which is now incorporated into 'Integrated Children's Services'.

learndirect

The largest provider of e-learning in the world. Aims to enable adults without a Level 2 or Skills for Life qualification to gain the skills and qualifications they need to find a job or to achieve and progress at work. See www.learndirect.co.uk

LLN

Literacy, Language, Numeracy.

LLUK

Lifelong Learning UK. Responsible for the professional development of all those working in libraries, archives and information services, work-based learning, higher education, further education and community learning and development. See www.lluk.org.uk

LLU+

National consultancy and professional development centre for staff working in the areas of literacy, numeracy, dyslexia, family learning and ESOL. See www.lsbu.ac.uk/lluplus

LSC

Learning and Skills Council. Responsible for funding and planning education and training for learners over 16 years old in England. See www.lsc.gov.uk

LSDA

Learning and Skills Development Agency. See LSN.

LSN

Learning and Skills Network. Independent not-for-profit organisation launched in April 2006; took over some of the role of LSDA. See www.lsneducation.org.uk

NAA

National Assessment Agency. Launched in April 2004 to develop and deliver high quality national curriculum tests and supervise the delivery and modernisation of GCSE and A level examinations. See www.naa.org.uk

NCSL

The National College for School Leadership exists to help to make a difference to the lives and the life chances of children and young people through the development of world-class school leaders. See www.ncsl.org.uk

NIACE

National Institute of Adult Continuing Education – England and Wales. Non-governmental organisation working for more and different adult learners. See www.niace.org.uk

NVQ

National Vocational Qualification. NVQs are work-related, competence-based qualifications, accredited by QCA and included in the National Qualifications Framework. See www.qca.org.uk/14-19/qualifications/index_nvqs.htm

OECD

Organisation for Economic Cooperation and Development. The OECD groups thirty member countries sharing a commitment to democratic government and the market economy. See www.oecd.org

Ofsted

Non-ministerial government department responsible for inspecting and regulating the care of children and young people, and education and skills for learners of all ages. See www.ofsted.gov.uk

QCA

Qualifications and Curriculum Authority. Non-departmental public body, sponsored by government. Maintains and develops the national curriculum and associated assessments, tests and examinations as well as accrediting qualifications in colleges and at work. Also regulates awarding bodies and exams to ensure they are fit for purpose. See www.qca.org.uk

QIA

Quality Improvement Agency. Non-departmental public body; successor to LSDA. Works across the entire learning and skills sector. See www.qia.org.uk

QTLS

Qualified Teacher Learning and Skills. Non-subject-specific qualifications that give qualified teacher status; effective from September 2007.

QTS

Qualified Teacher Status – awarded to a teacher who is fully qualified in terms of training, certification and experience.

Skills for Life

National strategy for improving adult literacy and numeracy skills in England. See www.dfes.gov.uk/readwriteplus

SNS

The Secondary National Strategy for school improvement is part of the Government's major reform programme for transforming secondary education to enable children and young people to attend and enjoy school, achieve personal and social development and raise educational standards in line with the 'Every Child Matters' agenda. See www.standards.dfes.gov.uk/secondary/about/

SSAT

The Specialist Schools and Academies Trust is the leading national body for secondary education in England, and delivers the Government's Specialist Schools and Academies programme. Is responsible for CPD for the Diplomas. See www.specialistschools.org.uk

SSC

Sector Skills Council. SSCs are independent, employer-led UK-wide organisations licensed by the Secretary of State for Innovation, Universities and Skills to tackle the skills and productivity needs of their sector throughout the UK. See www.ssda.org.uk

TDA

Training and Development Agency for Schools: responsible for funding the provision of teacher training in England, and providing information and advice on teaching as a career. See www.tda.gov.uk

UFI

University for Industry. The organisation behind learndirect. It has a mission to use technology to transform the skills and employability of the working population, in order to improve the UK's productivity. See www.ufi.com