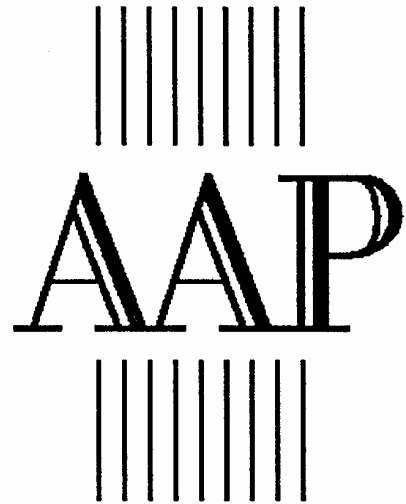


Assessment  
of  
Achievement  
Programme



# Seventh Survey of Mathematics 2004

**Assessment of Achievement Programme**

**Report on the Seventh AAP Survey of  
Mathematics (2004)**

**Scottish Executive Education Department  
2005**



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# Preface

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The 2004 Mathematics Survey was the last survey to be carried out within the Assessment of Achievement Programme (AAP), which this year is replaced by the expanded Scottish Survey of Achievement. The stages assessed were P3, P5, P7 and S2, with pupil testing taking place in May and June 2004. Almost 10000 pupils in just under 850 mainstream schools across Scotland attempted mathematics test booklets, that is 2000-3000 pupils per stage. In addition, around 5500 pupils in almost 800 of these same schools attempted reading and writing tasks. Almost 400 of the schools also participated in practical assessments, of mathematics and ICT skills. To provide a context for the attainment findings, participating schools were invited to complete questionnaires about the resources available to them for mathematics and about their mathematics provision, and at every stage those pupils who attempted mathematics assessments were invited to complete questionnaires about their learning experience in mathematics.

The National Assessment Bank provided the ‘pencil and paper’ and the ‘mental’ mathematics assessment tasks used in the survey, supplemented by practical mathematics tasks, ICT tasks, and reading and writing tasks newly developed by the Scottish Qualifications Authority (SQA). School and pupil questionnaires were developed by the Scottish Executive Education Department (SEED) and SQA. The SQA was responsible for printing the test booklets and distributing these to schools. The survey schools organised and supervised their own written test sessions, but the practical assessments were the responsibility of itinerant field officers – practising primary teachers and secondary mathematics teachers released by their education authorities for survey involvement. Completed test booklets were received and processed by SQA. The pupil response data were keyboarded by Datapro Data Services Ltd and analysed by Assessment Europe. The survey report was produced by Sandra Johnson (Assessment Europe) and Tom Macintyre (University of Edinburgh).

This report presents a rich snapshot view of the situation in Scottish schools today as regards mathematics and core skills 5-14. Like previous surveys in the AAP series, this survey was an ambitious exercise, that has resulted in a wealth of information about pupil attainment in an important curricular area, set within the context of learning circumstances and experiences both within and outside the classroom.

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# Acknowledgements

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This survey, like all AAP surveys before it, could not have taken place without the invaluable cooperation of numerous individuals and organisations:

- Carolyn Hutchinson, Head of Assessment Branch, Qualifications, Assessment and Curriculum Division, SEED, who has been instrumental in sustaining the Assessment of Achievement Programme and guiding its evolution;
- Jim McArthur, AAP Coordinator, who organised activity, coordinated effort and contributed as usual in a major way to a successful survey implementation, ably supported by Kelly Hoy;
- Lillian Munro, Liz Wharton, Barbara Hill and Elaine Tarrant of the Scottish Qualifications Authority, who were responsible for task development and marking;
- Tuula Tuominen (Datapro Data Services Ltd), who ensured that the attainment data were quickly and competently keyed;
- Sandra Johnson, AAP Technical Adviser, who designed the survey, analysed the survey data in collaboration with Rod Johnson (Assessment Europe), and produced Chapters 1 to 6 of this report;
- Tom Macintyre, University of Edinburgh, who served on the Mathematics Reference Group and produced Chapter 7 of this report, reflecting on the survey findings from the perspective of a mathematics educator;
- The members of the Mathematics Reference Group, who contributed ideas and suggestions, and generally supported the Survey Design Team (see Appendix A);
- The practising teachers who assisted in the development of new assessment tasks;
- The head teachers who agreed to the participation of their schools in the survey;
- The education authorities who nominated and released practising teachers for participation as field officers;
- The field officers themselves, who visited the schools undertaking practical assessments of various kinds, and who assisted in the evaluation of pupils' writing;
- The class teachers who organised and supervised assessment sessions in their schools;
- The students who marked the written tests and prepared mark sheets for data keying;
- Last but not least, the several thousand pupils who were assessed and questioned, and without whose input the survey would have no meaning whatsoever.

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# 1. Introduction

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## 1.1 Overview

The aims of this last survey in the Assessment of Achievement Programme (AAP) series<sup>1</sup> were to:

- assess the mathematics attainment of pupils in P3, P5, P7 and S2;
- assess the core skills attainment of pupils in P3, P5, P7 and S2;
- compare attainment across the four stages and between boys and girls;
- compare attainment in 2004 with that in 2000;
- report attainment in terms of 5-14 levels whenever possible;
- explore pupils' perceptions about mathematics;
- provide a learning context against which to reflect on the attainment and attitude findings.

The survey involved around 15500 pupils in almost 850 mainstream schools across Scotland (see Appendix B for sampling details), and testing took place in May and June 2004. Around two-thirds of the pupils attempted written and mental mathematics tasks, between them attempting more than one thousand different atomistic tasks across the six levels, while the remainder participated in core skills reading and writing assessment. In over two-fifths of the survey schools the 'mathematics' pupils also took part in practical mathematics assessments while the 'core skills' pupils undertook ICT tasks.

To provide a context for the attainment findings, both pupils and teachers were invited to complete subject-relevant questionnaires. Those pupils attempting mathematics assessments were invited to complete questionnaires seeking their views about their learning experiences in mathematics and exploring their perceptions about the importance of mathematics in the world of work. In half the participating schools, managers and class/subject teachers were invited to complete questionnaires about the resources available to them for mathematics and about their subject provision.

## 1.2 The assessment framework and task selection/development

### 1.2.1 Mathematics

The survey was designed primarily to assess and to report pupil attainment for mathematics and for mental mathematics, in terms of specific 5-14 levels at each stage: P3 attainment would be assessed at Levels A and B, P5 at Levels B, C and D, P7 at Levels C, D and E, and S2 at Levels D, E and F. In addition, it was planned to offer comment on pupil performance on the 'written' items for each outcome separately, in the form of average scores on items classified at the same level in each area.

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<sup>1</sup> 2005 has seen the launch of the Scottish Survey of Achievement, whose remit extends beyond that of the Assessment of Achievement Programme, to embrace attainment reporting at the level of education authorities in addition to the country as a whole.



The current 5-14 framework for mathematics, as described in the National Guidelines<sup>2</sup>, comprises the following outcomes and strands:

*Information handling:*

- Collect information
- Organise information
- Display information
- Interpret information
- Probability

*Number, Money & Measurement:*

- Range and type of numbers
- Money
- Add and subtract
- Multiply and divide
- Round numbers
- Fractions, percentages and ratio
- Patterns and sequences
- Measure and estimate
- Time
- Perimeter, formulae and scales
- Functions and equations
- Algebra

*Shape, Position & Movement:*

- Range of shapes
- Position and movement
- Symmetry
- Angle

*Problem solving and enquiry:*

- Problem solving.

A Mathematics Reference Group, comprising subject specialists, practising primary teachers, practising secondary mathematics teachers and other education professionals (membership details are given in Appendix A), advised on how best to implement this framework to meet survey aims within the inevitable practical constraints of this large-scale exercise. The way in which the general framework was eventually represented in the set of atomistic assessment tasks ('test items') administered in the survey is illustrated in Chapter 2.

The 5-14 National Assessment Bank furnished the majority of the 1000+ test items needed for the survey (for examples see Chapter 2). Remaining gaps in intended coverage were filled through new item development, organised by staff in the SQA and involving the contributions of practising primary teachers and secondary mathematics teachers. All newly developed items were piloted before survey use.

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<sup>2</sup> *National Guidelines: Mathematics 5-14*, Edinburgh: Scottish Office Education Department, 1991, and *National Guidelines: Mathematics 5-14 Level F*, Edinburgh: Scottish Office Education and Industry Department, 1999.

In addition, a small number of multi-item ‘mathematics literacy’ tasks were developed. These were intended to offer pupils the opportunity to apply their numeracy skills in response to a coherent set of test questions, all linked to the same paper-based stimulus information.

Over-time attainment comparisons are offered on the basis of ‘written’ items previously administered in the 2000 mathematics survey and reused on this occasion. Given that P4 was not assessed in the 2004 survey, and given that Level F did not feature strongly in the 2000 survey, over-time comparisons are presented for P7 and S2 only at Levels C, D and E.

### **1.2.2 Practical mathematics**

This survey included an important component of practical assessment in mathematics. Practical mathematics tasks, administered by itinerant field officers, directed pupils to work through a number of atomistic but linked activities. The four tasks focused, respectively, on money, time and measure, fractions, percentages and ratio, and shape, angle and direction.

### **1.2.3 Core skills**

In addition to numeracy, which naturally featured in the general mathematics assessment, the core skills of reading, writing and using ICT were also assessed within the survey, with tasks set within a mathematics context.

Several reading and writing tasks were newly developed for use here. The reading tasks took the same general form as those used in previous AAP subject surveys, including English Language, Social Subjects and Science, and in National Assessments, *viz.* a source text, whose length and difficulty increased with level, followed by a series of test questions exploring comprehension of that text. The difference between these new tasks and those already available from previous surveys is the fact that here the texts focused on some issue or personage in mathematics, though without any requirement for prior knowledge and understanding of mathematics *per se*. Writing tasks were based on the same stimulus material as the reading tasks.

A small number of ICT tasks were also developed for use in the survey. These required pupils to work with laptop computers supplied by assessing field officers, undertaking various activities involving text manipulation and use of spreadsheets.

A number of experimental problem solving tasks were also piloted in the survey.

## **1.3 Task administration and marking**

All the survey pupils were involved in some form of written assessment, and around one-third also participated in some form of practical assessment.

The pupils’ own teachers organised and supervised written test sessions, but the practical assessments were the responsibility of itinerant field officers (see section 1.3.3). Once the written testing had taken place, the survey schools returned completed scripts to SQA for processing and marking. Field officers completed their assessments of pupils as they engaged in the practical activities.

### **1.3.1 Mathematics ‘written’ assessment**

The atomistic written mathematics test items were presented to pupils in the form of mixed-level mixed-outcome test booklets, lasting around 40-45 minutes at P3/P5 and 50-60 minutes at P7/S2. It was intended that each pupil would attempt two such booklets, booklet pairs being randomly allocated to them. Pupils also undertook a mental test before they started on their written items. The schools themselves organised and supervised the assessment sessions, which were to take place within the period mid-May to mid-June 2004. Test booklets were despatched to and received back from schools by SQA. Completed booklets were processed centrally by SQA, with students marking pupils’ responses. The ‘mathematical literacy’ tasks were marked by the field officers who administered them (see section 1.3.3).

### **1.3.2 Reading and writing**

It was intended that each pupil would attempt two different reading booklets, at different levels and assigned at random, plus a single writing task. Reading tasks were presented to pupils in the form of test booklets, one reading task forming a single booklet. A source booklet contained passages for the two reading tasks, and two associated writing tasks. Pupils had the freedom to choose one or other of the writing tasks. Reading booklets were designed to have the same general time requirement as the mathematics booklets, and it was expected that schools would organise both types of assessment to occur in the same test sessions. Writing was undertaken in a third session. Completed reading booklets, like completed mathematics booklets, were processed centrally, using students to mark responses and prepare mark sheets for keying. Random samples of pupils’ writing were selected for evaluation by the practising teachers who had served as field officers in the survey (see section 1.3.3).

### **1.3.3 Practical tasks**

Education authorities throughout the country provided the 137 practising teachers, both primary class teachers and secondary mathematics teachers, who served as field officers. The field officers worked in pairs, half at P3/P5 and half at P7/S2, spending five days visiting schools located within reasonable travelling distance of their home areas. In preparation for this work, the field officers were given a day of task orientation in May/June 2004. They then spent one day in each of their five assigned schools, setting up and supervising the practical sessions, rating pupils on the spot, using checklists to record observations and judgments as pupils worked through their practical mathematics (see Chapter 3) and ICT tasks (see Chapter 4), or participated in experimental group discussions. Their involvement in the practical assessment was formally ended in a debriefing day held in June 2004.

## **1.4 Reporting pupil attainment**

Pupils’ mathematics attainment, as well as their reading and writing attainment, is reported in terms of the percentage of pupils at each stage who were deemed to have attained specific 5-14 levels. In mathematics and reading, cut-off scores were applied to identify attainment groups (see Appendix B, section B.4, for details), whereas in writing pupils were classified into levels through the application of a ‘best fit’ evaluation scheme (further details are given in Chapter 4). By their nature, the ‘mathematical literacy’ tasks, the practical mathematics tasks and the ICT tasks do not lend themselves to the same kind of level-based reporting. In

these cases, pupil performance is either averaged over test items or behaviours classified at particular levels, and average facility values or rating distributions given, or performance is reported item by item.

The resulting attainment findings are presented in Chapters 2, 3 and 4. Chapter 2 focuses on the assessment of written and mental mathematics, Chapter 3 presents the results of the assessment of practical skills in mathematics, and Chapter 4 presents the results of the core skills assessment.

Chapter 5 presents findings from the pupil questionnaire enquiries, while Chapter 6 presents findings from the school questionnaire. Finally, Chapter 7 summarises and reflects on the principal findings of the survey, and addresses some of the issues arising.



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## 2. Mathematics

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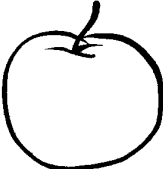

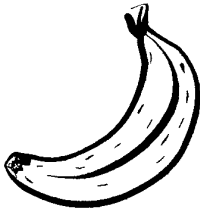
### 2.1 The assessment process

#### 2.1.1 The assessment tasks

The principal intention of this survey was to assess the mathematics attainment of pupils in P3, P5, P7 and S2 at two or three consecutive levels: Levels A and B at P3; Levels B, C and D at P5; Levels C, D and E at P7; Levels D, E and F at S2. To this end, a total of 1120 atomistic ‘pencil and paper’ test items (single-item tasks) were administered in the survey, every item having been classified by outcome, strand and level prior to survey use. The majority of the items pre-existed in the 5-14 National Assessment Bank. Additional items were newly developed, as necessary, to fill gaps in the intended curriculum coverage of the survey.

The items took a form which everyone with any experience of mathematics assessment is familiar, presenting pupils with a short stem and inviting a single quick response (see Figure 2.1a to Figure 2.1f for examples).

**Figure 2.1a**  
**Example test item: Level A**  
*Number, Money & Measurement: Subtract*

			
grapes 3p	apple 5p	plum 4p	banana 6p

Paula buys some grapes and pays with a 10p coin.

What is her change?

Answer: \_\_\_\_\_ p

**Figure 2.1b**  
**Example test item: Level B**  
*Information Handling: Interpreting information*

The class with the most stars wins a prize.

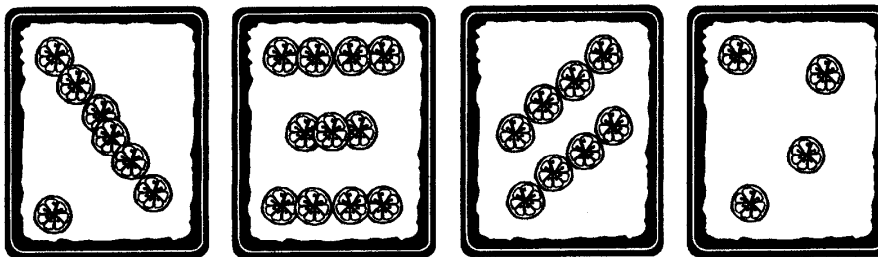
	August	Sept	Oct	Nov	Dec	Jan	Feb
P1	☆				☆		
P2		☆		☆			☆
P3/4		☆					
P5			☆	☆		☆	☆
P6	☆					☆	
P7			☆		☆		

Which class has the most stars?

Answer: \_\_\_\_\_

**Figure 2.1c**  
**Example test item: Level C**  
*Shape, Position and Movement: Symmetry*

Tick (✓) the symmetrical pattern.



**Figure 2.1d****Example test item: Level D***Problem Solving and Enquiry: Problem solving*

Children from South Primary School went on a residential trip by coach, minibus and car.

- $\frac{4}{7}$  of the children went by coach.
- $\frac{2}{7}$  of the children went by minibus.
- There were 8 children left to go in cars.

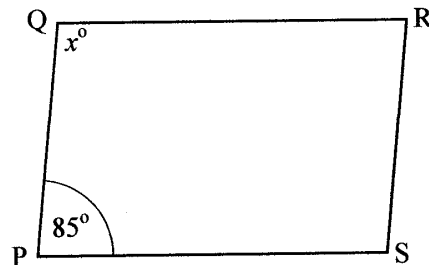
How many P7 children were going on the trip altogether?

Answer: \_\_\_\_\_ children

**Figure 2.1e****Example test item: Level E***Shape, Position & Movement: Range of shapes*

PQRS is a parallelogram with angle SPQ =  $85^\circ$ .

Calculate the size of the angle PQR.  
(Marked  $x^\circ$  in the diagram.)



Answer: \_\_\_\_\_ $^\circ$

**Figure 2.1f****Example test item: Level F***Number, Money & Measurement: Algebra*

Solve the following equation.

$$3(x - 2) + 7x = 24$$

Answer:  $x =$  \_\_\_\_\_



Table 2.1 shows the intended distribution of the survey items over the assessment framework. Where no items appear in particular cells in the grid, this is usually because the strands concerned do not feature at the levels concerned within the national guidelines for this subject, for example ‘multiply and divide’ at Level A.

**Table 2.1**  
**Distribution of the 1120 ‘pencil and paper’ test items**  
**over outcomes, strands and levels**

<i>Outcome</i>	<i>Level</i>					
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
<i>Number, Money &amp; measurement:</i>	40	60	60	60	80	80
- Add & subtract	10	15	10	10	10	10
- Multiply & divide		15	10	10	10	10
- Fractions, % & ratio			10	10	10	10
- Functions & equations/algebra					20	20
- Other strands	30	30	30	30	30	30
<i>Information handling:</i>	40	40	40	40	40	60
- Interpreting information	25	25	25	25	25	25
- Probability						20
- Other strands	15	15	15	15	15	15
<i>Shape, Position &amp; Movement: All strands</i>	40	40	40	40	40	40
<i>Problem Solving &amp; Enquiry: Problem solving</i>	40	40	40	40	40	40
<i>Total number of items</i>	<b>160</b>	<b>180</b>	<b>180</b>	<b>180</b>	<b>200</b>	<b>220</b>

In addition to the 1120 ‘pencil and paper’ items, a total of 384 ‘mental’ test items were also administered in the survey, comprising 64 items per level, Levels A to F. With the exception of three ‘problem solving’ items, all the mental items were from the outcome *Number, Money & Measurement*. An important point to note regarding the level classification of the mental items is that, following the definition of targets given in the 5-14 Guidelines<sup>3</sup>, some items were classified at one level above the level that would normally be assigned to the item were it to be presented within a written test booklet; thus a Level D ‘pencil and paper’ item would be considered a Level E item in a mental test. Table 2.2 shows the distribution of these items over the assessment framework, while Table 2.3 provides examples of the type of item involved.

**Table 2.2**  
**Distribution of the 384 ‘mental’ test items**  
**over outcomes, strands and levels**

<i>Outcome</i>	<i>Level</i>					
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
<i>Number, Money &amp; measurement:</i>						
- Add & subtract	37	21	20	15	15	9
- Multiply & divide		22	16	15	15	12
- Fractions, % & ratio		3	6	7	9	15
- Other strands	27	18	22	27	25	28
<i>Problem Solving &amp; Enquiry: Problem solving</i>					3	
<i>Total number of items</i>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>

<sup>3</sup> *National Guidelines: Mathematics 5-14*, Edinburgh: Scottish Office Education Department, 1991.

**Table 2.3**  
**Examples of mental items from Level A to Level F**

<p><i>Level A</i></p> <ul style="list-style-type: none"> <li>- Write the next number after 18</li> <li>- Sally buys a drink for 8p. How much change does she get from 10p?</li> <li>- There are only 7 boys in Tom's class. 2 more boys join the class. How many are there now?</li> </ul>
<p><i>Level B</i></p> <ul style="list-style-type: none"> <li>- What is the next number in the sequence 5, 9, 13, ...?</li> <li>- Mr. Brown shares £12 equally among his 4 children. How much will each child get?</li> <li>- Add 9 and 17</li> </ul>
<p><i>Level C</i></p> <ul style="list-style-type: none"> <li>- Add 276 plus 5</li> <li>- 3463 tickets were sold for a pop concert. Round this number to the nearest 10.</li> <li>- Write down the number which is 100 less than 7000</li> </ul>
<p><i>Level D</i></p> <ul style="list-style-type: none"> <li>- Add 47 and 34</li> <li>- Write 0.5 as a fraction</li> <li>- At a sale all goods are half price. What is the sale price of a watch which usually costs £25?</li> </ul>
<p><i>Level E</i></p> <ul style="list-style-type: none"> <li>- The volume of a cube is 8 cubic centimetres. What is the length of each of its sides?</li> <li>- A hallway is 6.5 metres long. Andy sees a rug 4.6 metres long. How much longer does the rug have to be to fit the hallway?</li> <li>- Multiply 12 by 40</li> </ul>
<p><i>Level F</i></p> <ul style="list-style-type: none"> <li>- Find 5% of 600</li> <li>- Write down the square root of 121</li> <li>- Calculate 15 times 400</li> </ul>

The written and mental atomistic items were complemented by longer newly developed multi-item tasks, 'maths literacy tasks'. Each of these tasks comprised 10 or more test questions (items), all based on the same set of text-based and graphical stimulus materials. Thumbnail sketches of three of the tasks are offered in Table 2.4. Practical tasks of different kinds also featured – these are described and reported in Chapter 3.

In principle there were three multi-item maths literacy tasks at each of Levels A to E. In practice there was disagreement about the appropriate level classifications of many of the tasks when four different teachers were invited independently to validate them. Any level-based results given later in this chapter should in consequence be considered indicative rather than robust.

**Table 2.4**  
**Overview of one ‘mathematical literacy’ task at each of Levels A, C and E**

<p>‘My friends’ – <i>Level A</i></p> <p>Here, pupils were presented with a short descriptive text about fictional friends, with particular comment on hair colour. The text was accompanied by a set of sketch pictures of the faces of the friends, clearly showing dark or fair hair.</p> <p>Five questions focused on the pictures or text, inviting the pupils to retrieve information, two questions involving counting and one subtraction.</p> <p>Further text explained that some of the friends had pets, and showed pictures of those friends with cats and those with dogs. Five more questions then explored understanding of the text and picture sets.</p>
<p>‘The Exhibition’ – <i>Level C</i></p> <p>The source material here is a fictitious letter and poster. The letter is from an employee of an art gallery, acknowledging the request of a head teacher for a photograph from the gallery’s ‘Children at Play’ exhibition for his/her school. The letter includes an invitation to teacher and pupils to a private viewing of the exhibition, and an enclosed poster provides a comprehensive set of exhibition information: artists featured, opening hours, etc.</p> <p>Again there were 12 questions based on the source material, with children sometimes required simply to retrieve information from the letter and/or poster and at other times having to use the retrieved information to calculate sums and differences (ages, prices, durations, etc).</p>
<p>‘Crime Survey’ – <i>Level E</i></p> <p>The source material for this task comprised eight pie charts, illustrating the results of a survey into people’s experience of crime. Each pie chart showed the proportion of individuals in the crime survey who answered in particular ways to questions such as “Have you, or another member of your immediate family, been a victim of crime in the last five years?” (response options: ‘yes, self’; ‘yes, other family member’; ‘no’).</p> <p>Pupils were asked 12 questions, all requiring them to read information from one or other of the charts: five were short-response items, including “What percentage of people surveyed had <b>personally</b> had a crime committed against them in the last 5 years?” and seven were multiple-choice items.</p>

### 2.1.2 Task administration

Even with an unlimited amount of testing time per pupil, no single pupil could ever be expected to undertake all the items and tasks concerned at the levels proposed for that pupil’s stage. As in all large-scale attainment surveys there must be a limit to the testing time demanded of pupils and teachers. Here, as in previous AAP surveys, the time assumed was around 30-40 minutes per session at P3, 40-50 minutes at P5 and 50-60 minutes per session at P7/S2, with two separate assessment sessions available.

The Mathematics Reference Group was consulted about the most appropriate numbers of items that pupils at the different stages might reasonably be expected to attempt within these timescales. The advice was: around 21 items at P3, around 25 items at P5, and 30-35 items at P7/S2. It was also confirmed that no pupil should be expected to take a test at one level only, given that there was no prior information available about the attainment level that pupils might be working comfortably at when the survey was planned to take place. It was considered ill-advised to contemplate giving a P5 pupil a Level D test, for example, when that

pupil might currently be working at Level C or even at Level B. For different reasons, it was considered equally inappropriate to give a P5 pupil a Level B test when that pupil might already be working at Level D. It was therefore decided to include items from more than one level in every written test booklet and in every mental test.

The 1120 ‘pencil and paper’ items were consequently subdivided into a number of different test booklets, each designed to take around the given testing time, and each comprising the same mix of test items in terms of curriculum coverage and levels. There were 20 different test booklets in total at each stage, comprising 17 items at P3, 27 at P5, 28 at P7 and 30 at S2 (see Appendix B, section B.2, for the rationale behind these numbers). At P3 every booklet contained items from two levels (A and B), whereas at the other stages every booklet contained items from the three relevant levels. The order of presentation of items within a booklet was randomised, so that pupils did not face a string of items at the same level or from the same outcome, and booklets were produced in two versions, the second version simply reversing the order of item presentation. Where pupils at different stages were to be assessed at the same level (e.g. P3 and P5 at Level B) the same items were used as the basis for the assessment.

The 384 mental test items were also distributed among a number of different mental tests, 16 tests at each stage. At P3, tests were eight items long, with four items representing each of Levels A and B. At the other stages tests were 12 items long, with four items from each of three consecutive levels (Levels B, C and D at P5, Levels C, D and E at P7 and Levels D, E and F at S2).

The written and mental assessment sessions were organised by the schools themselves, within the period mid-May to mid-June, with teachers in the schools delivering the mental tests and supervising the written testing. Prior to the survey, every pupil in the sample was randomly allocated two different written booklets, to be attempted in two separate assessment sessions, with a break between to be decided by each school. Since mental testing requires oral delivery of items, it would clearly not be feasible to expect teachers to deliver numerous different mental tests to their pupils. Therefore, every school was randomly allocated two different mental tests, each to be delivered to the whole pupil group before the pupils embarked on their individualised written test booklets. Thus, all the pupils in any one school would take the same two mental tests, but different pupils would take different pairs of written tests. Completed scripts were returned to SQA for marking. Typically, each written test booklet, and hence every ‘pencil and paper’ test item, was attempted by 200-250 pupils at P3, P5 and P7 and 250-300 pupils at S2. The mental tests were each attempted by 250-300 pupils at the primary stages and 350-400 pupils at S2.

The multi-item maths literacy tasks were administered to a subsample of the pupils in a subsample of the schools by the itinerant field officers responsible for the practical assessments in mathematics. Each task was attempted by 150-200 pupils, the numbers varying by stage.

### **2.1.3 Marking**

The mental tests, written test booklets and maths literacy tasks were processed by the SQA, with students employed to mark pupils’ responses during a continuous marking period throughout July 2004. After instruction in marking procedures, the markers were organised

into five teams of five, and at any one time, four teams were involved in marking and one team in checking. Booklets and tasks were marked stage by stage, starting with P3.

All the ‘mental’ items and the majority of the pencil and paper items were allocated one mark each. A minority of the pencil and paper items, particularly algebra items at Level F, such as that shown in Figure 2.1f, were allocated two marks, usually one for method and one for a correct answer. Non-responses were noted, as were those occasions when pupils selected more than one answer option in multiple-choice items.

#### **2.1.4 Reporting attainment**

Pupils’ written mathematics attainment is reported in terms of the percentages of pupils deemed to be working at the 5-14 levels assessed at the stage concerned. Attainment decisions were based on the application of cut-off scores to the total marks achieved by pupils on the set of items at the same level distributed across their two booklets. The numbers of items at each level across two booklets were as follows: 16 at Level A, 18 at each of Levels B, C and D, 20 at Level E and 22 at Level F. Following practice in recent AAP surveys, pupils achieving 80% or more of the marks were considered as having demonstrated “considerable strengths” at the level concerned; pupils with 65% or more of the marks but less than 80% were considered as being “secure” at the level; pupils achieving 50% or more of the marks but less than 65% were considered as having “basic skills” at the level<sup>4</sup>. For each pair of booklets at a stage the proportions of pupils achieving or exceeding the cut-off scores were calculated, and the results were then averaged over all booklet pairs to produce the attainment figures presented in the next section.

Given the small numbers of items/tasks attempted by any individual pupil relating to the separate outcomes (four to six items per level per pupil), mental mathematics (eight items per level per pupil) and mathematical literacy (one task per pupil), performance reporting is in these cases in terms of average mean scores rather than level attainments.

## **2.2 Overview of pupils’ attainments**

### **2.2.1 The attainment picture across the stages**

For the written assessment of mathematics, Table 2.5 provides an overview of attainment at all four stages, in terms of the proportions of pupils meeting the 65% success criterion on the items they attempted at particular levels, averaged over all booklet pairs. Figure 2.2 illustrates the picture.

Table 2.5 and Figure 2.2 show an expected pattern: ‘secure attainment’ rates rise through the stages at any one level, and decrease within each stage as levels increase. At P3, almost 90% of the pupils tested were at least ‘secure’ at Level A and around one-third were also secure or better at Level B. At P5, almost three-quarters of the pupils were at least secure at Level B, 40% also at Level C and 10% at Level D. At P7 we see a similar picture, but removed by one level: almost three-quarters of the pupils were secure or better at Level C, over 45% at Level

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<sup>4</sup> In practice, the ‘percentage correct’ was rarely exactly 65%, given that this percentage rarely corresponded with whole integers on the variable mark scales for the different sets of items.

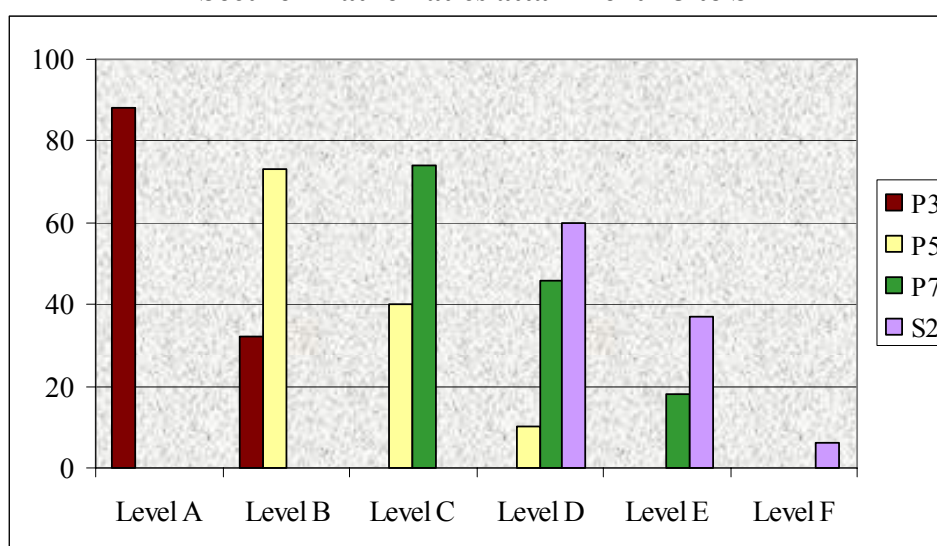
D, and almost 20% at Level E, the level above their expected level. Meanwhile, at S2, 60% of the pupils were secure at Level D, over 35% at Level E and over 5% at Level F.

**Table 2.5**  
**‘Secure’ Mathematics attainment P3 to S2**  
 (% pupils achieving 65% or more of the marks for 16-22 tasks at a level, averaged over booklet pairs\*)

	Level A	Level B	Level C	Level D	Level E	Level F
S2				60	37	6
P7			74	46	18	
P5		73	40	10		
P3	88	32				

\* Figures show the percentages of pupils demonstrating attainment at the indicated level or higher: 2000-3000 pupils at each stage, weighted data; margins of error around 1.5 percentage points.

**Figure 2.2**  
**‘Secure’ Mathematics attainment P3 to S2\***



\* Each bar shows the percentage of pupils achieving 65% or more of the marks at the level concerned: 2000-3000 pupils at each stage.

Within each level we can look further than the proportions of pupils who are at least secure at the level, extending the picture to those showing considerable strengths as well as to those achieving only basic levels of attainment or even lower than basic. Table 2.6 provides the relevant data.

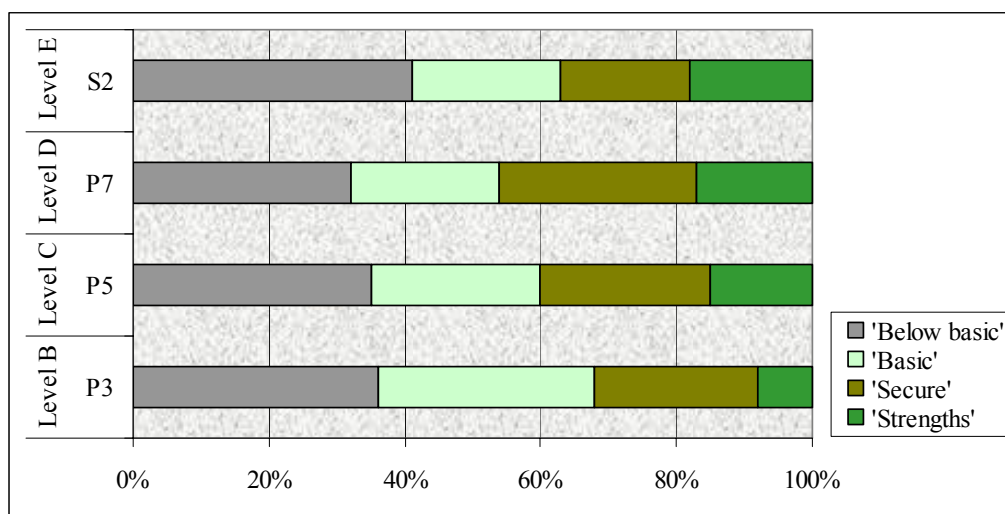
Perhaps one of the most interesting features in Table 2.6 is the general similarity in the attainment profiles of the pupils at P7 and S2 at Levels D and E, respectively their expected levels, and of the pupils at P3 and P5 at Levels B and C, respectively. The pattern is illustrated in Figure 2.3.

**Table 2.6**  
**Mathematics attainment within levels**  
 (% pupils classified into each attainment group at each level\*)

Stage	Pupils	Level	< Basic	Basic	Secure	Strengths
S2	2969	F	83	11	4	2
		E	41	22	19	18
		D	20	20	30	30
P7	2447	E	65	17	12	6
		D	32	22	29	17
		C	12	14	30	44
P5	2124	D	73	17	8	2
		C	35	25	25	15
		B	10	17	32	41
P3	2047	B	36	32	24	8
		A	3	9	20	68

\* '< basic' means fewer than 50% of marks achieved, 'basic' is between 50% and 64%, 'secure' is 65% to 79%, and 'strengths' is 80%+; weighted data

**Figure 2.3**  
**Profiles of Mathematics attainment P3 to S2\***



\* '< basic' means fewer than 50% of marks achieved, 'basic' is between 50% and 64%, 'secure' is 65% to 79%, and 'strengths' is 80%+.

While there is some variation in the proportions of pupils showing considerable strengths at the respective levels, this variation is not great between P5 and S2: 15% at P5 for Level C, 17% at P7 for Level D, 18% at S2 for Level E. At the other extreme, we see similar variation in the proportions of P3, P5 and P7 pupils showing 'below basic' levels of skill and understanding, with around one-third falling into this category. At S2 this rises to just over 40% demonstrating 'below basic' levels of skill and understanding at their expected level.

Focusing now on the lowest attaining pupils, 20% of the S2 pupils failed to demonstrate basic skills at Level D, the level below their expected level. At P5 and P7, a lower 10% or so of the pupils showed similarly low attainment at Levels B and C, respectively, while at P3 fewer than 5% of the pupils failed to demonstrate basic skills at Level A.

In total, 40, 60 or 80 different items were administered in the survey to represent each of the four outcomes at each level, the number depending on outcome and level (see Table 2.1). These numbers allow us to explore pupil performance in the different outcomes, in terms at least of averaged percentage item scores if not in terms of percentages of pupils attaining a level (individual pupils attempted a handful only of items from any one outcome). Table 2.7 provides the results of this comparison.

**Table 2.7**  
**Mathematics performance by outcome, P3 to S2\***  
*(average item facilities: 40-60 items in total per outcome)*

<i>Stage</i>	<i>Pupils</i>	<i>Level</i>	<i>NMM</i>	<i>IH</i>	<i>SPM</i>	<i>PS</i>
S2	2969	F	28	33	25	20
		E	54	58	57	41
		D	71	72	67	55
P7	2447	E	38	45	37	31
		D	63	62	57	47
		C	75	84	75	60
P5	2124	D	35	44	35	24
		C	53	73	60	40
		B	76	85	72	59
P3	2047	B	51	73	56	38
		A	88	89	80	72

\* *NMM – Number, Money & Measurement, IH – Information Handling, SPM – Shape, Position & Movement, PS – Problem Solving & Enquiry. The figures in this table are averaged percentage item scores, and not percentages of pupils attaining levels (weighted data).*

The clearest feature evidenced in Table 2.7 is the lower performance typically associated with *Problem Solving* items, at all stages and levels. This finding might be expected given that items were principally classified as problem solving items if correct answers required pupils to carry out two or more operations rather than one, and without any cueing. The Level D item shown in Figure 2.1 is an example. In this item, pupils are told that a P7 class was making a school trip, with the children travelling by coach, minibus or car: 4/7 by coach, 2/7 by minibus and eight children by car. They are asked how many pupils in total went on the trip. To answer this question, the survey pupils concerned had first to add 4/7 and 2/7 to find the total fraction travelling by coach or minibus, subtract from 1 to find the fraction travelling by car (1/7), equate this fraction to 8 pupils, and then multiply 8 by 7 to reach the answer of 56 pupils. Items asking pupils to find 1/7 of 56 or to find the sum of 4/7 and 2/7 would be classified as *Number, Money & Measurement*. Clearly, the more steps are involved in arriving at a successful conclusion the more opportunities there are for error.

It is more difficult to interpret differences between the other three outcomes. The performance scores for these outcomes are generally rather similar, and apparent differences are not consistent from one level or stage to another. Even where performance differences appear to be replicated at two or more stages (for instance, Level B at P3 and P5, where *Information Handling* appears to be ‘easier’ than *Number, Money & Measurement* and *Shape, Position & Movement*), this could quite simply be an artefact of the particular items used to



represent these outcomes at this level, or even a reflection of the way that the 5-14 assessment framework has defined this level for these outcomes.

Moving on to mental mathematics, where all but a handful of the 384 items were from the outcome *Number, Money & Measurement*, Table 2.8 presents the relevant performance data, and also provides a direct comparison with the results shown in Table 2.7 for the ‘pencil and paper’ items from this outcome (the items in the two modes were different items).

**Table 2.8**  
**Mental mathematics performance P3 to S2,**  
**compared with ‘pencil and paper’ performance**  
*(weighted average item facilities: 64 ‘mental’ items per level \*)*

<i>Stage</i>	<i>Level A</i>	<i>Level B</i>	<i>Level C</i>	<i>Level D</i>	<i>Level E</i>	<i>Level F</i>
S2				80 (71)	65 (54)	41 (28)
P7			87 (75)	72 (63)	51 (38)	
P5		89 (76)	69 (53)	43 (35)		
P3	92 (88)	64 (51)				

*\* The figures in this table are averaged percentage item scores, and not percentages of pupils attaining levels. Corresponding figures for the pencil and paper assessment of Number, Money & Measurement are shown in brackets.*

The performance data in Table 2.8 reveal a very clear picture of difference, with item scores 10-15 percentage points higher on average for the mental as opposed to the pencil and paper items, at all stages and levels. It should be remembered that some items presented orally would be classified at one level higher than they would be had they been presented on paper (see section 2.1.1). Moreover, while every one of the ‘mental’ items reproduced in Table 2.3 could very readily be presented to pupils in pencil and paper form (classified at a level below), the same cannot be said in reverse for the ‘pencil and paper’ items shown in Figures 2.1a and 2.1f, where the memory demand in terms of the source information is clearly too great to make oral presentation a fair option (compare the Level A pencil and paper item in Figure 2.1a with the Level A mental item reproduced in Table 2.3, both of which involve calculating change). That said, the picture of attainment in mental mathematics is a positive one.

Finally, the performance of pupils on the few mathematics literacy tasks administered by the itinerant field officers is shown in Table 2.9. In principle, three tasks per level were administered, for Levels A to E, individual pupils attempting just one task in their ‘practical’ assessment sessions. With just two exceptions, the tasks comprised ten questions, or test items, each, based on information presented in various forms (see Table 2.4 for examples).

Despite some problems classifying the tasks by 5-14 level, the data in Table 2.9 reveal a strikingly similar pattern of performance from one stage to another at the various levels. At P7 and S2 the averages of the mean percentage task scores<sup>5</sup> for the three tasks at Levels D and E, respectively, were just over 45%, falling to just over 40% for Levels B and C, respectively, at P3 and P5. At one level below at each stage the average mean percentage task score was 60-70%. Average item performance for the atomistic ‘pencil and paper’ assessment was typically higher at every level and stage.

<sup>5</sup> The mean percentage task score for a particular multi-item task is simply the number of items within the task that a pupil correctly answered, expressed as a percentage of the total number of items, averaged over all the pupils who attempted that task.

**Table 2.9**  
**Performance on exploratory ‘maths literacy’ tasks, P3 to S2,**  
**compared with ‘atomistic’ item performance**

*(average % task scores: 3 tasks per level with 150-200 pupils/task\*)*

<i>Stage</i>	<i>Level A</i>	<i>Level B</i>	<i>Level C</i>	<i>Level D</i>	<i>Level E</i>
S2				60 (67)	46 (53)
P7			63 (74)	47 (58)	
P5		71 (74)	42 (56)		
P3	63 (82)	41 (54)			

\* *The figures in this table are average percentage task scores, and not percentages of pupils attaining levels. Bracketed figures are average percentage item scores (average facilities) for the ‘atomistic’ pencil and paper assessment (all outcomes combined).*

### 2.2.2 Gender comparisons

There were no statistically significant gender differences at any stage at any level, for any type of mathematics.

### 2.2.3 Change over time

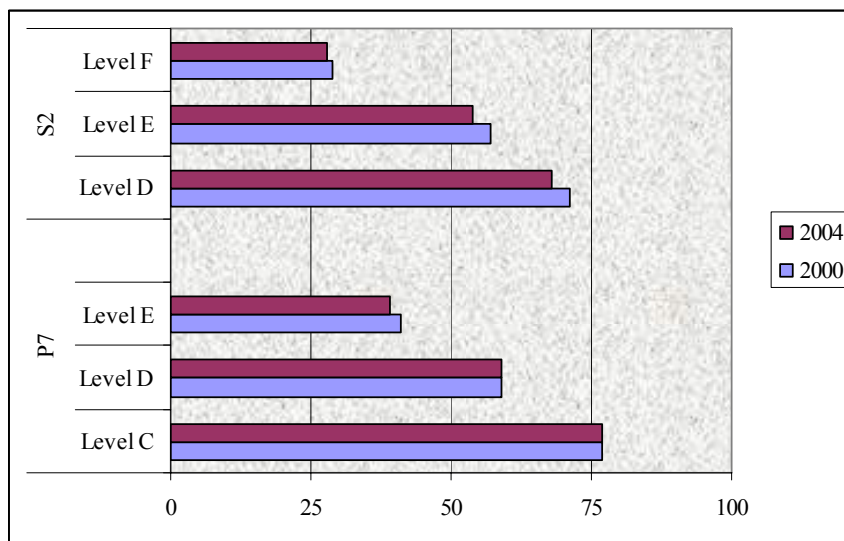
The previous AAP mathematics survey took place four years earlier, in 2000. In 2001 the stages assessed in the AAP programme changed from P4, P7 and S2 to P3, P5, P7 and S2. It is therefore not possible to offer comment on change over time for P3 and P5. At P7 and S2, while it is possible to offer comment, this can only be on the basis of mean item facilities and not in terms of percentages of pupils attaining levels. This is because in preparation for the launch of the National Assessment Bank in the autumn of 2003, the reservoir of test items provided by the AAP through surveys prior to the 2004 survey was reviewed, and every item re-evaluated in terms of the 5-14 framework and, if framework-relevant, classified by level. Wherever possible, test items were drawn from the 2000 pool within the National Assessment Bank for use in the 2004 survey, but these items were scattered at random throughout the test booklets.

Table 2.10 presents the resulting performance picture for the two years, a picture illustrated in Figure 2.4.

**Table 2.10**  
**Mathematics performance at P7 and S2 in 2000 and 2004**  
*(average item facilities)*

<i>Stage</i>	<i>Level</i>	<i>Items</i>	<i>2000</i>	<i>2004</i>	<i>2004-2000</i>
S2	F	84	29	28	-1
	E	113	57	54	-3
	D	108	71	68	-3
P7	E	111	41	39	-2
	D	120	59	59	0
	C	102	77	77	0

**Figure 2.4**  
**Mathematics attainment at P7 and S2 in 2000 and 2004**  
*(average facilities for 84-120 items/level that were administered in both surveys)*



At P7, there is literally no difference between the average item scores at Levels C and D, and the small sample difference at Level E is not statistically significant. While the small sample differences shown at all levels at S2 are in favour of the pupils in the year 2000, none of these differences reaches statistical significance either. There is thus no evidence of any real change in pupil performance at these stages and levels between 2000 and 2004.

## 2.3 Summary

A number of different types of mathematics assessment featured in this survey. Pupils' mathematical knowledge and skills were assessed through the administration of 1120 'atomistic' test items presented within numerous 'pencil and paper' test booklets, through the administration of 384 'mental mathematics' items presented to pupils orally by their own teachers, through use of a small number of multi-item 'mathematical literacy' tasks, administered to pupils by the itinerant field officers, and through a number of practical mathematics tasks (reported in Chapter 3).

On the basis of their performances on the atomistic 'pencil and paper' items, pupils were deemed as 'secure' at a level if they achieved at least 65% of the marks for items attempted at that level, as demonstrating 'considerable strengths' if they achieved 80% or more of the marks, as having 'basic skills' if they achieved half the marks but less than 65%, and as being 'below basic' if they could not achieve half the marks. As might be expected, 'secure attainment' rates rose through the stages at any one level, and decreased within each stage as levels increased. At P3, almost 90% of the pupils tested were at least 'secure' at Level A and around one-third were also secure or better at Level B. At P5, almost three-quarters of the pupils were at least secure at Level B, 40% also at Level C and 10% at Level D. At P7, almost three-quarters of the pupils were secure or better at Level C, over 45% at Level D, and almost 20% at Level E. At S2, 60% of the pupils were secure at Level D, over 35% at Level E and over 5% at Level F.

At P5, P7 and S2, 15-20% of the pupils showed ‘considerable strengths’ at Levels C, D and E, respectively. At the other end of the performance scale, 30-40% of the pupils at P3, P5, P7 and S2 showed ‘below basic’ levels of skill and understanding at, respectively, Levels B, C, D and E.

One-fifth of the S2 pupils failed to demonstrate basic skills at Level D, the level below their expected level, while 10% of the pupils at P5 and P7 showed similarly low attainment at Levels B and C, respectively, and fewer than 5% of the P3 pupils at Level A.

On the basis of average item scores, among the four outcomes of mathematics the lowest performances were associated with *Problem Solving*, at all stages and levels. The performance scores for the other three outcomes were generally rather similar, and any differences were not consistent from one level or stage to another.

As far as mental mathematics is concerned, item scores were 10-15 percentage points higher on average for the mental as opposed to the pencil and paper test items, at all stages and levels, a difference at least in part reflecting the nature of items administered in the two modes along with the fact that some items were classified at a level above normal for oral presentation.

Average percentage mean scores on three ‘mathematical literacy’ tasks per level were just over 45% for P7 and S2 at Levels D and E, respectively, and just over 40% for P3 and P5 at Levels B and C, respectively. At one level below, the average percentage mean score was 60-70% at each stage. Average facilities for the atomistic ‘pencil and paper’ items was typically higher at every level and stage than for the multi-item maths literacy tasks.

There were no statistically significant gender differences at any stage at any level, for any type of mathematics.

Finally, on the basis of around 100 repeated items per stage and level (on average), there is no evidence of any real change in P7 performance at Levels C, D or E or in S2 performance at Levels D, E or F since the last mathematics survey in 2000.



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## 3. Practical mathematics

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### 3.1 The assessment process

#### 3.1.1 The assessment tasks

The practical assessments conducted within this survey included aspects of the curriculum which are not readily assessed through paper and pencil assessments. Tasks were developed by identifying attainment targets which might be assessed by a field officer through one-to-one interaction with pupils, adopting a format which would allow the field officer to explore a pupil's mathematical understanding in a little detail. Given the constraints of the survey, and the limited number of practical tasks which could be included, particular attention was paid to identifying tasks which showed a clear progression within strands across levels. Consideration was also given to the likely availability of any resources or equipment which would need to be used.

Four resource-based practical mathematics tasks were newly developed for use in the survey. Each task comprised a series of questions and activities, progressively moving from Level A to Level E, and was designed to be undertaken by pupils in an interactive session, with an adult (in this survey an itinerant field officer) guiding and observing the activity, posing the questions and completing an associated checklist.

One task focused on pupils' abilities to handle money. The resources comprised a selection of coins and notes, a series of cards picturing various items labelled with prices, a currency conversion chart with simplified sterling/euro exchange rate, and a 'sale card'. A calculator was available for any pupils who might reach the Level E activities, which involved currency conversions and discount calculations. At Levels A to C, pupils were asked to give the exact money to the field officer to pay for particular objects, and were then asked whether they could have paid for the object concerned in some other way, still giving the exact amount but with a different combination of notes and coins. The field officer would then offer to 'buy' the object from the pupil, giving a higher amount of money than the object's price, and the pupil would need to calculate the appropriate change. Pupils were each time asked to explain how they worked out the amount of change. At Level E the concept of exchange rate was introduced, while at Level F pupils were tested for their ability to calculate sale discounts.

A second task looked at time and measure. The 'time' resources were an analogue clock and a card showing digital displays. The 'measure' resources were a measuring tape, a metre stick, a ruler marked with cm and mm, four different lengths of string, and a card showing pencils of different length. Level A to C activities required pupils to set the analogue clock to various times, while those at Levels D and E instructed them to set the analogue clock to the times shown on one or other of the digital displays. After each activity, pupils were invited to explain what they had done. The assessment of pupils' understanding of measure began by asking the pupils to compare given objects by length, width or height, identifying the longest, the widest and the tallest (Level A), always explaining their choices. They were then asked to measure the length of a given object, and to choose one of the pieces of string that matched a given length (Level B activities). Measurement moved on to the length/width of the classroom (which involved measurement in metres – a Level C activity), and then (Level D)

to the mm lengths of the illustrated pencils (this involved, among other things, giving a millimetre measurement as a decimal centimetre measurement).

A third task explored pupils' understanding of fractions, percentages and ratio. The first half of the task, Levels A to C, focused on activities involving paper circles and blank grids (20 square, 36 square, 50 square, 100 square). Pupils were asked to divide the circle into halves (for them 'two pieces of exactly the same size') and then into quarters ('four pieces of exactly the same size'), to name the resulting shapes and to explain their responses. At Levels C to E they had to shade various fractions and percentages of different squared grids, explaining how they worked out how many squares to shade. The second half of the task focused on coloured cubes/counters, with pupils required to give the field officer appropriate numbers of cubes to represent particular fractions (Levels A to C) or percentages (Level D) or to count appropriate numbers of coloured cubes to represent given ratios (Level E).

The fourth task featured shape, angle and direction. The 'shape and angle' resources included a collection of 3D shapes, including spheres, cubes, cuboids, cones and cylinders, triangular prisms and square pyramids. A protractor was also available, along with a ruler and pencil. The 'direction' resources comprised a roamer, floor turtle or similar, an optional floor grid and paper turtle grids, a compass and paper compass rose. Pupils were first asked to identify which of the various 3D shapes would roll, and to name the shapes (Level A). They were then asked (Level B activities) to identify an edge and face of a cylinder, to count the edges and faces, to select a shape with nine edges and five faces, and to name it (triangular prism). At Level C they were to identify 2D shapes in the triangular prism, to count the angles, to identify a 90 degree angle and an angle smaller than this, and to give the names for these (right angle and acute angle). At Level D pupils had to measure one angle and draw another of given size, while at Level E they were asked to draw a triangle with one given side length and two angles, and to measure the third angle. In addition, pupils were asked (Level A to C activities) to programme the turtle to make various movements within the turtle grid (or to instruct the field officer to make the same movements on the floor should a turtle or similar not be available), and then to give (Level D) the compass directions of and (Level E) 3-figure bearings for two given objects.

### **3.1.2 Task administration**

The same four tasks were used at all four stages. Consequently no artificial floor or ceiling was put on a pupil's attainment. Pupils were encouraged to work as far through their task as they could, with the assessment ending as soon as it became clear that the limit of a pupil's knowledge/ability had been reached.

For cost and logistic reasons, the tasks were administered in a subsample only of the survey schools, and, within these schools, to subsamples of the pupils involved in the 'pencil and paper' assessment of mathematics. Typically, four randomly selected pupils in each 'practical' school undertook practical mathematics tasks, each of the four attempting a different one of the four tasks available, along with one or other of the 'mathematical literacy' tasks described in Chapter 2.

The tasks were prepared and presented to the pupils by trained field officers. The 137 field officers were practising teachers, who had been released by their authorities from their normal teaching duties for seven days each to take part in the practical assessment. They attended one day of task orientation in May/June 2004 (different meetings at different times for

different stages and locations). They then worked in pairs, visiting five assigned schools, spending one day in each (dates agreed beforehand with the schools concerned), before ending their involvement in a debriefing day in June 2004. Just over half the field officers (71) worked at P3/P5, the rest (66) working at P7/S2.

Both field officers in any pair worked together when administering the various practical assessments, including these practical mathematics tasks. One of the field officers introduced the task to the individual pupil and proceeded to work through the task with that pupil, while the other observed and recorded observations on the appropriate checklist (the guidance given to the field officers for this type of assessment is reproduced in Appendix C).

In the event, 250-450 pupils at each stage (1465 in total) were involved in this particular type of practical assessment, drawn from 299 primary schools and 74 secondary schools. Between 70 and 110 pupils attempted any one task, the number varying by task and stage.

### 3.1.3 Rating pupil performance

Pupils were rated for the quality of their responses, actions and explanations, where they gave/demonstrated any, in terms of correctness and of amount of support needed from the interacting field officer: 'minimal support', 'some support', 'considerable support'. They were also rated for their use of appropriate mathematical language, and for their competence when using the supplied equipment: 'competent', 'unsure' and 'incompetent'.

Clearly, many of the judgements demanded in this particular assessment exercise were inevitably subjective in nature, and subjectivity in assessment raises questions about the comparability of rating standards. What to one field officer would be considered 'minimal support' might to another be considered 'some support'. What one field officer might consider 'competent use' of equipment might by another be considered less so. What one field officer might accept as an appropriate pupil explanation for an action or calculation might to another be considered wanting. Unfortunately, for a number of reasons, it was not possible to conduct formal rater agreement trials before the practical mathematics tasks were used in the survey. We cannot therefore comment on the extent to which different field officers applied the same standards of judgments when making their real-time ratings in some areas.

Objectivity will have been highest when field officers were simply judging whether or not a pupil had offered a correct answer to a direct question (e.g. 'How many quarters are in a whole?' or 'How much are the trainers reduced by, when there is 10% off £60?'), or whether or not a pupil had carried out an appropriate action in response to a direct instruction (e.g. 'Shade  $\frac{3}{4}$  of the squares' in a 6x6 grid or 'Set the analogue clock to half past ten'). This chapter therefore focuses on reporting the findings of this particular type of assessment: i.e. correct answers or actions.

### 3.1.4 Reporting knowledge and skills attainment

Given the nature of the four practical tasks that were administered in the survey, it is not possible to offer attainment results in terms of the proportions of pupils attaining particular levels in practical mathematics, even for the objectively rated aspects of the assessment. This is because the number of level-classified demands (essentially test items) within the tasks varied from highs of 7 to 11 per level to lows of 1 or 2 per level (see Tables 3.1 to 3.4). For



the same reason it is not useful to offer task comparisons, in terms of task mean scores. Pupil performance is therefore described for each individual question/activity, for the case where the question was answered correctly, or the activity appropriately carried out, with ‘minimal support’ from the interacting field officer.

## 3.2 Overview of pupils’ attainments

### 3.2.1 The attainment picture across the stages

Table 3.1 presents the performance results for the first task, focusing on money.

**Table 3.1**  
**Task: Money**  
*(% pupils correctly responding with ‘minimum support’ from the field officer\*)*

<i>Level</i>	<i>Demand/Question**</i>	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
A	Select coins to make 20p	93	97	95	96
	Select an alternative set of coins to make 20p	94	97	94	96
	Calculate change for 6p from 10p	66	91	92	93
B	Select coins to make 45p	86	96	94	96
	Select an alternative set of coins to make 45p	77	96	94	92
	Calculate change for 45p from 60p	30	78	85	95
	Select coins to make 93p	77	93	92	94
C	Select an alternative set of coins to make 93p	71	88	91	93
	Calculate change for 93p from £1	52	76	87	85
	Select coins to make £3.75	74	90	93	94
	Select an alternative set of coins to make £3.75	64	87	90	92
D	Calculate change for £3.75 from £5	11	43	69	81
	Select coins to make £17.99	41	65	85	95
	Select an alternative set of coins to make £17.99	31	60	82	95
E	Calculate change for £17.99 from £20	14	51	72	84
	Convert 20 euros to pounds	3	13	45	58
	Convert £100 to euros	0	1	28	37
	Find 10% of £60	0	11	42	63
	Find 50% of £120	0	7	53	77
	Find 25% of £22	0	5	32	53

\* In each case the percentage “correct” is based on all pupils embarking on the task, whether or not they actually reached the question/activity concerned.

\*\* This is not the wording actually used with pupils.

As Table 3.1 shows, high proportions of the pupils at P7 and S2, typically 80-95%, were competent in all the money handling activities at Levels A to D, with lower proportions successful at Level E (currency conversion and percentage calculation), especially among the P7 pupils.

High proportions of the P5 pupils were successful in the activities at Levels A to C, with the exception of calculating change at Level C, where the proportion of successful pupils fell to just over 40%. For the Level D activities the proportions of successful P5 pupils were still over half, with the change calculation again the least well done. Very low proportions of P5 pupils successfully managed the Level E activities.

The proportions of successful P3 pupils fell steadily through the levels, from 90%+ at Level A to none at Level E (at which level few P3 pupils would actually have been assessed). Calculating change again proved clearly the most difficult task at every relevant level.

At all stages, 90% or more of the pupils who could successfully calculate change, carry out currency conversions and calculate percentages, could also appropriately explain how they had carried out the tasks.

The second task, on time and measure, is profiled in Table 3.2. The picture of performance is again very positive at P7 and S2, with 85-95% of the pupils successfully completing the various clock setting activities at Levels A to E, with the interesting exception of the one Level D activity, in which pupils were to set an analogue clock to display the time on a drawn digital display (the similar Level E activity was better done). For the measuring activities, high proportions of the P7 and S2 pupils, 80%+, were successful at Levels A and B, falling to around 70% at S2, and 50-75% at P7, for the activities at Levels C to E.

**Table 3.2**  
**Task: Time and measure**

*(% pupils correctly responding with 'minimum support' from the field officer\*)*

<i>Level</i>	<i>Demand/Question**</i>	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
A	Set the analogue clock to 7 o'clock	90	94	96	89
B	Set the analogue clock to half past ten	72	84	90	86
	Set the analogue clock to quarter to three	51	87	91	89
	Set the analogue clock to quarter past eight	59	85	91	89
C	Set the analogue clock to twenty five to one	21	71	85	89
D	Set the analogue clock to 6:42 (time in first digital display)	15	60	70	78
E	Set the analogue clock to 13:05 (time in second digital display)	8	58	83	92
A	Identify the shorter of two objects	85	88	88	86
	Identify the wider of two objects	83	81	84	88
	Identify the taller of two objects	78	83	80	85
B	Measure the length of a given object (<20 cms) in cm	55	71	89	86
	Identify, by measuring, a given piece of string (½ metre long)	44	77	85	83
C	Using a metre stick or tape, measure the length/width of the room	20	53	74	69
D/E	Measure the length of a given pencil (pictured on card) in mm	2	29	57	64
	Express the measured length in cm (i.e. as a decimal)	0	15	51	71
	Through measurement, identify the drawn pencil closest in length to the first	5	27	67	74

\* In each case the percentage "correct" is based on all pupils embarking on the task, whether or not they actually reached the question/activity concerned.

\*\* This is not the wording actually used with pupils.

At P5, 85-95% of the pupils were also successful in carrying out the clock setting activities at Levels A and B, falling to 60-70% for the activities at Levels D and E. The majority of the P5 pupils, 70-90%, were also able to demonstrate a sound understanding of length, and the ability to accurately measure integer cm lengths. Just over half were able to use a metre stick to measure the sides of their classroom, just under 30% were able to measure integer mm lengths, but only 15% were able to express an integer mm length as a decimal cm length.

At P3, success rates for 'time' fell steadily from 90% for the Level A clock setting activity to under 10% for the Level E digital to analogue display activity (not all the P3 pupils would have reached this activity). Similarly, for measurement, an 80% or so success rate for Level A activities fell to 5% or less for Level D/E activities.

As for the task on money, pupils who were able successfully to complete the various activities were generally also able to explain how they did so to the field officer (80-90%, with explanatory ability increasing with stage).

The performance findings for the third task, on fractions, percentages and ratio, are presented in Table 3.3.

**Table 3.3**  
**Task: Fractions, percentages and ratio**

*(% pupils correctly responding with 'minimum support' from the field officer\*)*

<i>Level</i>	<i>Demand/Question**</i>	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
A	Divide the circle into two equal pieces	58	80	88	84
	Name the shape of each piece	64	85	91	92
B	Divide the circle into four equal pieces	69	82	88	90
	Name the shape of each piece	54	86	91	95
C	Name the marked fractions (1/4, 3/4)	28	60	74	92
	How many quarters are in a whole?	51	89	91	95
	How many quarters are in a half?	45	90	93	93
	Shade one fifth of a 4x5 grid	5	34	51	69
	Shade one fifth of 20 squares	2	37	53	67
D	Shade three quarters of a 6x6 grid	5	17	38	62
	Shade three quarters of 36 squares	3	15	41	60
E	Shade 15% of a 10x10 grid	5	15	51	62
	Shade 20% of 50 squares	0	4	24	56
A	Count 8 cubes and give ½ to the field officer	78	89	97	95
	One cube removed: Can you still give ½ to the field officer?	65	85	88	86
B	Count 16 cubes and give ¼ to the field officer	35	65	92	86
	2 cubes removed: can you still give ¼ to the field officer?	28	67	76	75
C	Give the field officer 1/8 of 32 cubes	2	33	61	70
	Give the field officer 3/8 of 32 cubes	1	12	43	56
D	Identify the symbol '%' as 'percentage'	4	26	77	88
	Give the field officer 40% of 10 cubes	4	16	61	71
	Give the field officer 50% of 20 cubes	1	12	64	80
	Give the field officer 60% of 30 cubes	0	2	20	34
E	Identify the ratio of blue cubes to red cubes (given 1 red, 5 blue)	0	2	22	67
	Implement the ratio 1:5 red to blue cubes, given 3 red cubes	0	1	19	52
	Implement the ratio 1:3 red to blue cubes, given 12 blue cubes	0	0	21	41

\* In each case the percentage "correct" is based on all pupils embarking on the task, whether or not they actually reached the question/activity concerned.

\*\* This is not the wording actually used with pupils.

According to the evidence in Table 3.3, the majority of pupils at P7 and S2 (85-95%) were familiar with the fractions ½ and ¼, and could demonstrate/apply these successfully whether using paper circles or cubes/counters (Levels A/B). At S2, 60-70% of the pupils were successfully able to work with the fractions 1/5, 1/8 and ¾, and with simple percentages, compared with 40-60% of the pupils at P7 (Levels C/D). Two-thirds of the S2 pupils showed understanding of ratio, though fewer could implement given ratios using coloured cubes/counters (Level E). At P7, around one-fifth of the pupils could identify a given ratio and could also implement simple ratios.

At P5, most of the Level A/B activities were successfully carried out by 80% or more of the pupils, with a lower 65% successfully demonstrating an ability to handle the fraction ¼ with

coloured cubes/counters. Level C activities involving the fractions  $\frac{1}{5}$  and  $\frac{1}{8}$  were less well done, with a third or fewer pupils showing familiarity with these fractions. Percentages (Level D) were not well handled by P5 pupils either, 15% or fewer successfully calculating given percentages, whether shading squares or counting cubes. Ratio (Level E) was a concept handled successfully by just handfuls of pupils at this stage (most will not have reached the Level E activities).

At least half the P3 pupils were familiar with the fractions  $\frac{1}{4}$  and  $\frac{1}{2}$ , with the exception of the cube counting activity involving  $\frac{1}{4}$ , where the percentage successfully completing the activity fell to around a third. Other fractions, and simple percentages, were familiar only to very small proportions of the pupils (5% or less) and the concept of ratio to none.

Again, the majority of pupils who successfully carried out the activities could explain their method/reasoning to the field officers.

Table 3.4 completes the picture, giving the performance results for the fourth task, on shape, angle and direction.

**Table 3.4**  
**Task: Shape, angle and direction**

(% pupils correctly responding with 'minimum support' from the field officer\*)

Level	Demand/Question**	P3	P5	P7	S2
A	Among given 3D shapes, identify shapes that roll	73	77	85	84
	Name the shapes	53	70	72	71
B	Identify the edge and face of a cylinder	69	71	76	86
	Count the edges and faces	41	64	62	67
	Identify a shape with nine edges and five faces	29	55	58	67
	Name the shape ( <i>triangular prism</i> )	25	56	65	63
C	Identify and name 2D shapes in the triangular prism	28	53	68	83
	Count the angles on the triangular prism	4	18	35	56
	Identify a 90 degree angle	6	43	63	83
	Give the alternative name for a 90 degree angle	3	41	64	86
	Identify an angle less than 90 degrees	5	43	74	84
	Name this type of angle ( <i>acute</i> )	0	34	63	79
D	Measure two angles ( $36^\circ$ and $103^\circ$ )	0	1	32	64
	Draw an angle of $65^\circ$ , $95^\circ$ , $25^\circ$ or $175^\circ$	0	3	34	69
E	Draw a triangle with a side of 7.5cm and angles of $35^\circ$ and $85^\circ$	0	1	16	44
	Measure the size of the third angle	0	1	21	61
A	Programme a turtle to reach a marked spot on the turtle grid	33	61	69	76
B	Programme the turtle to make a rectangle	17	47	67	69
C	Programme the turtle to move through a series of given squares	7	45	71	71
D	Set the compass to North	12	44	58	69
	Give the direction of a given object ( <i>e.g. door, N/S/E/W</i> )	21	60	78	81
	Give the direction of a second object ( <i>NE/NW/SE/SW</i> )	9	47	72	84
E	Give a 3-figure bearing for the first object	0	3	30	59
	Give a 3-figure bearing for the second object	0	4	25	53

\* In each case the percentage "correct" is based on all pupils embarking on the task, whether or not they actually reached the question/activity concerned.

\*\* This is not the wording actually used with pupils.

Table 3.4 reveals another clear pattern of stage progression. Typically, 65-85% of the S2 pupils were able to answer the questions successfully and carry out the various activities. The least well done activities were counting the angles on a triangular prism (Level C, 56%),

drawing a triangle with given dimensions (Level E, 44%), and giving 3-figure bearings for two given objects (Level E, 53%, 59%). At P7, performance was similar to that of S2 for identifying and naming shapes that roll, recognising edges and faces of objects, programming a turtle and giving compass directions. Markedly lower proportions of the P7 pupils compared with the S2 pupils could count the angles on a triangular prism, identify and measure angles, including right angles, draw a triangle of given dimensions, and give 3-figure bearings.

At P5, between one half and three quarters of the pupils were able to identify and name shapes that roll, and were familiar with the concepts of edge and face; 45-60% were familiar with right angles and acute angles, could programme a turtle and give compass directions. Very low proportions of the P5 pupils (fewer than 5% in each case) reached and successfully carried out the Level D/E activities involving measuring or drawing angles or the Level E activities involving 3-figure bearings. This finding will not be surprising. More surprising is the fact that any P5 pupils actually achieved at these levels in these topic areas, and with 'minimum support'.

At P3, between one half and three quarters of the pupils could identify and name shapes that roll and identify the edge and face of a cylinder. For other activities the proportions were much lower, with none at all reaching or successfully completing the Level D/E activities involving angle measurement and 3-figure bearings.

Only one explanation was asked for in this task, and that was to explain how the pupils could tell that the shapes they identified could roll without actually trying them out. As before, where pupils could identify appropriate shapes they could usually (in 90% or more of cases) explain how they knew.

In all four tasks, the frequency of use of mathematical terminology (e.g. 'equal', 'three quarters', 'one tenth', 'ratio', 'multiply', 'currency', 'minute hand', 'shorter', 'metre stick', 'rectangle', etc) increased with stage.

### **3.2.2 Gender comparisons**

It is difficult to say anything useful about possible gender differences in practical mathematics, given the small numbers of pupils that attempted each of the four tasks (70-110 in total, varying by task and stage, with a roughly equal representation of boys and girls). For the time and measure task there was no particular pattern of gender difference. The same was the case for the fractions task. In the money task, proportionally more of the boys than girls at P5, P7 and S2 succeeded on the two currency conversion activities (Level E), but for only one task at one stage did the difference reach statistical significance. For the shape, angle and direction task there was a tendency, at least at P7 and S2, for the boys to be more successful than the girls in giving compass directions and 3-figure bearings, but the activity differences rarely reached statistical significance. A larger-scale enquiry, in terms of pupil sample sizes, would have been useful in allowing any gender differences in practical mathematics to emerge more clearly.

### 3.3 Summary

Four resource-based practical tasks were administered at all four stages in the survey. The tasks focused on one or other of ‘money’, ‘time and measure’, ‘fractions, percentages and ratio’ and ‘shape, angle and direction’, with each task involving activities at increasing 5-14 levels.

Between 70 and 110 pupils at any stage attempted the individual tasks, 300-400 pupils in total at a stage. The pupils were guided through the tasks by itinerant field officers, the assessment ending when pupils were deemed to have reached their personal levels of capability.

Success rates were generally higher at P7 and S2 than at P5, and higher at P5 than at P3, and success rates naturally fell as the level of the activity demand increased.

At P5, P7 and S2, 80% or more of the pupils successfully carried out most of the activities involving money, up to Level B/C at P5, Level C at P7 and Level D at S2. Performance was lower at P3, particularly when pupils were required to calculate and deliver change rather than simply offer coins up to a given price. Discount problems were handled well by half to three-quarters of the S2 pupils, and 30-50% of the P7 pupils.

Time (setting analogue and digital displays) also proved relatively unproblematic for the P7 and S2 pupils, 80% or more of whom successfully completed the activities at all levels unaided. At P3, 50-70% of the pupils managed the Level B activities unaided, whereas 60-70% of the P5 pupils successfully tackled the Level C to E activities. A roughly similar picture emerged for activities involving length measurement, except that metre and millimetre measurement was less well done than integer centimetre measurement, with marked attainment gaps between consecutive stages.

The fractions/percentages task revealed a steady attainment progression through the four stages, with particularly marked attainment gaps between P5 and P7 at Level D (percentages) and between P7 and S2 at Level E (ratio). The majority of the pupils at P7 and S2 (85-95%) were familiar with the fractions  $\frac{1}{2}$  and  $\frac{1}{4}$  (Levels A/B), along with 80% or so at P5 and half or more at P3. At Levels C/D, 60-70% of the S2 pupils were also successfully able to work with the fractions  $\frac{1}{5}$ ,  $\frac{1}{8}$  and  $\frac{3}{4}$ , compared with 40-60% of the pupils at P7, at most one-third at P5, and fewer than 5% at P3. The proportions able to handle simple percentages successfully were around the same at P7 and S2, but fell markedly at P5 to around 15%, with 5% or fewer at P3. Two-thirds of the S2 pupils showed an understanding of ratio, compared with one-fifth of the P7 pupils, a handful of the P5 pupils and no P3 pupils.

A variety of activities involving naming and drawing shapes and angles again revealed clear evidence of stage progression. Turtle programming, or giving equivalent verbal instructions, was successfully achieved by 20-30% of the P3 pupils, 45-60% of the P5 pupils and 70% or more of the pupils at P7 and S2. Similar proportions of pupils were successfully able to use a compass to give directions, except for a drop in performance for this activity at P3. At S2, 50-60% of the pupils could give 3-figure bearings for objects, compared with 25-30% of the pupils at P7, fewer than 5% at P5 and none at P3 (if they even reached these activities before assessment ended)

At all stages and levels, the majority (typically 90% or more) of those pupils who successfully carried out the various activities could give an acceptable explanation for their methods and answers.

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## 4. Core skills

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### 4.1 Introduction

The core skills reported in this chapter are reading, writing and use of ICT.

Fifteen reading tasks were newly developed for use in the survey, three each at Levels A to E. At all levels, writing tasks were also devised that used as stimulus material the same texts as the reading tasks. There were thus also 15 different writing tasks in total. Keeping within the subject theme of the survey, the source texts for the reading and writing tasks focused on some issue or personage in mathematics, though without any requirement for prior knowledge and understanding of mathematics *per se*.

Six different ICT tasks were also newly developed for use, each task carefully set in a 'mathematical' context. These were administered in schools by trained field officers (see Chapter 1 for general information about the practical assessment).

In principle, all the survey schools participated in the assessment of reading and writing. Mathematics assessment, though, was given priority, so that where the number of pupils in a school's sample was not large enough to accommodate both mathematics and reading/writing assessment, then that school took part in the mathematics assessment only. Among the schools that agreed to take part in the survey, with enough pupils to take part in reading and writing assessment as well as mathematics assessment, 90-95% did so at each stage: 200-250 schools at each primary stage and just over 150 schools at S2. Over 40% of the schools at each stage also participated in the assessment of pupils' practical skills, including ICT skills (see Appendix B for further details of samples and task administration).

### 4.2 Reading

#### 4.2.1 The reading tasks

Each of the 15 reading tasks administered in the survey took the same general form as those typically used in AAP English surveys, i.e. a source text, or series of related texts, plus a set of comprehension questions. In this case, however, the texts focused on mathematical topics or issues, as the titles in Table 4.1 suggest. Table 4.2 describes one task at each of Levels A, C and E.

The number of test items varied across tasks, from 21 per task at Level A rising to 30 per task at Level E, and featured a variety of different formats, including multiple choice, summary completion, sentence completion, and short response. Items sharing common formats were grouped into sections, as illustrated in the task examples given in Table 4.2.

Reading tasks were classified by 5-14 level on the basis of the perceived level of their source texts. No prior mathematical knowledge was needed in order to respond successfully to the tasks, although inevitably prior knowledge might occasionally have helped.



**Table 4.1**  
**Reading task titles**

<i>Level</i>	<i>Task name</i>
Level A	Finger Counting My Sponge Cake Numbers
Level B	Measuring Length and Height Party Games Time
Level C	Aspects of Measurement Christmas in Grandma's Day Einstein
Level D	The History of Numbers Climate Change Breakthroughs in Maths
Level E	Computing: From human fingers to man-made brains Einstein's Theory of Relativity Some Famous Mathematicians

**Table 4.2**  
**Overview of three reading tasks**

<p><i>'Numbers'</i> – Level A</p> <p>A short text of just under 250 words focuses on the topic of numbers: how they appear on everyday objects, how they are used to measure things, and how length can be measured, using hand spans, paces, rulers. Like other Level A tasks, the passage is followed by 21 test items in sections, the majority of items being of multiple choice format: word choice boxes, selection lists, aided summary completion, etc</p>
<p><i>'Christmas in Grandma's Day'</i> – Level C</p> <p>The multi-section source text is around 550 words long, and comprises a short paragraph about a visit to Santa's grotto, a puzzle and its answer, and two recipes (Coconut ice and Peppermint stars). Three sections of test items follow, presenting 24 items in total – the number applying to every Level C task. Section A is a 15-gap summary completion, based on the grotto visit and puzzle, Section B invites pupils to underline in a given list the three ingredients that are common to both recipes, while Section C requires pupils to properly sequence a randomised list of the activities involved in making Peppermint stars.</p>
<p><i>'Computing'</i> – Level E</p> <p>The 840-word passage offers a brief history of progress in calculating machines, from the earliest calculators, including the abacus in its various forms, to modern-day computers. As for other tasks at this level, a total of 30 test items are based on the reading: Section A is a 15-gap summary completion exercise, Section B invites pupils to identify phrases in the text, for example a phrase to illustrate 'how people would find it difficult to do without mobile phones', Section C asks pupils to identify supporting ideas, to offer an explanation, to identify the main purpose of the passage and the type of publication it would probably have appeared in, while Section D asks them to circle three features used by the author to help readers' understanding.</p>

Tasks were presented to pupils in the form of test booklets, a single reading task comprising a test booklet. Individual pupils attempted two test booklets, one at each of two different levels:

P3 pupils attempted reading tasks at Levels A and B, P5 pupils attempted tasks at Levels B and C, P7 and S2 pupils attempted tasks at Levels C and D, Levels C and E or Levels D and E. The reading passages for the two tasks were presented within a separate source booklet.

Completed booklets were processed centrally, and marked by students, who had received training and induction into the necessary procedures. Each booklet was attempted by between 250 and 400 or so pupils, the number varying by booklet and stage. In total, just under 10750 booklets were analysed, emanating from around 5500 pupils in just under 800 schools.

#### 4.2.2 Pupils' reading attainment

The attainment results for reading were produced by applying the usual 65% cut-off score to the pupils' total task scores, as described in Chapter 1, and then averaging the proportions of 'secure' attainers over the three tasks at each level. The resulting proportions of pupils classified as 'secure' at the level concerned (the level of the task) are given in Table 4.3, and illustrated in Figure 4.1.

**Table 4.3**  
**Reading attainment by stage\***  
(% pupils achieving 65% or more marks per task,  
averaged over three tasks at each level)

Stage	Level A	Level B	Level C	Level D	Level E
S2			85	74	29
P7			80	60	16
P5		82	54		
P3	66	53			

\* 1000-2000 pupils per stage in total; margins of error for the estimated proportions vary between 1.5 and 3.5 percentage points

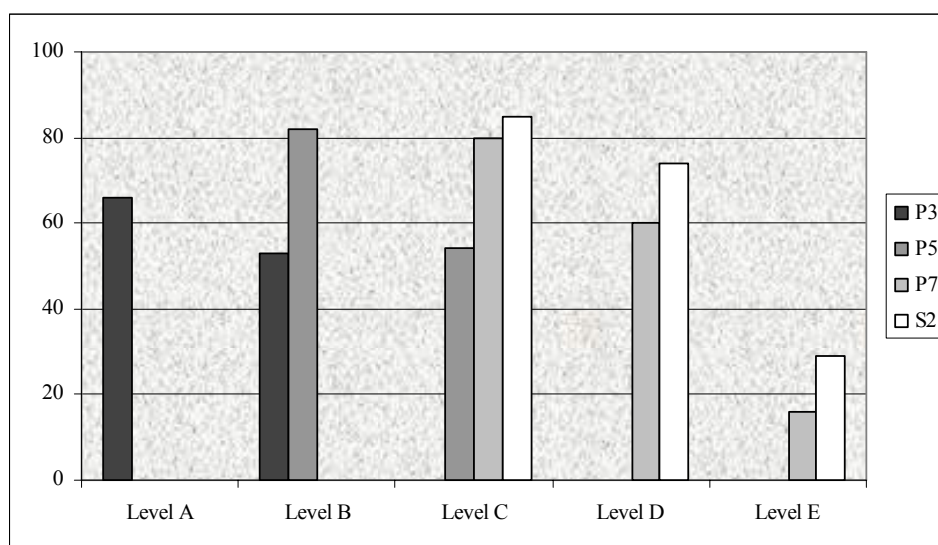
As Table 4.3 shows, around two-thirds of the P3 pupils demonstrated secure attainment at Level A, and over half also at Level B. At P5, just over 80% of the P5 pupils demonstrated secure attainment at Level B and over half also at Level C. At P7, the picture is similar for Levels C and D (80% classified as secure at Level C and 60% at Level D also). At S2, 85% of the S2 pupils were classified as secure at Level C, just under three-quarters also at Level D and just under 30% at Level E. Thus, at all levels there is a clear picture of stage progression, this progression being weakest between P7 and S2 at Level C, where attainment proportions were already high at P7.

Interestingly, while the reading attainment results in the 2003 AAP Science survey<sup>6</sup>, where reading passages were set in 'scientific' contexts, resembled those in the 2001 AAP English Language survey<sup>7</sup>, the attainment results in this 2004 survey differ. Table 4.4 presents the relevant data for P7 and S2 (the two stages that featured in all three surveys) at those levels assessed on all three occasions.

<sup>6</sup> Assessment of Achievement Programme. *Sixth Survey of Science 2003*, Chapter 4. Edinburgh: Scottish Executive Education Department, 2005.

<sup>7</sup> Assessment of Achievement Programme. *Report of the Sixth Survey of English language (2001)*. Chapter 2. Edinburgh: Scottish Executive Education Department, 2003.

**Figure 4.1**  
**Reading in a mathematical context: attainment across the stages**  
*(% pupils achieving 65% or more marks per task ,  
 averaged over three tasks at each level)*



As Table 4.4 shows, markedly higher proportions of the P7 pupils in the 2004 survey were deemed 'secure' at both Levels C and D compared with 2003 and 2001, with a similar picture emerging for the S2 pupils at Level D also. At Level E, however, the pattern is less clear. The differences could be interpreted as indicating real differences in reading attainment between 2003 and 2004 at the different stages and levels or, alternatively, as reflecting the influence of different reading contexts. But they could equally, or perhaps more likely, be the result of topic effects, or even more simply of differences in task difficulty, given the very small numbers of tasks used at each level in the surveys of 2003 and 2004 (the fewer tasks that are used the more influence that task topic and task difficulty will have on average attainment).

**Table 4.4**  
**Reading attainment at P7 and S2:**  
**2001 English Language survey, 2003 'science context' Core Skills**  
**survey and 2004 'maths context' Core Skills survey**  
*(% pupils achieving 65% or more marks per task,  
 averaged over the tasks at each level\*)*

Stage	Level C			Level D			Level E		
	2001	2003	2004	2001	2003	2004	2001	2003	2004
S2				43	57	74	16	43	29
P7	72	63	80	41	37	60			

\* Three tasks per level in 2003 and 2004, four to six per level in 2001.

As far as gender differences are concerned, Table 4.5 shows a tendency for the girls to have produced better performances in general than the boys (differences of five points or more reach statistical significance). This is a common finding in surveys of reading attainment, but one which did not emerge in the 2003 AAP Science survey, where the stimulus passages used were set in scientific contexts (although still requiring no prior science knowledge for successful completion of the reading tasks themselves). However, only three tasks featured at

each level here, and gender gaps varied in size from one task to another within any level. Caution should therefore be exercised when attempting to interpret these overall findings.

**Table 4.5**  
**Reading in a mathematical context: boys and girls\***  
*(% pupils achieving 65% or more marks per task,  
 averaged over three tasks at each level)*

		Level A	Level B	Level C	Level D	Level E
S2	Boys			82	69	27
	Girls			89	80	31
	B-G			-7	-11	-4
P7	Boys			77	56	16
	Girls			83	63	16
	B-G			-6	-7	0
P5	Boys		81	54		
	Girls		82	55		
	B-G		-1	-1		
P3	Boys	64	50			
	Girls	67	56			
	B-G	-3	-6			

\* 500-1000 pupils in total per gender per stage

## 4.3 Writing

### 4.3.1 The writing tasks and writing evaluation

Each of the 15 reading tasks had an associated writing task, stimulated by the same reading passage (see Tables 4.6 and 4.7).

**Table 4.6**  
**The linked reading and writing tasks**

Level	Reading	Writing
Level A	Finger Counting	Counting
	My Sponge Cake	Decorating a Sponge Cake
	Numbers	Help an Alien
Level B	Party Games	My Favourite Game
	Time	The Time Machine
	Measuring Length and Height	Building a Fence
Level C	Aspects of Measurement	How We Measure
	Einstein	Numbers for All
	Christmas in Grandma's Day	Celebration
Level D	The History of Numbers	Life Without Numbers
	Climate Change	A Warmer Scotland
	Breakthroughs in Maths	Maths machines
Level E	Computing: From human fingers to man-made brains	The Age of the Computer
	Einstein's Theory of Relativity	Life on the Moon
	Some Famous Mathematicians	Dear Mr Newton

**Table 4.7**  
**Overview of three writing tasks**

<p><i>'Help an Alien'</i> – Level A</p> <p>Pupils are asked to write a few sentences explaining what they know about number, for an alien. They are provided with a few prompts including telling the alien when people might see and use numbers in the classroom and in other areas of their lives.</p>
<p><i>'Celebrations'</i> – Level C</p> <p>Pupils are asked to write about their favourite celebrations and the planning and preparation that is required. Pupils are prompted to think about how mathematics is involved in the planning of a party of special event.</p>
<p><i>'The Age of the Computer'</i> – Level E</p> <p>Pupils are invited to write a short report explaining how they think computers affect themselves and others. They are asked to identify any disadvantages of living in the computer age as well as to consider the impact of computers in areas such as hospitals, transport, and sport and leisure.</p>

Each writing task was loosely related to the relevant reading text, but could be attempted without reading the passage: in other words, the writing tasks were associated with, but not dependent on, the reading tasks. The tasks were all within a mathematical context but generally related to how we might use numbers in our everyday lives. The general format of the writing task was constant throughout the levels: a short statement, followed by the actual task with a number of bullet points to provide a degree of support.

Each pupil was given a choice between two different writing tasks, relating to the reading tasks the pupil had been assigned and presented within the reading source booklet. Teachers were asked to organise a third assessment session dedicated to the writing. The writing was evaluated using the holistic scheme shown in Table 4.8, a scheme that had been used for the same purpose in the 2003 Science survey.

In total, 100 of the field officers who had undertaken the practical assessments in the survey volunteered to participate in the evaluation exercise. While most of the evaluators (85) were practising primary class teachers, some secondary mathematics teachers were also involved. In June 2004, the writing evaluators were given some orientation for the writing evaluation activity, after their post-survey practical assessment debriefing. During the orientation meeting they first reviewed a small sample of scripts as a group, applying the holistic evaluation scheme. For various reasons, it was later in the year before scripts were actually sent out to the evaluators for judgment. At this time, and with access to exemplification materials and written guidance (see Table 4.9), they each independently evaluated their assigned scripts.

The evaluation of writing is inevitably a subjective process, leading to natural concerns about the comparability of rating standards between different raters. It cannot be assumed that different evaluators judging the same script will come to the same decision about writing relevance or quality, whatever the nature of the evaluation scheme that is used and however much guidance and exemplification material they are given. This issue was explored within the 2003 science survey, and was explored again here.

**Table 4.8**  
**The ‘best fit’ descriptions used to judge pupils’ writing**

<p><i>Level A</i></p> <p><b>The writing conveys one or two details, which are linked and mostly relevant.</b> Common linking words are used to organise ideas (e.g. and, then). A capital letter and a full stop are used to mark at least one sentence. Commonly used words are spelt accurately.</p>
<p><i>Level B</i></p> <p><b>The writing conveys a main idea with sufficient information to make the message clear. The information is mostly organised logically.</b> Common linking words are used to organise ideas into sentences (e.g. and, then, but, so, that) and punctuation is beginning to support what has been written. An increased range of commonly used words is spelt accurately.</p>
<p><i>Level C</i></p> <p><b>The writing conveys a clear sense of ideas that are in the main organised logically without significant omissions/repetition.</b> There is a simple conclusion or rounding off, where appropriate. Some attempt is made to paragraph writing. In the main, the punctuation supports what has been written. Less commonly used words are spelt with increasing confidence and accuracy.</p>
<p><i>Level D</i></p> <p><b>Ideas are described in detail and are logically and clearly organised throughout. The writing includes relevant and consistent supporting detail.</b> There is a simple but effective conclusion, where appropriate. Paragraphs, where relevant, are used correctly for the most part. There is some variety in sentence structure and most sentences are punctuated accurately. Most of the words needed for the task are accurately spelt.</p>
<p><i>Level E</i></p> <p><b>The writing begins to convey discernment. Ideas are logically and clearly organised throughout and are well linked and supported with appropriate detail.</b> There is a well-developed effective conclusion, where appropriate. Paragraphs, where relevant, are used correctly throughout. There is appropriate variety in sentence structure and sentences are accurately constructed, linked and punctuated. Spelling is accurate in the main.</p>

**Table 4.9**  
**Guidance given to the writing evaluators for applying the ‘best fit’ scheme**

<p>Read the piece of writing, ideally more than once.</p> <p>Ask yourself:</p> <ul style="list-style-type: none"> <li>• Do the language and structure meet the conventions of the genre?</li> <li>• Does the writing address the purpose of the task?</li> </ul> <p>Once you are satisfied that the writer has addressed the task set, then, using professional judgement, mentally award the writing a level. Read the description for the appropriate level and decide if the piece of writing fits the description. Because you are using a ‘best fit’ approach, the piece of writing might not meet the criteria fully. This is acceptable. However, the writing must meet the criteria highlighted in <b>bold</b> for a particular level to be awarded. <b>If the writing appears to sit equally well at two levels, look for the relative strengths and weaknesses within the writing and decide if the strengths outweigh the weaknesses or vice versa.</b></p>
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In total, across the four stages, 3192 pieces of writing were evaluated, using the best fit scheme. Among these, 3110 were each evaluated by three different raters, working independently in rater groups, with each group rating up to 200 scripts from one booklet at one or two stages. Of the 3110 writing booklets randomly selected for evaluation, 82% were classified in the same way by at least two of the three raters, the proportion dropping to

around 25% for unanimous agreement (Table 4.10 provides the rater agreement findings for the various different tasks).

**Table 4.10**  
**Inter-rater agreement rates for writing evaluation**

<i>Task</i>	<i>Stages</i>	<i>Scripts</i>	<i>% agreement*</i>
Age of the computer	P7/S2	180	74 (11)
Life on the Moon		167	89 (22)
Dear Mr Newton		156	84 (28)
Maths machines	P7/S2	200	77 (17)
A warmer Scotland		200	72 (24)
Life without numbers		200	81 (27)
How we measure	P5/P7/S2	259	85 (25)
Celebration		284	85 (26)
Numbers for all		276	68 (14)
Building a fence	P3/P5	200	92 (32)
My favourite game		200	95 (42)
The time machine		200	80 (24)
Counting	P3	188	96 (43)
Decorating a sponge cake		200	97 (53)
Help an alien		200	88 (26)

\* % scripts independently judged at the same level by at least two of three different raters, with (in brackets) the unanimous agreement rate.

Of the 3110 booklets, 10 in fact contained no writing. Among the 3100 pieces of writing that were able to be judged, 1-3%, varying by stage, were considered not to be of the correct genre and a further 1-5% were considered to have irrelevant content. The number of remaining 'valid' scripts for which there was majority or unanimous agreement about appropriate levels was 2372.

### 4.3.2 Pupils' writing attainment

The attainment findings presented in this section are based on those scripts of the appropriate genre, with relevant content, that were allocated the same level by at least two of the three raters that evaluated them, i.e. 2372 scripts. Table 4.11 presents the general findings in terms of stage profiles, with Figure 4.2 illustrating the profile differences.

The majority of the P3 pupils produced writing at Levels A and B, the majority of the P5 and P7 pupils produced writing at Levels B and C, while the majority of the S2 pupils produced writing at Levels B, C and D. The stage progression is particularly striking between P3 and P5: whereas more than 60% of the P3 pupils were deemed to be working at Level A or below, the corresponding proportion at P5 was under 25%, at P7 under 15% and at S2 under 10%. The proportions of pupils deemed to be working at Levels D or E at P5, P7 and S2 were 5%, 15% and 32%, respectively.

Table 4.12 presents the results of the writing evaluation for boys and girls separately, and reveals a very clear gender gap in favour of the girls at every stage (all the profile differences reach statistical significance at the 0.1% level). At S2, just over 20% of the boys produced work considered to be at Level D or Level E compared with just over 40% of the girls. At P7, 40% of the boys produced work at Levels C, D or E compared with 60% of the girls. At P5,

two-thirds of the boys produced writing deemed to be at Level B or above compared with over 80% of the girls. At P3, around 80% of the boys produced work at Level A, B or C compared with around 90% of the girls; around twice the proportion of boys as girls produced writing considered to be of a quality below Level A (19% versus 11%, respectively).

**Table 4.11**  
**Writing attainment by stage\***

*(% pupils deemed to have demonstrated given attainment levels)*

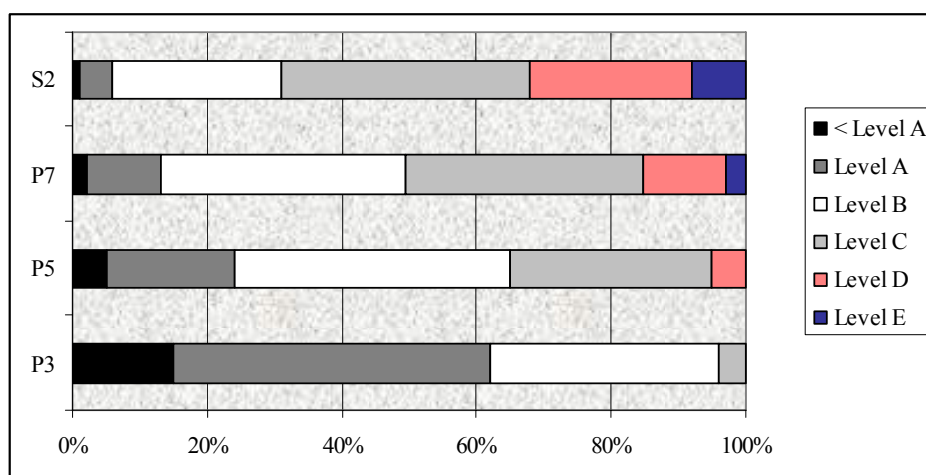
Stage	Scripts	< Level A	Level A	Level B	Level C	Level D	Level E
S2	561	1	5	25	36	24	8
P7	602	2	11	36	35	12	3
P5	435	5	19	41	30	5	0
P3	774	15	47	34	4	0	0

\* Figures based on valid scripts (correct genre and relevant content) with at least majority rater agreement about appropriate level allocations

**Figure 4.2**

**Writing in a mathematical context: attainment across the stages**

*(% pupils deemed to have demonstrated attainment at the given levels, with at least majority rater agreement)*



The results shown here for writing in a mathematical context reveal a more positive picture of attainment than that reported for writing in a scientific context, as assessed in the 2003 Science survey<sup>8</sup>. For example, in the science survey just under half the S2 pupils, two-thirds of the P7 pupils and over 80% of the P5 pupils were classified as having produced writing at Levels A or B, whereas in the 2004 survey these proportions have dropped to under a third, one half and under two-thirds, respectively (the writing attainment of P3 pupils was not assessed in 2003). The apparent improvements are less likely to be attributable to the change in context than they are to other factors, including differences in the tasks and their administration, differences in the ways writing evaluators were trained, and differences in data validity and reliability.

For example, in the 2004 survey the 'maths context' tasks were only loosely related to the context of the reading passages, and good writing production did not depend on pupils having

<sup>8</sup> Assessment of Achievement Programme. *Sixth Survey of Science 2003*, page 39. Edinburgh: Scottish Executive Education Department, 2005.



first read and understood the passages concerned. In the 2003 survey pupils were obliged to read the relevant passage and reproduce some of the material contained in the passage in their writing. In addition, the 2004 tasks were formulated in a different style, more familiar to pupils. In the 2004 survey pupils had a choice of topic, since they were required to produce a single piece of writing, whereas in 2003 pupils were obliged to produce two pieces of writing, related, respectively, to their two reading tasks.

**Table 4.12**  
**Gender differences in writing attainment in a mathematical context**  
*(% pupils deemed to have demonstrated given attainment levels)*

Stage	Gender	Scripts	< Level A	Level A	Level B	Level C	Level D	Level E
S2	Boys	275	1	6	35	36	17	4
	Girls	286	<1	4	16	39	30	11
P7	Boys	291	4	14	42	29	10	1
	Girls	311	<1	8	32	41	14	5
P5	Boys	185	9	24	43	19	5	0
	Girls	250	3	15	39	38	5	0
P3	Boys	394	19	49	30	2	0	0
	Girls	380	11	45	37	7	0	0

*\* Figures based on valid scripts (correct genre and relevant content) with at least majority rater agreement about appropriate level allocations*

In the 2004 survey teachers were advised that sufficient time should be provided for pupils to undertake their single writing task comfortably, and the writing was carried out in a dedicated third test session. In the 2003 science survey the writing tasks were undertaken within the reading test sessions, after the stimulus reading tasks had been completed.

In the 2004 survey the writing evaluators were given more training support than had been offered to their colleagues in 2003, and in particular were given substantially more exemplification material. The guidelines for assigning levels were also simplified. The fact that only 15% of the evaluators in 2004 were secondary subject teachers (of mathematics) compared with over 30% in 2003 (secondary science teachers) will also have had an effect, since subject teachers, other than those of English, are not generally involved in assessing writing quality, and this lack of familiarity is rendered even more difficult for them when they are faced with factual inaccuracies in the writing.

Finally, the attainment results for 2004 will be more valid and reliable than those for 2003, since they are based on level classifications independently agreed by at least two evaluators working independently, whereas in 2003 they were based on the judgment of single evaluators.

## 4.4 Using information technology

### 4.4.1 The tasks and their administration

Six different CDROM-based tasks were developed for use in the survey, all designed to assess the same range of ICT skills, focusing on the strands 'Using the technology', 'Creating and

presenting', 'Collecting and analysing' as described in the 5-14 National Guidelines for ICT<sup>9</sup>. Each task comprised a series of activities, and was planned to take about 30 minutes of testing time. The activities included modifying graphics and editing text (using Word), and entering data into a spreadsheet and manipulating that data (using Excel). Table 4.13 overviews the general format of the ICT tasks.

**Table 4.13**  
**Overview of an ICT task**

On the instructions of the field officer, and after a few minutes of familiarisation with the laptop computer, pupils were first questioned about their familiarity with the Windows environment: using a keyboard, using a mouse, using a PC with Windows, using Word and using Excel. They were then asked to open a particular folder and file, to scroll within the document, and to save the text under a new file name. They were invited to make the appearance of the text more interesting and appropriate for the particular use indicated in the task, and, having done this, were asked to suggest how they might take the resulting file home or to another class to work on, and how they might present the information in other ways using ICT. Finally, pupils were faced with a set of spreadsheet tasks. They were asked either to enter data into a spreadsheet with given row and column headings, or to create a spreadsheet table and enter data (varied by task), and then to create a graph based on the data, interpreting the chart to answer given questions.

The tasks were administered by the itinerant field officers, who also administered the mathematics practical tasks described in Chapter 2 (see Chapter 1 for details of field officer numbers and training). Four of the tasks were administered at P3/P5, and four at P7/S2, with two tasks common to all four stages. Typically, in any one school four pupils undertook ICT tasks, each pupil attempting a different one of the four tasks assigned to that stage. In total, the field officers assessed 1320 pupils in 335 schools (40% of the survey schools).

Pupils worked on laptop computers provided by the field officers. They were given a few minutes to familiarise themselves with these before the assessments began, using the mouse to control the cursor. As they did so, they were questioned by the field officers to explore their familiarity with using a keyboard and mouse, with using a PC with Windows, and with using Word and Excel. The results of this enquiry are given in Table 4.14.

As far as the technology is concerned, and on the basis of pupils' self-reports, Table 4.14 suggests a high degree of familiarity among pupils at all four stages in the use of a keyboard and mouse, with much lower levels of familiarity among the P5 and P3 pupils with the use of a PC with Windows. As to the software that featured in the ICT tasks, the majority of P7 and S2 pupils claimed to be familiar with Word (80-90%), but familiarity rates were lower for Excel, at under 60% of the pupils at S2 and around one-third at P7. Among the younger pupils familiarity with the software was even less widespread: half the P5 pupils and over two-thirds of the P3 pupils claimed not to be familiar with Word, while almost 90% of the P5 pupils and virtually all the P3 pupils claimed to be unfamiliar with Excel. Clearly, these findings should be borne in mind when the attainment results are reviewed.

<sup>9</sup> *Information and Communications Technology. National Guidelines 5-14*. Glasgow: Learning & Teaching Scotland, 2000.

**Table 4.14**  
**Pupils' familiarity with ICT**

*(% pupils claiming familiarity with use of the technology/software)*

Stage	Pupils	Keyboard	Mouse	PC/Windows	Word	Excel
S2	260	97	97	94	91	59
P7	394	98	98	91	81	33
P5	340	93	97	72	50	12
P3	326	84	95	57	32	2

After the brief laptop familiarisation and questioning, the pupil under assessment was given the relevant task sheet and asked to follow the instructions. If the pupil was struggling, the field officer directed him/her to the next question or brought the session to a close. Individual activities were rated as 'completed successfully and independently', 'completed successfully with some support' or 'no real attempt'. At the end of the task the pupil's task sheet was collected in and filed with the checklist for later analysis.

Before the attainment results are presented, some of the problems that arose during this exercise merit comment. Firstly, as already noted, pupils were constrained to work with the laptops provided by the field officers, despite the fact that such a laptop environment was unfamiliar to most of them. Secondly, the tasks were only available for use on PCs, so that those pupils who were not familiar with the PC environment would have been disadvantaged (see Table 4.14). Thirdly, the text handling and data manipulation tasks required use of Word and Excel, software which was unfamiliar to most of the younger pupils (again see Table 4.14). Fourthly, there were occasional technical difficulties, which meant that some pupils could not actually attempt one or more of the activities.

#### 4.4.2 Pupils' ICT performance

In addition to actively using the technology to access and save files, pupils were questioned to explore their passive file handling knowledge. The results of both enquiries are given in Table 4.15, which shows clear evidence of stage progression, particularly between P3 and P5, and between P5 and P7/S2.

With rare exceptions, all the P7 and S2 pupils were able to open a folder and file without help, and to scroll the file. High proportions were also able to save the text under a new file name and understood why this is good practice. At P5, around 90% of the pupils could open a folder and file and scroll the file; two-thirds could save the text under a new name and almost 60% knew why they should do this. At P3, two-thirds or more of the pupils could open a folder and file, and scroll the file. Just 30% knew how to save the text under a new file name and why this is a useful thing to do.

The term 'CDROM' and the format of a typical web address were familiar to 90% or more of the P7 and S2 pupils, to three-quarters of the P5 pupils and to around 45% of the P3 pupils. However, when asked how they might take a Word file home, or to another class, to work on, the majority of pupils at all stages suggested printing the document: two-thirds of the P3 pupils rising to over 90% of the pupils at S2. High proportions of the P7/S2 pupils (80-90%) also suggested copying the file onto a floppy disk or CDROM, or sending it as an email attachment (66% and 76%, respectively). Just 40% of the P5 pupils and 20% or fewer of the P3 pupils suggested one or both of these methods. Around a third of the S2 pupils and a quarter of the P7 pupils suggested accessing the file over a network; at P5 the proportion was

just under 15% and at P3 under 10%. Naturally, however good their knowledge about different ways of transferring and accessing files might be, the pupils' responses to this question must surely have been tempered by what they were actually able to do, or typically did, in their schools and homes on a day-to-day basis.

**Table 4.15**  
**Using the technology: file handling skills and passive knowledge**  
*(% pupils correctly completing the task or correctly responding unaided\*)*

<i>Activity **</i>	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Open a folder	71	89	98	100
Open a file	79	91	99	99
Scroll through the file	64	88	97	98
Save text under a new file name	29	64	88	95
Explain why we save files under new names (backup)	31	58	73	88
Show understanding of 'CDROM'	44	75	89	89
Recognise a web address as a web address	46	76	92	97
How to transfer files?				
- print the document	66	83	88	94
- use a floppy disk/CDROM	17	41	80	91
- send as an email attachment	20	38	66	76
- over a network	6	14	24	36

\* 250-400 pupils per stage; in each case the percentage "correct" is based on all pupils embarking on the task, whether or not they actually reached the question/activity concerned.

\*\* This is not the wording actually used with pupils.

Table 4.16 presents the results of the assessment of pupils' abilities to manipulate text and graphics in Word. The pupils were asked to do whatever they thought appropriate to improve the appearance of a given text for a given purpose (the purpose varied by task). The text concerned was held in a Word file – the file they had earlier opened, scrolled and saved under a new name – and contained one graphic (a picture).

As Table 4.16 shows, high proportions of the S2 pupils (85% or more) successfully added some text of their own, changed the appearance of fonts, added emphasis with italics or bold face, underlined some text and/or centred the heading/title. Almost three-quarters of the S2 pupils also used the spell checker. Under half justified the text and/or added bullet points or indentation. Just under 30% introduced text columns, and about a quarter made other types of improvement, most using Word art. One S2 pupil introduced headers and footers. Most P7 pupils (70-90%) and P5 pupils (50-85%) also typed text, changed font appearance and/or added emphasis. Just over 60% of the P7 pupils and around a third of the P5 pupils centred the text heading and/or applied the spell checker. A quarter of the P7 pupils justified the text and/or made other improvements, mainly using Word art (one P7 pupil previewed the document); at P5 proportions were lower. At P3, almost two-thirds of the pupils added text, and just over a quarter demonstrated the ability to alter the appearance of text by changing font, font sizes and/or font colour. Over 15% of the P3 pupils showed how to emphasise text through use of italics, boldface and underlining.

**Table 4.16**  
**Creating and presenting: text and graphic manipulation skills in Word**  
*(% pupils successfully completing voluntary activities unaided,  
to improve the appearance of a given text \*)*

<i>Activity **</i>	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Create a small piece of own text	64	83	85	87
Change the font or font size	27	60	87	94
Change the font colour	26	58	75	85
Add emphasis with italics or bold face	15	55	75	90
Underline some text	16	52	70	89
Centre text heading/title	8	36	60	86
Use the spell checker	8	33	64	72
Justify the text	5	16	23	40
Apply bullet points or indenting	2	11	32	48
Introduce text columns	0	5	15	27
Other	<1	3	8	8
Move an existing graphic	55	75	83	96
Resize an existing graphic	30	63	81	93
Insert a new picture	12	41	67	82
Wrap text	<1	4	15	27
Other	<1	<1	8	6

\* 250-400 pupils per stage; in each case the percentage successfully demonstrating the activity is based on all pupils embarking on the task, whether or not they actually voluntarily engaged in the activity concerned.

\*\* This is not the wording actually used with pupils.

The proportions of pupils who were able to move an existing graphic rose from 55% at P3 to over 95% at S2, whereas the corresponding proportions able to resize a graphic ranged from a lower 30% at P3 to over 90% at S2. The stage difference was marked also for the skill of inserting a new graphic (a picture) into the text: just over 10% of the P3 pupils managed to do this, rising to over 80% at S2. Over a quarter of the S2 pupils successfully wrapped text around a graphic: this compares with 15% at P7 and under 5% at P5 and P3. Just under one in ten pupils at P7 and S2 demonstrated other skills here, including shading, adding titles, and so on.

The final set of ICT skills that featured in the assessed comprised spreadsheet skills. Table 4.17 presents the results.

**Table 4.17**  
**Collecting and analysing: text and graphic Excel spreadsheet skills**  
*(% pupils successfully completing activities unaided \*)*

<i>Activity **</i>	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Enter given data into a table	16	37	31	65
Create a required graph (using the graphing tool)	3	15	19	34
Label axes	2	7	25	42
Provide a title	2	12	32	48
From the chart, identify the largest/smallest categories	24	42	45	61

\* 250-400 pupils per stage; in each case the percentage successfully demonstrating the activity is based on all pupils embarking on the task, whether or not they actually engaged in the activity concerned.

\*\* This is not the wording actually used with pupils.

The evidence is that spreadsheet skills are in general less well-developed than are basic word processing skills, but once again stage progression is clear. Two-thirds of the S2 pupils were able to enter data into a spreadsheet table, dropping to around one-third at P5 and P7, and to less than a fifth at P3. One-third of the S2 pupils were successfully able to create a required chart using the tabulated data: higher proportions were able to label the axes appropriately (42%) and to provide a chart title (48%). Proportions were lower among younger pupils, falling to under 5% at P3 for these skills.

There was no indication in the performance data of any difference in the ICT skills of boys and girls.

## 4.5 Summary

In total, 15 reading tasks, 15 writing tasks and six ICT tasks were administered in the survey, all set in mathematical contexts.

The reading tasks were level-based, with three different tasks per level, and over 5500 pupils in just under 800 schools were assessed. Attainment results were produced by applying the usual 65% cut-off score to the pupils' total task scores, as described in Chapter 1, and then averaging the proportions of 'secure' attainers over the three tasks at each level. At all levels a clear picture of stage progression emerged. Around two-thirds of the P3 pupils demonstrated secure attainment at Level A, and over half did so at Level B also. At P5, just over 80% of the P5 pupils demonstrated secure attainment at Level B and over half also at Level C. At P7, 80% of the pupils were classified as secure at Level C and 60% at Level D also. At S2, 85% of the S2 pupils were classified as secure at Level C, just under three-quarters also at Level D and just under 30% at Level E. The girls produced better performances in general than the boys at all stages.

In total, across the four stages, over 3000 pieces of writing were evaluated, using a best fit scheme. Each script was independently evaluated by three different raters, all practising teachers, and the 'majority' inter-rater agreement rate (same judgements offered by at least two of the three evaluators) was just over 80%. According to the evaluators, the majority of the P3 pupils produced writing at Levels A and B, the majority of the P5 and P7 pupils produced writing at Levels B and C, while the majority of the S2 pupils produced writing at Levels B, C and D. The stage progression was particularly striking between P3 and P5: whereas more than 60% of the P3 pupils were deemed to be working at Level A or below, the corresponding proportion at P5 was under 25%, at P7 under 15% and at S2 under 10%. The proportions of pupils deemed to be working at Levels D or E at P5, P7 and S2 were 5%, 15% and just over 30%, respectively. There was a very clear gender gap in favour of the girls at every stage.

The ICT tasks covered a range of relevant skills and knowledge, and were administered in the schools by trained field officers, with typically four pupils assessed in each 'practical' school (40% of the survey schools), pupils working individually on their assigned tasks. In total, around 1300 pupils were assessed in almost 350 schools, working on laptop computers provided by the field officers. On the basis of the pupils' self-reports, high proportions of pupils at all four stages were familiar with use of a keyboard and mouse, but there were much lower levels of familiarity among the P5 and P3 pupils with the use of a PC with Windows. As to the software that featured in the ICT tasks, the majority of P7 and S2 pupils claimed to

be familiar with Word (80-90%), but familiarity rates were lower for Excel, at under 60% of the pupils at S2 and around one-third at P7. Among the younger pupils familiarity with the software was even less widespread: half the P5 pupils and over two-thirds of the P3 pupils claimed not to be familiar with Word, while almost 90% of the P5 pupils and virtually all the P3 pupils claimed to be unfamiliar with Excel.

At all stages, high proportions of pupils were able to open a folder and file and scroll the file (90% or more at P5, P7 and S2, and two-thirds at P3). While high proportions of the older pupils could also save the text under a new file name, just 30% of the P3 pupils could do this. When asked how they might work on the file in a different location, the majority of pupils at all stages suggested printing it, although high proportions of the P7/S2 pupils (80-90%) also suggested copying the file onto a floppy disk or CDROM, or sending it as an email attachment (65-75%). Just 40% of the P5 pupils and 20% or fewer of the P3 pupils suggested one or both of these methods. Around a third of the S2 pupils and a quarter of the P7 pupils suggested accessing the file over a network; at P5 the proportion was just under 15% and at P3 under 10%.

High proportions of the S2 pupils (85% or more) and most pupils at P7 and P5 (70-90%) demonstrated competence in basic word processing skills: adding new text and changing the appearance of fonts, adding emphasis through italics, etc. At P3, almost two-thirds of the pupils added text, and just over a quarter demonstrated the ability to alter the appearance of text by changing font, font sizes and/or font colour. Over 15% of the P3 pupils knew how to emphasise text through use of italics, boldface and underlining. Under half the S2 pupils, a quarter of the P7 pupils and lower proportions of pupils at P3 and P5, justified the text and/or added bullet points or indentation. The proportion of pupils who were able to move an existing graphic in a text file rose from 55% at P3 to over 95% at S2, whereas the corresponding proportions able to resize a graphic ranged from a lower 30% at P3 to over 90% at S2. Just over 10% of the P3 pupils were able to introduce a new picture into a text, rising to over 80% at S2. Over a quarter of the S2 pupils successfully wrapped text around a graphic: this compares with 15% at P7 and under 5% at P5 and P3.

Two-thirds of the S2 pupils were able to enter data into a spreadsheet table, dropping to around one-third at P5 and P7, and to less than a fifth at P3. One-third of the S2 pupils were successfully able to create a required chart using the tabulated data, falling to under 5% at P3 for these skills.

There was no indication in the performance data of any difference in the ICT skills of boys and girls.

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## 5. Pupils' views about mathematics

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### 5.1 The pupil questionnaires

At P5, P7 and S2, the survey pupils who undertook mathematics assessments, as opposed to those who participated in the assessment of reading and writing, were invited to complete a questionnaire exploring their home and school learning circumstances and experiences, their views about their mathematics lessons and their perceptions about the importance of mathematics in general and for particular occupations. Four different questionnaires were used at all stages, simply to reduce the length of the paper questionnaire placed in front of each pupil. One set of enquiries – home resources, homework, out-of-school activities and job aspirations – was common to all four questionnaire versions. The other enquiries were distributed across the four versions, so that each pupil answered a subset of questions on each topic: the amount of time they spent in various activities in the company of the adults in their lives, their opinions about their school learning experiences in mathematics, how often they engaged in various different kinds of activities in their subject lessons, and how important they thought mathematics to be for people in various kinds of jobs. An exemplar questionnaire is given in Appendix D.

Around 2000 pupils at each stage completed questionnaires. Return rates on the part of schools was high: 95% of 'P5 schools' (i.e. survey schools in which P5 pupils were assessed), 88% of 'P7 schools' and 93% of secondary schools returned pupil questionnaires. Among the returning schools, 84% of the 'P5 schools' and 82% of the 'P7 schools' returned completed questionnaires for 90-100% of their sample pupils. At S2, around half the participating survey schools returned completed questionnaires for 70-75% of their sample pupils, the proportions being lower in the remaining half.

### 5.2 The pupils

The profile of general pupil characteristics that emerged in this survey almost exactly mirrors that which emerged in the same enquiry in the 2002 survey of Social Subjects Enquiry Skills<sup>10</sup> and the 2003 survey of Science<sup>11</sup>. It is only where subject-specific enquiries are concerned that the findings differ, and the differences are noted at relevant points throughout this chapter.

#### 5.2.1 Gender, language, hobbies and job aspirations

All three stage samples were evenly divided by gender, and on average just over 80% of the pupils claimed that English was their first language – 'the one you use most at home'. Another 5% of the pupils mentioned 'Scottish', while the remaining pupils mentioned one or other of 32 different languages.

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<sup>10</sup> Assessment of Achievement Programme. *First Survey of Social Subjects Enquiry Skills 2002*, Chapter 5. Edinburgh: Scottish Executive Education Department, 2004.

<sup>11</sup> Assessment of Achievement Programme. *Sixth Survey of Science 2003*, Chapter 5. Edinburgh: Scottish Executive Education Department, 2005.



Three-quarters of the pupils were members of at least one club or other activity-based organisation, the proportion falling from over 80% at P5 through around 75% at P7 to just under 60% at S2 (these figures exactly mirror the picture that emerged in the previous year's science survey). The clubs/societies concerned can loosely be grouped into 'sport', 'youth' (including scouts and guides), 'cultural' (drama, dance, music including choirs and bands), and 'intellectual' (science, chess, computer, library, etc). On the basis of their survey responses, club/group activities were significantly more popular amongst the girls than the boys at P5 and P7 (84% of the girls at P5 compared with 77% of the boys agreed that they belonged to a club or society out-of-school; at P7 the respective proportions were 79% and 73%) but less popular at S2 (56% of the girls mentioned clubs/groups compared with 64% of the boys).

As far as job aspirations are concerned, roughly four out of five pupils at each stage mentioned at least one occupation, and the resulting range of jobs was extremely wide. As reported for the 2002 survey of Social Subjects Enquiry Skills and the 2003 survey of Science, the evidence from this repeat enquiry confirms once again that jobs remain very heavily gender typed in the eyes of young people, with, for example, 'footballer' featuring largely in the boys' occupational aspirations and 'nurse' and 'hairdresser' in the girls'.

### 5.2.2 Home resources for learning

As well as traditional home resources, such as dictionary, atlas and calculator, pupils were asked whether they had access to a computer and the internet at home, whether they had a mobile phone (a possible learning tool), and whether they had access to a television and video recorder in their homes. They were also asked if they had a quiet place to study at home. Access rates are given in Table 5.1.

Again, the findings here reflect closely those already reported for the 2002 survey of Social Subject Enquiry Skills and the 2003 Science survey. High proportions of the pupils in all three stages had use of a quiet place to study at home, along with access to a dictionary and calculator (70-80% for each resource). And while access to a computer and the internet was lower at P5 than at P7 and lower at P7 than S2, the majority of pupils at all stages had access to these potential learning resources (60-80% for a computer; 50-75% for the internet). The learning resource which the fewest pupils claimed access to was an atlas (40-50%).

**Table 5.1**  
**Home resources**  
(% pupils with access)

<i>Resource</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Quiet place to study	74	72	73
Calculator	64	74	76
Dictionary	69	75	73
Computer	64	72	81
Internet	49	65	73
TV/Video	52	56	63
Atlas	41	48	49
Mobile phone	39	49	57
<i>Number of pupils</i>	<i>1996</i>	<i>2157</i>	<i>2037</i>

Some pupils had access to all the resources, the proportions increasing with age: 13% at P5, 20% at P7 and 29% at S2.

### 5.2.3 Home support for learning

Pupils were asked how often they engaged in different activities with the adults in their families. Table 5.2 presents the findings.

**Table 5.2**  
**Activities with family adults**  
*(% pupils giving each response: 500-700 pupils per stage per question)*

<i>Spend time with family adult(s)...</i>	<i>Stage</i>	<i>Most days</i>	<i>Most weeks</i>	<i>Once /month</i>	<i>2-3 times /year</i>	<i>Hardly ever</i>
..watching TV/videos	S2	68	20	5	1	7
	P7	68	22	3	2	5
	P5	61	26	4	1	9
..listening to music	S2	55	21	8	3	12
	P7	51	24	9	3	13
	P5	45	29	7	4	15
..playing sport/games, or keeping fit	S2	35	29	13	8	15
	P7	46	34	10	3	7
	P5	54	30	7	2	7
..talking about films/TV programmes	S2	33	35	14	3	15
	P7	34	34	10	4	19
	P5	31	26	10	4	30
..on outings/visits to places/events	S2	11	36	31	15	7
	P7	16	41	26	10	6
	P5	16	34	29	12	9
..reading or talking about books	S2	8	16	18	8	49
	P7	17	20	18	6	39
	P5	31	24	13	5	27
..at the cinema	S2	2	13	40	22	23
	P7	3	14	46	20	16
	P5	5	16	40	21	19
..at the theatre, concert or dance	S2	3	5	15	26	52
	P7	5	8	16	27	44
	P5	10	8	14	30	38

According to the pupils, the activities most frequently shared with adult family members were 'watching TV and videos' (60-70% of the pupils claimed to do this on 'most days') and 'listening to music' (around half the pupils answered 'on most days'). Playing sport/games and keeping fit, and talking about films and TV programmes were also relatively popular activities, with 30-40% of the pupils responding 'most days' in these cases. The least frequent family activities were going to the cinema, a theatre, a live concert or dance, the majority of pupils at all stages claiming to engage in this type of activity once a month at most (70-80%).

Two family activities showed clear age-related trends: 'reading or talking about books', with 31% of the P5 pupils agreeing that they did this 'on most days' compared with a lower 17% of pupils at P7 and an even lower 8% at S2, and 'playing sport/games or keeping fit', with

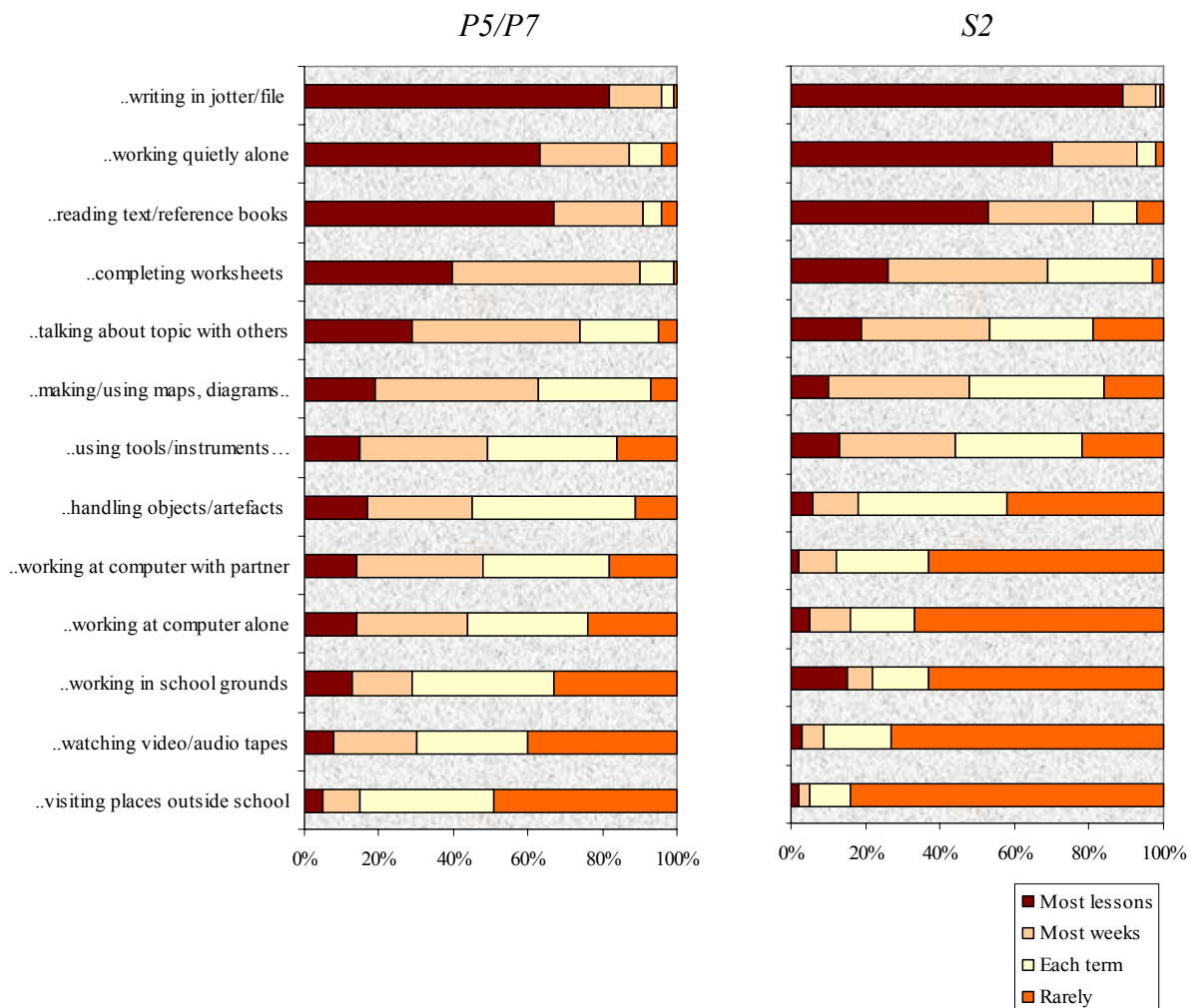
54% of the P5 pupils agreeing that they did this ‘on most days’ compared with a lower 46% of pupils at P7 and an even lower 35% at S2.

There were some marked gender differences at all stages in terms of the types of family activity that the pupils claimed to engage in frequently. In particular, the girls tended more frequently than the boys to spend time reading books or talking about them, listening to music and attending live theatre, a concert or dance. At S2, the boys tended more frequently than the girls to play sport/games or to keep fit with other family members.

### 5.3 Predominant activities in mathematics lessons

As far as their school experience of mathematics is concerned, pupils were asked to indicate how often they engaged in various activities in their mathematics lessons, checking the options ‘in most lessons’, ‘most weeks’, ‘each term’ and ‘rarely’. Figure 5.1 illustrates the activity profiles for the two sectors, while the detailed stage-related data are given in Table E.1 in Appendix E.

**Figure 5.1**  
**Activities in Mathematics lessons at P5/P7 and S2**  
*(% pupils giving each frequency response: 500-700 pupils per stage per question)*



According to their responses, 80-90% of the pupils at all stages spent at least some time in most lessons or in most weeks writing in their jotters/files, working quietly alone and reading texts/reference books.

While over 90% of the primary pupils also claimed to spend time in most lessons or most weeks completing worksheets, the proportion for S2 pupils was lower here at just under 70%. This is one of three activities that showed a clear stage-related trend, as opposed to simple sector-related differences, with almost 45% of the P5 pupils claiming to complete worksheets in 'most lessons, dropping to just over 35% at P7 and just over 25% at S2 (see Table E.1 in Appendix E). The other two activities showing age-related trends were 'handling objects and artefacts' and 'watching and responding to video and audio tapes', both of which decreased in reported frequency with increasing age.

According to the pupils' responses, working with a computer, alone or with a partner, was not a regular part of mathematics learning, particularly at S2 (over 60% of S2 pupils and 20-25% of primary pupils claiming to do this 'rarely'). Indeed, the evidence from the three subject surveys of 2002-2004 would suggest that, unless computer use has decreased generally over the period, computers are more frequently used in the social subjects curriculum than in science, and more frequently in science than in mathematics. Working in the school grounds and visiting places outside school were among the least frequent activities engaged in during mathematics lessons, with frequency decreasing with increasing age.

## 5.4 Homework

The questionnaire included two statements relating to homework: 'We get regular homework in mathematics' and 'I use a computer to do my mathematics homework'. It also invited pupils to indicate how much time they spent on homework each week.

A high 70-80% of the pupils at each stage agreed that they 'always' or 'mostly' had regular homework in mathematics, with one third answering 'always'. This picture differs significantly from that for science in the 2003 survey, where homework featured far more prominently in the experience of the S2 pupils compared with the primary pupils (well over half the S2 pupils claimed that they 'always' or 'mostly' received regular science homework compared with around 15% of the pupils at P5 and P7). In contrast, fewer than 10% of the pupils at any stage agreed that they 'always' or 'mostly' used a computer to do their mathematics homework, compared with 20-25% of the pupils in the 2003 Science survey with respect to science homework. Just over half the primary pupils and just under half the S2 pupils said that they definitely did not use a computer for their mathematics homework.

As with any information based on retrospective estimation, the pupils' responses about the time they typically spent on their mathematics homework can only be considered as very loosely indicative, even more so than their responses to frequency of specific lesson activities. That said, the S2 pupils claimed to spend significantly more time on average on homework than did the P7 or P5 pupils: an average of just under 2½ hours at S2 compared with around 1½ hours at P5 and P7.

## 5.5 Perceptions about classroom learning experience

In an exploration into views about classroom learning experience, pupils were invited to rate each of a set of given statements for perceived applicability to their mathematics lessons. For example, pupils were to indicate the degree to which the statement “We learn a lot of facts in mathematics” applied to their mathematics learning. Opinions were noted by checking one of the following response options: “Yes, always”, “Mostly”, “Not usually” and “Definitely not”, with “Don’t know” also a possibility.

The list of statements focused on a variety of issues, including the style of teaching/learning, the nature of assessment, the pupil’s interest in the subject, the pupil’s level of self-confidence, and so on. For ease of presentation the statements are here loosely grouped into those that relate to ‘The nature of teaching and learning’, ‘Motivation to learn’ and ‘Assessment and feedback’.

### 5.5.1 The nature of teaching and learning

In Table 5.3 we see a mixture of different statements, some relating to the nature of subject learning, others to the style of subject teaching, and yet others to issues of classroom climate (e.g. discipline).

**Table 5.3**  
**The nature of teaching and learning mathematics**  
 (% pupils giving each response: 500-700 pupils per stage per question)

	Stage	Yes, always	Mostly	Not usually	No	Don't know
Everyone is expected to work hard	S2	75	20	1	2	2
	P7	79	17	2	1	1
	P5	77	17	3	<1	2
Pupils get extra help when they need it	S2	53	33	7	1	5
	P7	63	29	5	1	2
	P5	58	29	9	1	3
Everyone has a chance to say what they think	S2	40	34	14	6	5
	P7	50	28	15	4	3
	P5	40	29	20	5	7
It is easy to concentrate and work hard in class	S2	25	52	17	5	1
	P7	26	53	16	3	2
	P5	33	41	18	5	3
Pupils hand in their work on time	S2	6	67	17	3	7
	P7	10	71	14	1	4
	P5	17	56	16	4	8
Learning is about asking ‘Why?’ and ‘What if?’	S2	6	26	33	9	26
	P7	9	25	39	9	19
	P5	12	29	31	12	15
I can use a computer to do the work during mathematics lessons	S2	6	8	37	37	12
	P7	10	12	42	25	10
	P5	10	12	35	35	8

Table 5.3 shows that the majority of pupils in all stages thought that they were expected to work hard in their mathematics lessons (95% responding ‘yes, always’ or ‘mostly’, with 75-

80% agreeing 'always'), that they were given help when they needed it (85-90%, with 50-60% agreeing 'always'), that everyone had a chance to say what they thought (around 75%, with 40-45% agreeing 'always'), and that they found it easy to concentrate and work hard in class (also around 75%, with 25-30% agreeing 'always'). Two-thirds of the pupils also agreed that work was 'mostly' handed in on time, though fewer than 10% at S2 and under 15% at P5/P7 agreed that this happened 'always'. Lower proportions of pupils thought that learning in mathematics is about asking 'Why?' and 'What if?'; indeed a quarter of the S2 pupils and just over 15% of the primary pupils claimed they didn't know. Confirming the finding in relation to frequency of various lesson activities, computer use in mathematics lessons was not common at any stage, according to the survey pupils.

### 5.5.2 Motivation to learn

A number of statements related to aspects of pupils' motivation to learn (see Table 5.4). Some of these focused on intrinsic motivation, e.g. the degree to which pupils found topics and investigations interesting, and others on extrinsic motivation, in particular their own and their family's perceptions about the value of mathematics for later learning and for jobs.

**Table 5.4**  
**Pupil motivation to learn mathematics**  
(% pupils giving each response: 500-700 pupils per stage per question)

	Stage	Yes, always	Mostly	Not usually	No	Don't know
Learning is important because it will help me to get a good job later	S2	67	22	2	1	8
	P7	68	21	2	1	9
	P5	74	13	4	1	8
Learning is important because it will help with other subjects later	S2	54	34	4	2	6
	P7	66	23	5	1	6
	P5	71	19	3	1	7
My family think this is an important subject	S2	70	19	2	<1	9
	P7	57	21	7	1	14
	P5	57	18	8	3	15
I want to do well in mathematics	S2	62	33	3	1	1
	P7	73	23	1	<1	2
	P5	79	15	2	1	3
I work hard on topics and investigations	S2	31	59	6	1	3
	P7	42	48	7	1	3
	P5	45	44	6	1	5
We get interesting topics and investigations to do	S2	4	32	34	24	5
	P7	16	43	27	9	5
	P5	28	38	20	7	7
Pupils settle down quickly at the start of lessons	S2	7	58	28	5	2
	P7	7	66	19	4	4
	P5	17	54	18	4	7
I look forward to lessons	S2	6	20	39	33	2
	P7	18	25	32	24	1
	P5	36	25	17	18	3
I enjoy books about mathematics	S2	4	14	37	41	4
	P7	13	20	29	35	3
	P5	29	20	26	23	3

Whatever else the pupils thought of mathematics, high proportions of them shared the view that this subject is important, in particular for their future working lives but also for later study in other subjects, and they thought that their families felt the same way (85-90% of the pupils at all stages offered a positive rating to statements about the importance of this subject). Perhaps not surprisingly, therefore, high proportions of the pupils also agreed that they wanted to do well in mathematics (95% of the pupils answering ‘always’ or ‘mostly’), and that they worked hard on topics and investigations (around 90% at each stage answering ‘always’ or ‘mostly’): the primary pupils were in general more positive on these counts than the S2 pupils.

The pupils were on the whole less convinced about the interest value of mathematics in school, and their enjoyment of it, both interest and enjoyment decreasing with increasing stage. For example, while almost 30% of the P5 pupils agreed that they ‘always’ had interesting topics and investigations to do in their mathematics lessons, the corresponding proportion at P7 was under 20%, dropping still further to under 5% at S2. Again, while over a third of the P5 pupils claimed to look forward to their mathematics lessons ‘always’, the figure at P7 was under 20% dropping further to just over 5% at S2. A similar picture emerged for enjoyment of books about mathematics.

### 5.5.3 Assessment and feedback

The findings for the statements that relate to “Assessment and feedback” are presented in Table 5.5.

**Table 5.5**  
**Teacher and self assessment in mathematics**  
(% pupils giving each response: 500-700 pupils per stage per question)

	Stage	Yes, always	Mostly	Not usually	No	Don't know
I find mathematics easy to understand	S2	7	75	13	3	2
	P7	10	77	9	2	2
	P5	19	66	10	2	4
We go through the work too slowly	S2	3	12	52	27	6
	P7	5	15	49	27	4
	P5	7	16	41	31	6
I get behind with the work	S2	3	9	64	17	7
	P7	4	13	60	18	6
	P5	7	17	50	21	5
It is hard to catch up if I miss a lesson	S2	14	20	56	7	3
	P7	16	22	50	9	3
	P5	21	25	38	13	4
Most of the assessment is done in short tests	S2	12	41	28	5	13
	P7	8	37	38	7	11
	P5	14	34	34	7	12

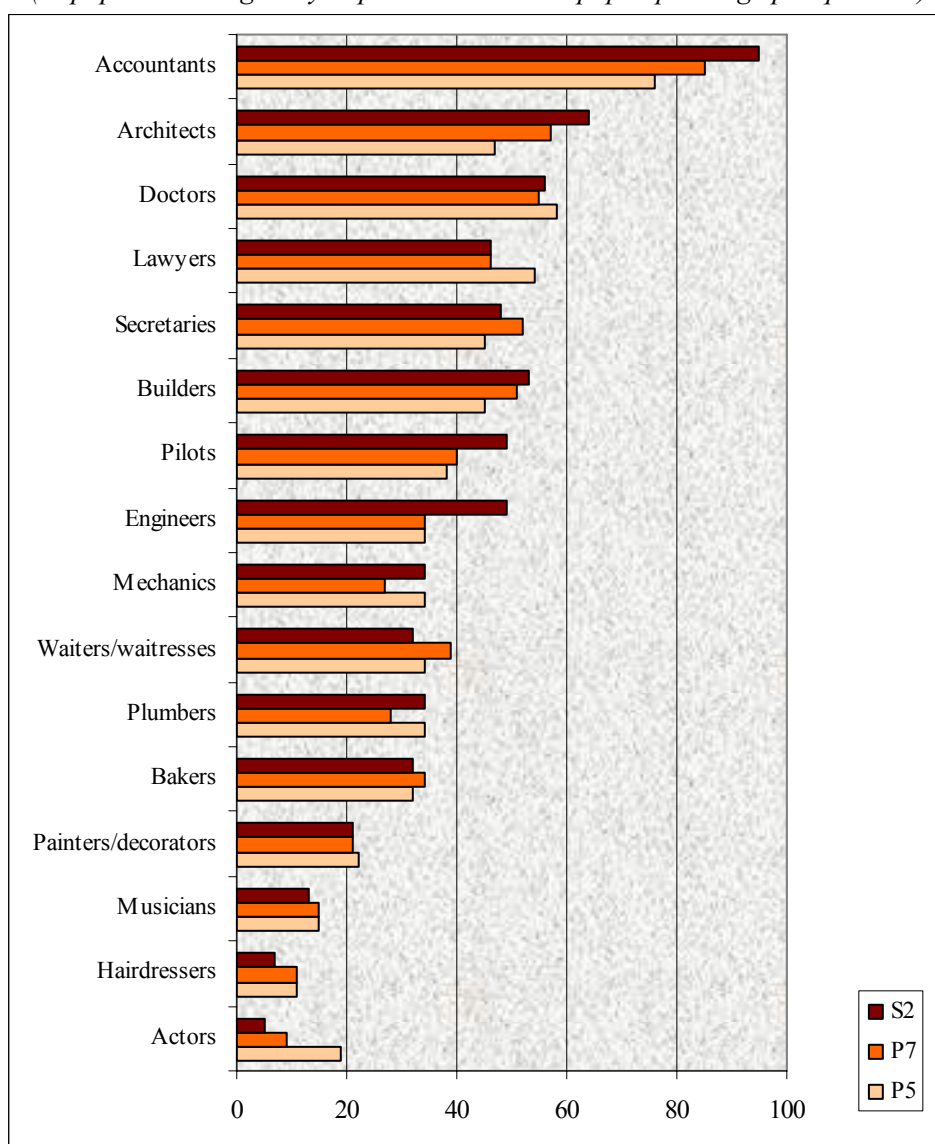
High proportions of pupils at all stages claimed that they typically found this subject ‘always’ or ‘mostly’ easy to understand (80-90%), with the P5 pupils significantly more positive about this than the P7 pupils and the P7 pupils significantly more positive than the S2 pupils on the whole. High proportions of pupils also disagreed that they went through the work too slowly or that they fell behind with their work (70-80% answering ‘no’ or ‘not usually’ in each case). Just over 60% of the S2 pupils and 50-60% of the primary pupils claimed that it was not, or not usually, hard to catch up if they missed a lesson.

As far as their experience of teacher assessment was concerned, rather similar proportions of the pupils in both sectors claimed that this generally took the form of short tests (around half responding 'always' or 'mostly').

## 5.6 Perceptions about mathematics and jobs

An enquiry specific to this particular survey related to pupils' perceptions of the value of mathematics in different professional occupations. Figure 5.2 illustrates the general pattern of opinion, while the detailed data are given in Table E.2 in Appendix E.

**Figure 5.2**  
**Perceptions of the importance of mathematics**  
**for different occupational groups**  
*(% pupils checking 'very important': 500-700 pupils per stage per question)*





The purpose of this enquiry was not so much to explore how realistic pupils' perceptions are about the importance of mathematics to particular jobs, but rather to explore general perceptions of the importance of this subject as far as this might affect learning motivation. And indeed the evidence is that mathematics was perceived to be 'very important' or 'quite important' for most of the occupations listed by the majority of pupils in both sectors, accountants topping the list (see Table E.2 in Appendix E). The view that mathematics is 'very important' for accountants and architects increased steadily from P5 through P7 to S2, as Figure 5.1 illustrates, while for pilots and engineers pupils' appreciation of the importance of mathematics increased between P7 and S2, with significantly more of the S2 pupils than of the primary pupils feeling that mathematics is 'very important' for these jobs.

## 5.7 Summary

Those pupils at P5, P7 and S2 who had attempted mathematics booklets, rather than reading booklets, were invited to complete a questionnaire exploring their home and school learning circumstances and experiences, their views about their mathematics lessons and their perceptions about the importance of mathematics in general and for particular occupations. Around 2000 pupils completed questionnaires at each stage, with an even gender mix. The majority of the pupils claimed that English was their first language – 'the one you use most at home', while a small proportion mentioned 'Scottish' and the rest mentioned one or other of 32 different languages. Most of the pupils were members of at least one out-of-school club or group, the proportion decreasing with age. The girls were more likely than the boys to be members of clubs/groups at P5/P7 but less likely at S2. Pupils' job aspirations were very varied and heavily gender typed at all stages.

At least half the pupils at every stage had access to one or other of a series of potential learning resources at home; access to a computer and to the internet increased with age. The most popular family activities were watching TV programmes and videos and listening to music, followed by playing sport/keeping fit and talking about films and television programmes. The least frequent activities were going to the cinema, or to a theatre, concert or dance. Reading and talking about books with family members decreased markedly in popularity with age, as did listening to music and cultural outings. Reading and talking about books was more popular with girls than boys at all stages.

In mathematics lessons in both sectors the most frequent activities were writing in jotters/files, working quietly alone and reading texts/reference books. Other lesson activities were generally more frequent for the primary pupils than for S2, including the use of computers, which was not common in either sector. Working in the school grounds and visiting places outside school were among the least frequent activities engaged in, with frequency decreasing with increasing age.

The majority of pupils in all three stages thought that they were expected to work hard in their mathematics lessons, that they were given help when they needed it, that everyone had a chance to say what they thought, and that they found it easy to concentrate and work hard in class. Relatively low proportions of pupils thought that learning in mathematics is about asking 'Why?' and 'What if?', and once again computer use in mathematics lessons was confirmed as uncommon at any stage.

The majority of pupils at all stages shared the view that mathematics is an important subject, for later study and also for future jobs, and agreed that their families thought so too. When presented with a list of different occupations, the pupils in all three stages were in general agreement about the value of mathematics to the people in the jobs concerned. Only for accountants, architects, pilots and engineers did the pupils' views change markedly from one stage to another, with perceptions of the importance of mathematics for these jobs becoming stronger with increasing age.

High proportions of the pupils agreed that they wanted to do well in mathematics, and that they worked hard in their lessons. Enjoyment of mathematics, however, decreased markedly with increasing age (having interesting topics and investigations to do, enjoying reading books about mathematics, looking forward to mathematics lessons).

High proportions of pupils at all stages claimed that they typically found mathematics easy to understand, and disagreed that they went through the work too slowly or that they fell behind with their work. The majority claimed that it was not usually hard to catch up if they missed a lesson. As far as their experience of teacher assessment was concerned, around half the pupils in both sectors claimed that this generally took the form of short tests.



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## 6. Teachers' reports on mathematics in the schools

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### 6.1 The teacher questionnaires

Teacher questionnaire enquiries were incorporated into the survey at all stages. The questionnaires, which were designed to gather information about the provision and resourcing of mathematics in the schools, and to invite teachers' views about the quality of different aspects of pupils' mathematics experience in classrooms, were sent to a randomly selected half of the survey schools. One questionnaire was designed to be completed by school managers, i.e. primary school head teachers and S2 principal teachers, while the other was designed to be completed by class teachers at P3, P5 and P7 and by S2 mathematics teachers (both questionnaires are reproduced in Appendix F).

In the school managers' questionnaire, respondents were asked in what year their current mathematics programme was introduced, what were the bases for the course/programme, and whether it was currently under revision. Respondents were also asked to indicate on what basis the school reported pupil progress to parents, after which followed an invitation to rate the quality of various aspects of subject resourcing and related issues, and then to evaluate pupils' motivation for learning mathematics, teachers' expectations of pupils and teacher morale.

The class teacher questionnaire began with a set of demographic questions, followed by an enquiry into the nature of mathematics lessons at the stage concerned: respondents were asked how frequently their pupils engaged in different activities when studying mathematics, and how much use they themselves made of various kinds of resource materials in mathematics lessons.

### 6.2 Responses of primary head teachers and secondary principal teachers

#### 6.2.1 The respondents

In the subsample of schools contacted, the school managers' questionnaire was completed by 303 head teachers/principal subject teachers: 245 primary head teachers (75 from schools in which P3 pupils were assessed, 76 from 'P5 schools' and 94 from 'P7 schools') and 58 secondary mathematics principal teachers. These figures translate to response rates of 65-70% in each sector.

#### 6.2.2 Courses/programmes

In the primary schools where head teachers responded to the questionnaire, just over half (52%) the current mathematics programmes had been introduced in 2000 or later, compared with two-thirds of the S2 programmes in the responding secondary schools. Around 40% of the primary programmes, whether introduced prior to 2000 or later, were currently under

revision. In the secondary schools, all the programmes introduced before 2000 were currently under revision, as were 80% of those introduced more recently.

Table 6.1 confirms that the most popular bases for mathematics programmes in both sectors were the national 5-14 guidelines (91% of the primary head teachers and 90% of the S2 principal teachers checked this option) and commercial textbooks and resource packs (89% in the primary sector and 95% at S2). The school's (or department's) own materials featured significantly more often among the S2 principal teachers' responses compared with the primary head teachers (42% of the primary head teachers indicating these compared with 57% of the S2 principal teachers), while local authority 5-14 guidelines were mentioned significantly less often by the S2 principal teachers than by the primary head teachers (54% of the primary programmes were based on this and other resources, compared with 26% of the S2 programmes). Other possible resources were used infrequently in either sector.

**Table 6.1**  
**Bases of courses/programmes**  
(% indicating each basis among 245 primary head teachers  
and 58 secondary principal teachers)

<i>Basis</i>	<i>P3/P5/P7</i>	<i>S2</i>
National 5-14 guidelines	91	90
Commercial textbooks/resource packs	89	95
The school's (department's) own materials	42	57
Local authority 5-14 guidelines	54	26
Materials from teacher's group or association	9	9
Materials from another school or department	2	2
Another authority's 5-14 guidelines	7	3
Other	15	5
Number of respondents	245	58

The following are a selection of comments offered on the question of programmes of work (PHT – Primary head teacher, SPT – Secondary principal teacher):

*We are looking at maths as an area of development for our HMI action plan and hope to augment materials during this time. [PHT]*

*We have opted into proposals of developments in mathematics in Scottish Borders council in year 1, 2004-5. It is also a major part of our school improvement plan over the next two sessions. [PHT]*

*Although our current maths programme has been in place for some time, components are updated, e.g. mental maths, problem solving, data handling on computer. [PHT]*

*At present Scottish Heinemann is being phased into school at primary 1 and 2 stages August 04. ... [PHT]*

*This year, 2003/2004, we have introduced a new core scheme for learning/teaching mathematics. The scheme was evaluated in February 2004 and found to be very good for most pupils. High achieving pupils, however, require additional resources. We are currently reviewing extra resources for pupils who are gifted in mathematics. [PHT]*

*Maths programme/scheme has been added to give breadth. However there is financial constraint on adopting the Scottish version of the scheme used as the core. [PHT]*

*Modifications have been made to the maths programme each year since it was introduced in order to suit children's learning. [PHT]*

*We have steadily been redeveloping the maths programme throughout the school. This development has included the introduction of formative assessment approaches. We are in the process of developing the programme for P6, having successfully introduced a similar approach across P1 to P5. Our P7 programme will be addressed in due course and will be formed in consultation with the high school. [PHT]*

*We reviewed our maths curriculum at the beginning of the session. However, Edinburgh has introduced a new 10-14 curriculum for maths which will be implemented in August. [PHT]*

*We would like to update our commercial resources. ...Unfortunately, this is impossible given our financial circumstances. DSM budgets in the borders have been at a standstill for several years now and funding for such improvements is simply not there. [PHT]*

*... I have been looking at condensing Maths in Action text books 1 and 2 into a first year course. I don't think there is enough to challenge the more able pupils. [S2]*

*This coming session we have bought many new resources to hopefully see a big improvement. [S2]*

*We have a 'creating time to learn' programme which is being phased in - it is basically a broad-banded approach with acceleration for the upper half. [S2]*

With regard to methods of reporting pupil progress to parents, Table 6.2 shows very clearly that almost all the schools at both stages (98% primary, 95% secondary) reported to parents in terms of 5-14 levels, with high proportions also using teachers' own comments (89% primary, 93% secondary).

**Table 6.2**  
**Bases for reporting pupil progress to parents**  
(% indicating each basis among 245 primary head teachers  
and 58 secondary principal teachers)

<i>Basis</i>	<i>P3/P5/P7</i>	<i>S2</i>
5-14 levels	98	95
Teacher's own comments	89	93
Marks or grades for effort	26	60
Comment bank	48	31
% marks in end-of-unit tests	3	17
% marks in end-of-year tests or exams	1	14
Other	7	21
Number of respondents	245	58

As far as other methods of reporting progress to parents are concerned, pupil progress at S2 was significantly more often reported in terms of marks or grades for effort (60% mentions by S2 principal teachers compared with 26% from primary head teachers), percentage marks in

end of unit tests (17% compared with 3%) and percentage marks in end of year tests or exams (14% compared with just 1%). In contrast, comment banks were significantly more often used by the primary schools for reporting to parents than by the secondary schools (48% of primary head teachers checking this option compared with 31% of the S2 principal teachers). Among the 'other' possibilities mentioned by 21% of the S2 principal teachers were grades for quality of class work and of homework, a 1-5 scale covering the whole cohort, an average percentage relative to the class average, detailed comment on strengths and weaknesses, and an indication of progress into next levels.

### 6.2.3 Quality of resourcing and other issues

Using a four-point rating scale ('very good', 'generally good', 'fair' and 'unsatisfactory'), the school managers were invited to rate the quality of each of the following with respect to their pupils (P3, P5, P7 or S2, as appropriate): the availability of learning support, the availability of teaching/learning resources, the availability of computers for teachers and for pupils, internet access for teachers and for pupils, school/departmental accommodation, pupils' class attendance and behaviour, and parental support.

As there were no significant differences among the three groups of primary head teachers, with regard to pupils at P3, P5 and P7, Table 6.3 simply compares the responses of the primary head teachers, as a group, with those of the S2 principal teachers.

As Table 6.3 shows, among the primary head teachers the most positive ratings were given to computer and internet access for teachers and for pupils, and for pupil attendance at, and behaviour in, subject classes. The 'very good' proportions varied between 54% (internet access for teachers) and 37% (pupil access to computers). Differences in the rating patterns of primary head teachers and S2 principal teachers reached statistical significance for most aspects, including the availability of computers for teachers and for pupils, internet access for pupils, pupil attendance in classes and pupil behaviour in mathematics lessons. Interestingly, there was no difference in the rating patterns of the two sectors for teachers' in-school access to the internet. Parental support for their children's learning was less highly rated in both groups, as was the availability of learning support or enrichment for individual pupils in mathematics.

The following are some of the volunteered comments on resourcing and other issues covered here:

*Due to a fire in school two years ago we do not have internet access for pupils readily available. We are in the midst of a rebuild and many classes are working out of hatted accommodation. [PHT]*

*Internet access due to improve via broadband 2004-7. [PHT]*

*Accommodation impacts on the ability to have computers. School is currently trying to develop its own ICT facility - self funded. [PHT]*

*Internet access is a fairly new resource in school. [PHT]*

*Our internet access has only been available for a few weeks. However it is now available in all classrooms. [PHT]*

*Broadband/airport technology being introduced at present should ensure better access in future. [PHT]*

*Parental support varies from stage to stage. However we have noted a marked lack of interest by parents in general at the early stages over the past few years. Home/school activity sheets are not well supported. [PHT]*

*This school is the most socially deprived primary school in the authority and we experience the related difficulties of deprivation, such as poor attendance, parents/carers of limited skills in literacy & numeracy, and impoverished home environments. [PHT]*

**Table 6.3**  
**Quality ratings for various issues**  
(% giving each rating among 245 primary head teachers  
and 58 secondary principal teachers: sample statistics)

<i>Issues...</i>	<i>Stage</i>	<i>Very good</i>	<i>Good</i>	<i>Fair</i>	<i>Unsatisfactory</i>
internet access for teachers	S2	54	30	11	5
	P3/P5/P7	54	36	7	4
internet access for pupils	S2	34	37	16	13
	P3/P5/P7	48	36	12	4
availability of resources for teaching/learning	S2	44	44	12	0
	P3/P5/P7	47	51	2	0
pupils' attendance at classes	S2	34	45	19	2
	P3/P5/P7	46	50	4	0
pupils' behaviour in lessons	S2	24	59	14	3
	P3/P5/P7	51	46	3	0
computer access for teachers	S2	28	41	21	10
	P3/P5/P7	48	42	9	1
computer access for pupils	S2	9	53	21	17
	P3/P5/P7	37	42	18	3
school or departmental accommodation	S2	14	40	24	22
	P3/P5/P7	31	47	19	3
parental support for learning	S2	12	62	17	9
	P3/P5/P7	16	58	26	1
availability of learning support/enrichment	S2	14	54	23	9
	P3/P5/P7	19	50	26	5

#### 6.2.4 Pupil motivation, teachers' expectations and teacher morale

The final enquiry in this questionnaire invited the respondents to evaluate the motivation of their pupils to learn mathematics, the expectations their teachers had of pupils to achieve in this subject, and the morale of teachers in their school or department. The results are shown in Table 6.4.



**Table 6.4**  
**Evaluations of pupil motivation, teacher expectations and morale**  
 (% giving each rating among 245 primary head teachers  
 and 58 secondary principal teachers)

<i>Issues...</i>	<i>Stage</i>	<i>Very high</i>	<i>Mod. high</i>	<i>Fair</i>	<i>Low</i>
Teachers' expectations of pupil achievement	S2	59	41	0	0
	P3/P5/P7	59	39	2	0
Teacher morale	S2	14	47	30	9
	P3/P5/P7	45	47	7	1
Pupils' motivation to learn	S2	19	50	24	7
	P3/P5/P7	29	65	6	0

For teacher expectations of pupil achievement in mathematics, there was no significant difference in the rating distributions for the two groups: just under 60% of the respondents in each case evaluated this as 'very high'. But there were statistically significant differences between the groups in their evaluations of, particularly, pupil motivation to learn (with 94% of the primary head teachers rating this as 'very high' or 'moderately high' compared with 69% of the S2 principal teachers) and teacher morale (39% of the S2 principal teachers rating this 'fair' or 'low' compared with just 8% of primary head teachers).

The following comments relate in particular to these issues:

*Although staff have high expectations of pupils many are not supported at home, e.g. tables not known, and late coming and absence also affect learning and teaching. ... However there are groups of pupils who are motivated and supported. [PHT]*

*Motivation of pupils tends very much to be influenced by individual members of staff. [PHT]*

*Interactive teaching and learning is beginning to impact on children's motivation. However having children in class with SEBD has a detrimental effect on other children and the teachers' ability to deal with and focus on mathematical problems. [PHT]*

*The skill of the teacher in motivating pupils is paramount in mathematics. A variety of strategies, i.e. interactive methods, opportunities to demonstrate learning to peer group, opportunities for independent learning, ensure that pupils are supported and challenged. [PHT]*

*Self motivation of pupils a big problem. Very few possess a good work ethic. There is a lack of achievement due to lack of effort, parental support at parents' nights, and 40 percent (better for able pupils) pupils tend to give up when the going gets hard at lower end. Up to 40 pupils out of 150 are working at Level A/B. [SPT]*

*We have a significant number of challenging pupils. Depending on the composition of the group behaviour varies from good to unsatisfactory. Difficulty in persuading children to purchase and bring calculators. Homework response is poor in most classes. School has been earmarked for closure. [SPT]*

### 6.3 Responses of P5 and P7 class teachers and S2 subject teachers

#### 6.3.1 The respondents

In total, 293 class/subject teachers in 270 schools responded to the questionnaire: 70 P3 teachers in 67 schools, 73 P5 teachers in 70 schools, 90 P7 teachers in 86 schools, and 60 S2 mathematics teachers in 47 schools. These figures represent response rates on the part of schools of around 60%.

Among the primary class teachers, 93% were female, compared with 52% at S2. All the S2 teachers were teaching mathematics and 92% of them had mathematics degrees. Few of the primary class teachers held a degree qualification involving mathematics (2%).

#### 6.3.2 Current teaching situations

The numbers of years respondents had been teaching and the numbers of years they had been in their current posts were positively correlated (0.6-0.7), with both variables ranging widely in both sectors, from one year to decades.

Class sizes varied very widely in both sectors, from one pupil to over 30 in primary schools, and from 9 pupils to a reported 33 pupils at S2. On average, class sizes were around 24 in the primary schools and 27 at S2. Class contact time was six hours per week on average in the primary schools and four hours at S2. Primary teachers reported their lesson preparation time to be four hours a week on average, whereas among the S2 teachers the weekly average was just two hours.

The respondents were asked how often they met with other subject teachers to talk about professional issues in mathematics. As Table 6.5 shows, there was a clear, and statistically significant, difference between the response profiles of the primary class teachers and the S2 mathematics teachers: over half the S2 mathematics teachers (55%) indicated that they met with colleagues once a week or more frequently to discuss mathematics education issues, compared with around one-third (34%) of the primary class teachers.

**Table 6.5**  
**Frequency of meetings with other teachers to talk about subject issues**  
*(% respondents indicating each frequency*  
*among 233 primary teachers and 60 S2 mathematics teachers)*

<i>Stage</i>	<i>&gt; once</i> <i>/week</i>	<i>Weekly</i>	<i>1-2 times</i> <i>/month</i>	<i>1-2 times</i> <i>/term</i>	<i>1-2 times</i> <i>/year</i>	<i>Hardly</i> <i>ever</i>
S2	22	33	14	8	6	17
P3/P5/P7	16	18	20	23	9	14

When asked how well motivated they thought their pupils were to learn mathematics, just over a quarter of the class teachers in both sectors (27%) responded 'very well'. However, a higher proportion of the S2 teachers than the primary teachers were negative in their perceptions of pupil motivation: the proportions checking 'not very well' or 'not at all' were 16% and 2%, respectively.

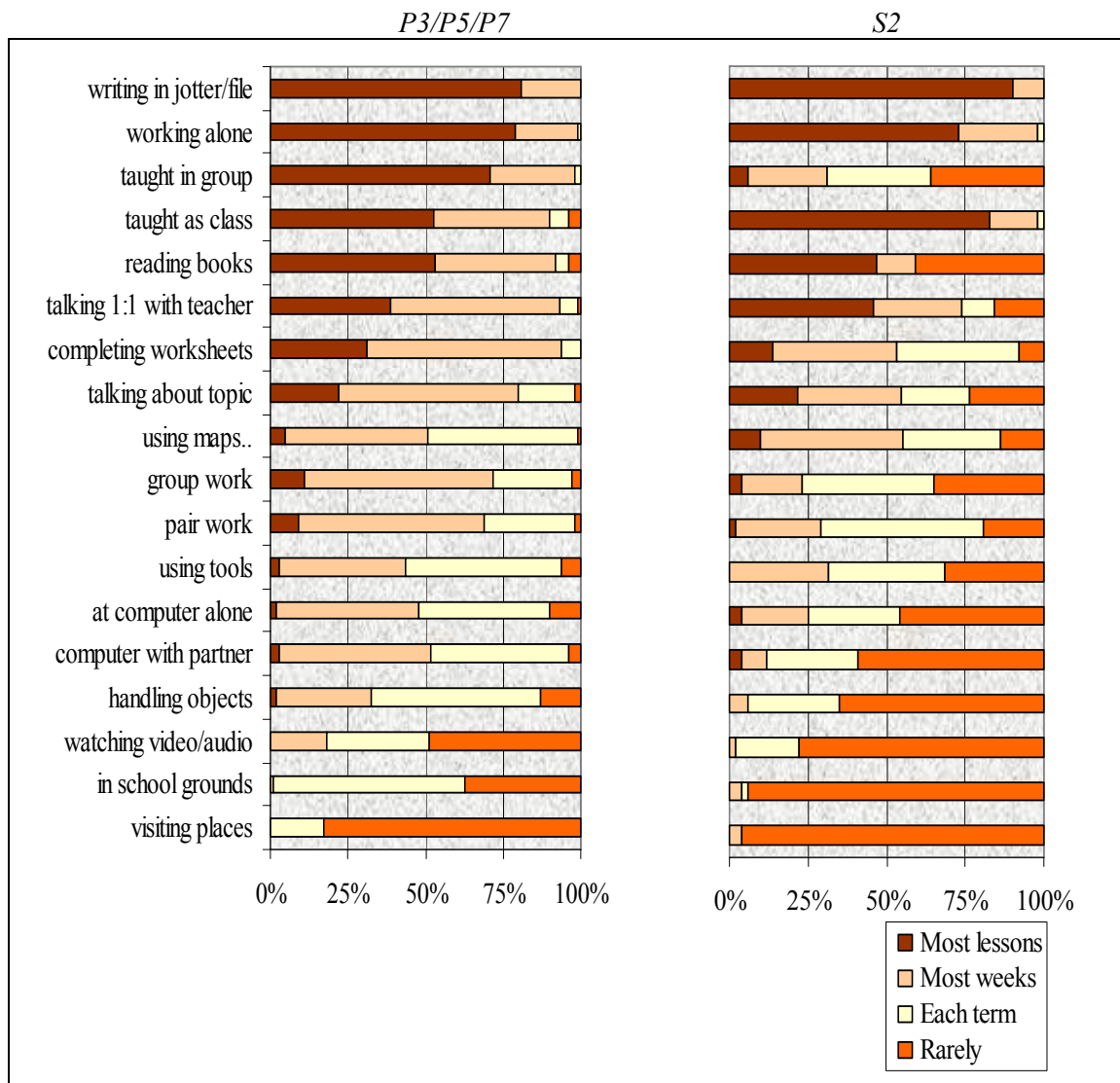
**Table 6.6**  
**How well motivated are your pupils to learn?**  
*(% respondents giving each rating among 233 primary teachers and 60 S2 teachers)*

Stage	Very well	Well	Not very well	Not at all
S2	27	57	12	4
P3/P5/P7	27	71	2	0

**6.3.3 Learning activities in the classroom**

The teachers were asked to rate 18 different learning activities, in terms of how often they estimated that their pupils were engaged in each. The findings are illustrated in Figure 6.1 and detailed in Appendix G.

**Figure 6.1**  
**Frequency of learning activities in lessons**  
*(% teachers indicating each frequency among 233 primary teachers and 60 S2 teachers)*



The teachers' reports on lesson activities closely reflect those of their pupils (see Figure 5.1 in Chapter 5). According to the majority of the teachers in both sectors (83% at S2 and over 55% at P3/P5/P7), pupils are taught as a class for at least some of the time in most lessons. Group teaching, however, was significantly less prevalent at S2 than at P5/P7 (just 6% of the S2 teachers agreeing that pupils were taught as a group in most lessons, compared with over 70% of the primary teachers). At all the stages the majority of pupils spent at least some of the time in most maths lessons writing in their jotters and files (90% at S2 and just over 80% at P5/P7). Pupils also worked in pairs for at least some of the time in most lessons in around 60% of the S2 classes. In the S2 classes the evidence is that pupils more often used tools and instruments in investigations than did their younger peers, and they also used maps, drawings and diagrams more frequently. Use of computers in class was relatively rare in both sectors, but particularly at S2: around a third of the S2 teachers claimed that their pupils 'rarely' used computers in small group work and almost 60% reported the same for pupils working alone on a computer. Mathematics lessons were rarely carried out in the school grounds or outside the school, according to the teachers' responses.

### 6.3.4 Learning resources used in class

The teachers were asked how much use they made of 5-14 guidelines and various support materials in their lessons. The results are shown in Table 6.7, where we can see that among the S2 subject teachers the most frequently used resource was the department's own materials, half of the teachers reporting use of these 'in most lessons'. This compares with around a third of the primary teachers reporting similarly frequent use of their own school's materials, although another 40% used them every week.

**Table 6.7**  
**Resource use in mathematics lessons**

*(% teachers indicating use of each resource: 233 primary teachers and 60 S2 maths teachers)*

<i>Resource:</i>	<i>Stage</i>	<i>Most lessons</i>	<i>Most weeks</i>	<i>Once or twice a term</i>	<i>Once or twice a year</i>
Own school's/department's materials	S2	50	14	5	31
	P3/P5/P7	32	40	15	13
National 5-14 guidelines	S2	33	26	21	20
	P3/P5/P7	49	27	11	12
Own local authority 5-14 guidelines	S2	34	15	20	31
	P3/P5/P7	38	23	20	20
Commercial textbooks/resource packs	S2	35	30	17	17
	P3/P5/P7	23	48	21	8
Self-developed materials	S2	29	32	21	18
	P3/P5/P7	26	39	22	13
Materials produced by another authority	S2	25	6	19	50
	P3/P5/P7	11	27	22	40
Materials produced by a teachers' group	S2	24	12	22	42
	P3/P5/P7	10	29	32	29
Materials produced by another school	S2	25	10	25	40
	P3/P5/P7	16	9	23	52

The national 5-14 guidelines were less frequently used by S2 teachers than by primary teachers, just one-third of the former compared with half of the latter claiming to use these in

most lessons; local authority 5-14 guidelines were used this frequently by 30-40% of the teachers in each group. Commercial textbooks and/or resource packs were used 'in most lessons' by over a third of the S2 teachers and just under half the primary teachers. Over a quarter of the teachers in both groups used materials they had developed themselves in most lessons, with another 30-40% using them most weeks.

Materials produced by a teachers' group or association, by other schools or by another education authority were the least used resources in both sectors.

## 6.4 Summary

The school managers' questionnaire was completed by 245 primary head teachers and 58 secondary mathematics principal teachers (a 65-70% response rate), and the class/subject teachers' questionnaire was completed by 233 primary teachers and 60 S2 mathematics teachers (a response rate of around 60% of the schools).

According to the head teachers and principal teachers who responded, just over half the current mathematics programmes in the primary schools had been introduced in 2000 or later, compared with two-thirds of the S2 programmes in the secondary schools. Around 40% of the primary programmes were currently under revision, along with the majority of the programmes at S2. The most popular bases for mathematics programmes in both sectors were the national 5-14 guidelines and commercial textbooks and resource packs. The school's (or department's) own materials featured significantly more often at S2 than in the primary school, with the reverse holding for local authority 5-14 guidelines. This was confirmed in the responses of the class/subject teachers with regard to the resources they used in their mathematics teaching: Other possible resources were used infrequently in either sector.

With regard to methods of reporting pupil progress to parents, almost all the schools in both sectors reported to parents in terms of 5-14 levels, with high proportions also using teachers' own comments. Compared with the situation in the primary sector, pupil progress at S2 was significantly more often reported in terms of test/exam results or marks/grades for effort. In contrast, comment banks were significantly more often used by the primary schools for reporting to parents than by the secondary schools.

When invited to rate the quality of various resources, differences in the rating patterns of primary head teachers and S2 principal teachers reached statistical significance for most aspects. Interestingly, there was no difference in the rating patterns of the two sectors for teachers' in-school access to the internet. Parental support for their children's learning was only moderately well rated in both groups, as was the availability of learning support or enrichment for individual pupils in mathematics. Among the primary head teachers the most positive quality ratings were given to computer and internet access for teachers and for pupils, and for pupil attendance at, and behaviour in, subject classes.

Most respondents in both sectors gave high ratings to teacher expectations of pupil achievement in mathematics. But for pupil motivation to learn and teacher morale, the primary head teachers gave significantly more positive ratings than the S2 principal teachers. When asked how well motivated they thought their pupils were to learn mathematics, just over a quarter of the class/subject teachers in both sectors responded 'very well'.

Class sizes varied very widely in both sectors, with an average of around 24 in the primary schools and 27 at S2. Class contact time was six hours per week on average in the primary schools and four hours at S2. Primary teachers reported their lesson preparation time to be four hours a week on average, whereas among the S2 teachers the weekly average was just two hours. Over half the S2 mathematics teachers indicated that they met with colleagues once a week or more frequently to discuss mathematics education issues, compared with around one-third of the primary class teachers.

According to the majority of the teachers in both sectors, pupils were taught as a class for at least some of the time in most lessons, while group teaching was significantly less prevalent at S2 than in the primary sector. Pupils also spent at least some of the time in most maths lessons writing in their jotters and files, and worked in pairs for at least some of the time in most lessons in the majority of the S2 classes. The evidence from the teachers' responses is that S2 pupils more often used tools and instruments in investigations than did their younger peers, and they also used maps, drawings and diagrams more frequently. Use of computers in class was relatively rare in both sectors, but particularly at S2, and mathematics lessons were rarely carried out in the school grounds or further afield.



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## 7. Summary and issues

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### 7.1 Survey overview

The 2004 AAP Mathematics Survey assessed pupil attainment within the outcomes of *Information Handling, Number, Money & Measurement, Shape, Position & Movement* and *Problem Solving & Enquiry* as detailed in the National Guidelines for Mathematics 5-14<sup>12</sup>. Pupil performance in the core skills of communication (reading and writing) was explored through written tasks, each set within a mathematical context. Skills in using ICT and other core skills were explored through practical assessments. The survey also gathered pupils' views on their learning experiences, through a written questionnaire.

Schools were invited to provide information about the provision and resourcing of mathematics in schools, and to provide teachers' views about the quality of teaching and learning in practice. This information was gathered through questionnaires sent to about half of the schools involved in the survey, seeking responses from both school managers (head teachers of primary schools and principal teachers in secondary schools) and classroom teachers with responsibility for teaching mathematics in each of the P3, P5, P7 and S2 stages included in the survey.

The reported findings are based on the assessment results of pupils from 835 schools out of over 1000 invited to participate. School participation in the primary sector was higher than in the secondary sector, where there was only a 76% participation rate. This is a matter that may have to be strengthened as the Scottish Survey of Achievement (SSA) assumes the main role of providing evidence of pupil progress across the stages within Scottish education.

### 7.2 Mathematics attainment in 2004

Almost 10,000 pupils participated in the written assessment of mathematics, with individual pupils attempting mixed-level booklets of items at two or three adjacent 5-14 levels: P3 at Levels A and B; P5 at Levels B, C and D; P7 at Levels C, D and E; and S2 at Levels D, E and F. For reporting purposes, throughout this section the 'expected level' refers to the broad criteria within the 1991 publication of guidelines for Mathematics 5-14, namely:

- Level A should be attainable in the course of P1-P3 by almost all pupils.
- Level B should be attainable by some pupils in P3 or even earlier, but certainly by most in P4.
- Level C should be attainable in the course of P4-P6 by most pupils.
- Level D should be attainable by some pupils in P5-P6 or even earlier, but certainly by most in P7
- Level E should be attainable by some pupils in P7-S1 but certainly by most in S2

On the basis of assessment results in the survey, pupils achieving 80% or more of the marks were considered as having demonstrated 'considerable strengths' at the level concerned; pupils with at least 65% but fewer than 80% of the marks were considered as being 'secure' at

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<sup>12</sup> *National Guidelines: Mathematics 5-14*, Edinburgh: Scottish Office Education Department, 1991, and *National Guidelines: Mathematics 5-14 Level F*, Edinburgh: Scottish Office Education and Industry Department, 1999.



the level; pupils achieving 50% or more of the marks but less than 65% were considered as having ‘basic skills’ at that level.

### 7.2.1 Pencil and paper written assessments

- Over 95% of the P3 pupils assessed in the survey were estimated to have shown at least basic skills at Level A, just under 90% were ‘secure’ or better at this level and almost 70% showed ‘considerable strengths’. At Level B the corresponding proportions were over 60%, around one-third and just under 10%.
- At P5, 90% of the pupils were estimated to have demonstrated at least ‘basic skills’ at Level B, over 70% were at least ‘secure’ and just over 40% showed ‘considerable strengths’. At Level C the corresponding proportions were 65%, 40% and 15%, respectively, and at Level D just over 25% demonstrated ‘basic skills’, 10% were ‘secure’ or better and 2% showed ‘considerable strengths’.
- At P7, just under 90% of the pupils were estimated to have demonstrated at least ‘basic skills’ at Level C, almost 75% were ‘secure’ and over 40% showed ‘considerable strengths’. At Level D the corresponding proportions were almost 70%, over 45% and over 15%, respectively, and at Level E almost 35% showed ‘basic skills’, almost 20% were ‘secure’ and just over 5% demonstrated ‘considerable strengths’.
- At S2, 80% of the pupils were estimated to have basic skills at Level D, 60% were secure and 30% showed considerable strengths. At Level E the corresponding proportions were just under 60%, almost 40% and just under 20%, respectively, while at Level F the figures were over 15%, over 5% and 2%.

The proportion of pupils demonstrating ‘secure’ knowledge or ‘considerable strengths’ at the expected level for their stage progressively increased from 32% at P3 (Level B) through 40% at P5 (Level C) to 46% at P7 (Level D). At S2, where the expectation is Level E, the proportion of pupils achieving at least ‘secure’ status is only 37%. This is a concerning figure for S2, where as many as 41% are recorded as demonstrating less than ‘basic’ skills and understanding at Level E. This compares with roughly a third of the other stages that fall below ‘basic’ level of attainment for the expected level, achieving fewer than 50% of the available marks at Levels B, C and D.

The survey was administered in May and June, towards the end of the pupils’ year. Given that timeframe, we can see that level B for P3 is potentially challenging, as this level should be attained by *some* pupils in P3 (or earlier), but by most pupils in P4. The AAP survey findings therefore present a positive picture for P3 with only 36% still to achieve this level over the following year. The challenge is to raise the proportion of pupils who can demonstrate the skills and understandings within this level in a ‘secure’ and confident manner, raising expectations for a strong foundation rather than any premature *pushing on* to Level C. It is good to note the very high proportion of pupils who demonstrate ‘considerable strengths’ at Level A whilst finishing P3.

Results for P5 pupils present a similar picture, with only 35% still to demonstrate ‘basic skills’ within Level C. Given there is another full year available for the expected level to be attained by *most* pupils, the current profile presents a positive position for study at Level C.

As with the P3 cohort, it is good to note the consolidation that appears to have taken place with a very high proportion of pupils showing ‘considerable strengths’ and ‘secure’ performance at Level B as they finish P5.

The same cannot be said of the P7 stage. Although the proportion of pupils who were showing ‘considerable strengths’ and ‘secure’ status in the expected level continues the pattern from the earlier stages with a gradual increase across the stages there appears to be a bigger tail failing to meet the basic skill level expected. In P7, most pupils should be attaining Level D, so we might have anticipated a higher proportion demonstrating secure attainment at that level in the survey. A very similar proportion as witnessed in P3 and P5 are currently failing to demonstrate ‘basic skills’ for Level D, but there is not another year of study scheduled for those pupils. If the expected levels are adhered to, then more needs to be made of P6 and P7 to ensure Level D can be attained by most of the pupils. As with the P3 and P5 cohorts, it is good to note the consolidation that appears to have taken place at Level C, with a similarly high proportion of pupils showing ‘secure’ performance or even ‘considerable strengths’ at this level as they finish P7.

A similar picture is in evidence for the S2 stage. The expectation is for Level E to be attained by most pupils in S2. Although the proportion of pupils showing considerable strengths remains stable, the proportion showing secure attainment has noticeably reduced. Only 37% of the survey pupils were demonstrating ‘secure’ status or better at the end of S2 and a higher proportion (41%) were failing to demonstrate the ‘basic skills’ for Level E. This would suggest that in the first two years in secondary school able mathematicians are well catered for. Some pupils, however, are not able to build on their secure attainment at Level D as they work towards the next level; and some of those with only basic skills at Level D find themselves in considerable difficulty as they encounter the greater challenges of Level E work.

Given the limited proportion of S2 pupils who have progressed to secure status or better at Level D, after another two years of study, a question is raised over the underperformance in upper primary and lower secondary stages. Indeed, focusing on the lowest attaining pupils, one-fifth of the S2 pupils failed to demonstrate ‘basic skills’ at Level D, the level below their formal expected level. The pace of learning, and particularly approaches to consolidation of previous learning, rather than ‘pushing on’ to the next level, may both need to be reviewed for S1-S2.

There is no evidence of any real change in pupil performance over time. The last survey of mathematics in 2000 assessed pupils at P4, P7 and S2 so there is only a possibility of comparing performance over time at the P7 stage (Levels C, D & E) and S2 stage (Levels D, E & F). The small sample differences in attainment do not reach statistical significance. There is similarly no evidence in the survey data of any difference in the mathematics attainment of boys and girls.

The evidence from the survey highlights some issues in mathematics attainment in the P7 and S2 stages. The data show relatively low proportions achieving the expected level of attainment within these stages given the pattern of development evident in the earlier stages. Any of these concerns assume the validity of the expected level within the reported findings. One response might be that the expected levels, as determined in 1991, are in need of review. This is not the first AAP mathematics survey to highlight a shortfall in meeting the set levels, so there might be an expectation to review the targets in light of any year-on-year evidence.

It is not, however, an across the board change that is highlighted, but rather a particular issue at the transition stage and early years of secondary provision.

The questionnaire evidence, gathered from a subset of the pupils and staff, highlights some interesting and pertinent points for consideration. Firstly, the majority of pupils at all stages considered mathematics to be important for later learning in other subjects and for future occupations, and they wanted to do well in the subject. Secondly, the majority of the pupils at all stages found mathematics an easy subject, were happy with the pace of work, were rarely left behind, and rarely found it difficult to catch up if they missed a lesson. Thirdly, the questionnaires acknowledged pupils were less positive about looking forward to lessons, with enthusiasm for mathematics learning decreasing with increasing age. These views will present further challenges for staff but it is reassuring to note the high regard and value pupils have for the subject and its importance for future options.

However, if pupils find it easy to catch up having missed a lesson, are rarely left behind and find it all fairly easy, then this suggests scope for higher expectations and greater demands to be made of pupils who are keen to do so well. The evidence of progress at the level *below* the expected level highlights the need to consolidate learning and to maximise the number of pupils who demonstrate a 'secure' understanding or 'considerable strengths' at whatever level is being pursued; as currently witnessed in the P3, P5 and P7 stages. At S2 the survey findings indicate only 60% of the pupils were secure at Level D, with 30% demonstrating considerable strengths. This is well down on the pattern of progress in the other stages.

No comment can be made about S2 pupils' performance at Level C, as that level was not assessed in the survey. It would be interesting to note the level of security and strength demonstrated at Level C as pupils finish their studies in S2 – how far has this progressed from the comparable performance of 40% of P7 pupils showing considerable strengths at Level C? Have the lower levels of study been fully explored and truly understood in preparation for further study as the pupils follow their chosen national qualification courses in later years? It would be reassuring to acknowledge an ever-increasing proportion of pupils demonstrating considerable strengths in the lower level attainment outcomes.

### 7.2.2 Problem solving

The scale of the survey permitted an exploration of pupil performance in the different attainment outcomes, but in terms of averaged percentage item scores because individual pupils only attempted a few items from any one outcome. There was little variation in the performance between the outcomes covering *Information Handling*, *Number*, *Money & Measurement* and *Shape, Position & Movement*, but a marked difference was noted in the problem solving items at all stages and levels in the pencil and paper assessments. It is almost as if the development in problem solving is phased by one stage, with comparable item scores recorded at the later date. Performance in *Problem Solving* at each of P5, P7 and S2 is comparable to the performance in the other attainment outcomes at the expected level for the earlier stage. For example, the average percentage item score at Level C in P5 [53%, 73%, 60%], is close to the *Problem Solving* performance at the same level in P7 [60%]. There is a similar picture for both Level D and Level E in the later stages (see Table 2.7, page 17).

As an attainment outcome, *Problem Solving* is not detailed in the Guidelines by 5-14 level as each of the other outcomes is presented. It is therefore more difficult to be certain of the 'level', other than the fact that the items are more complex and usually involve more than one

step. It is not unsurprising that problem solving performance is lower within each stage, replicating findings from earlier AAP mathematics surveys, but it is interesting to note this later development to an equivalent performance level, reflecting the increasing competence as other attainment outcomes are progressed to a higher level.

*Problem solving* items usually contain more words and may require comprehension and interpretive skills as well as mathematical ones. It is interesting to compare pupils' problem solving performance with performance in 'mathematics literacy' tasks administered by the field officers. At each stage, the data in Tables 2.7 and 2.9 (pages 17 and 19, respectively) illustrate some overlap with comparable 'average percentage item scores' in problem solving and maths literacy.

The lower problem solving performance could be explained by the pupils' restricted ability to interpret data, in combination with readability level and complexity of the tasks concerned. Pupils could benefit from more opportunities to develop literacy within mathematics. All teachers have a responsibility towards literacy within the initial teacher education Standards<sup>13</sup>. Given the overlap between problem solving performance and performance in the maths literacy tasks, further opportunities to consider such contexts will ideally support problem solving and in turn potentially influence pupils' general mathematical attainment.

In comparison with earlier survey data it should be noted that problem solving has not improved over time. The average percentage item scores at the expected levels for P7 and S2 in the 2000 survey were each 49%. The survey data for the same stages in this survey at Levels D and E are 47% and 41%, respectively. The survey data confirms that problem solving is an area of mathematics that continues to need attention, particularly at the S2 stage.

### 7.2.3 Mental mathematics

There is a clear picture of difference between recorded performance on the 'pencil and paper' items and those items presented to pupils orally. Average item scores were generally 10-15 percentage points higher for the mental testing at each level (the small numbers of mental items attempted at each level by individual pupils preclude the reporting of percentages of pupils attaining levels). This is a very encouraging finding given the recent emphasis that has been placed on mental calculation strategies and mental approaches to mathematics.

The picture of performance is very similar to that reported in 2000 for the expected levels at P7 and S2. In the 2000 AAP Mathematics survey it was noted that changes in classroom practice, such as the increased attention to mental approaches, might influence attainment in both mental calculation and possibly other areas of mathematics<sup>14</sup>. This increased performance in mental mathematics has not as yet significantly affected other aspects of mathematics, as suggested in the 2000 survey report. However, the picture of attainment in mental mathematics is a positive one.

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<sup>13</sup> The Standard for Initial Teacher Education (SITE), Scottish Executive Education Department, October 2000; The Standard for Full Registration (SFR), GTC Scotland, February 2002; and The Standard for Chartered Teacher (SCT), GTC Scotland, June 2003.

<sup>14</sup> *Assessment of Achievement Programme: Sixth Survey of Mathematics 2000, Findings and Issues*. Scottish Executive Education Department, 2000.

### 7.2.4 Practical mathematics

Four resource-based practical mathematics tasks were newly developed for this survey. Each task comprised a series of questions and activities, progressively moving from Level A to Level E, each designed to be completed in an interactive session with a field officer. This component of the survey provided a more in-depth exploration of particular topics. On this occasion, we have data on ‘money’, ‘time and measure’, ‘fractions, percentages and ratio’ and ‘shape, angle and direction’.

Focusing on ‘fractions, percentages and ratio’ through this practical sequence of tasks was potentially the most interesting, because of the historic weaknesses that have been reported through AAP surveys on this aspect of mathematics. The inclusion of ‘angle and direction’ provided an insight into the ‘Position and Movement’ strand of *Shape, Position & Movement*, where *turtle graphics* are located.

- Success rates were generally higher at P7 and S2 than at P5, and higher at P5 than at P3, and success rates naturally fell as the level of the activity demand increased.

#### *Money, Time and Measure*

- At P5, P7 and S2, 90% or more of the pupils successfully carried out the various activities involving money. Performance was lower at P3, particularly when pupils were required to calculate and deliver change rather than simply to offer coins up to a given price. Discount problems were handled well by half to three-quarters of the S2 pupils.

High proportions of pupils were competent in all the money handling activities at Levels A to D. The exception to this rested with subtraction and calculating change. The context might well have assisted the completion, but the task that threw up anomalies was fairly straightforward: *Calculate change for £3.75 from £5*. More than half the P5 pupils were unable to do this with minimal support and nearly a third of P7 pupils were unable to complete this task. Surprisingly, a similar calculation requiring the *change for £17.99 from £20* was more successfully completed, with over 50% of the P5 pupils and over 70% of the P7 pupils coping with minimal support. This may have as much to do with the emphasis placed on mental calculation discussed earlier than anything to do with the numbers themselves.

The other items that presented difficulty link in with percentage calculations:

*‘Find 50% of £120’*

*‘Find 25% of £22’*

Only half of the P7 pupils managed to find the first of these items and this reduced to a third who managed the second. The corresponding figures for the S2 pupils are 77% and 53%, respectively. Halves and quarters are not ‘new’ to the pupils, but percentages are only mentioned for the first time in Level D, the expected level for most of P7.

The picture of performance on time and measure was very positive at P7 and S2. The one difficulty that seems to be highlighted concerned the setting of an analogue display. The tasks of setting the analogue display to: “twenty five to one”, “6:42” and “13:05” given digital displays, resulted in a decreasing proportion of P5 pupils responding correctly. The targets in the ‘Time’ strand of *Number, Money & Measurement* offer examples of what might be expected, but they are limited in nature. One possible reason behind such a poor response may be the level of interpretation being made within the Guidelines, where there is scope to

be more inventive and extensive in challenging pupils to demonstrate ‘secure’ knowledge or indeed ‘considerable strengths’ rather than settling for a ‘basic’ level of understanding. The interpretation required in this strand is perhaps more obvious than elsewhere but the same principle of ensuring appropriate challenge to the pupils holds, as expressed in the section commenting on pencil and paper written assessments.

### *Fractions, Percentages and Ratio*

- The fractions/percentages task revealed a steady attainment progression through the four stages, with particularly marked attainment gaps between P5 and P7 at Level D (percentages) and between P7 and S2 at Level E (ratio).

The proportion of pupils correctly responding to the tasks in this topic was generally lower than in the other practical activities. The majority of pupils in P7 and S2 pupils were familiar with halves and quarters and could ‘work with’ these fractions successfully. But when the actual tasks reported in Chapter 3 are looked at, it is interesting to note that difficulties begin to appear in reasonably straightforward situations. Particular tasks that caused difficulties included work with basic fractions (fifths, eighths, three-quarters), standard percentages (20%, 50%), as well as compound percentages that might involve multiple steps (15%, 60%), all presenting increasing difficulties, even for the upper stages in the survey. The major concerns lie within the performance from the P7 and S2 stages, where more might certainly be expected in handling such calculations. The interrelationships between fractions and percentages (and decimals) need to be strengthened through multiple-exposure to practical activities – interestingly, the use of ‘square grids’ as opposed to ‘cubes’ presented varied responses and difficulties, as illustrated in Table 3.3 (page 28).

### *Shape, Angle and Direction*

- A variety of activities involving naming and drawing shapes and angles again revealed clear evidence of stage progression. Turtle programming was successfully achieved by 20-30% of the P3 pupils, 45-60% of the P5 pupils and 70% or more of the pupils at P7 and S2. Similar proportions of pupils at the different stages were successfully able to use a compass to identify direction.

One glaring discrepancy in this set of tasks came into Level C, where pupils were asked to “count the angles on the triangular prism” – not an unsurprising difficulty, given it is a rather unlikely and unusual activity for pupils to consider the number of angles in a 3D shape. Another cluster of tasks that highlighted a potential concern, focused on the 90-degree angle. A lot of emphasis is placed on this particular angle in the development of the angle strand at Level C, yet only 43% of the P5 pupils were able to correctly identify a 90-degree angle. A similarly low proportion of P5 pupils were correctly able to provide an alternative name for the angle (right-angle), or to identify and name an angle less than 90 degrees (acute). The proportion of P7 and S2 pupils able to do these tasks improved across the stages but the fact that the Level C task presented such difficulty for the P5 group remains a matter of concern.

### 7.3 Core skills attainment in 2004

The core skills of reading, writing and using ICT were assessed within a mathematics context in the 2004 survey.

#### 7.3.1 Reading

The reading attainment of more than 5000 pupils in almost 800 schools was assessed using multi-item tasks based on texts set in mathematics contexts (e.g. featuring famous mathematicians). No prior mathematical knowledge was needed in order to show evidence of reading comprehension.

- Over 65% of the P3 pupils were estimated to be ‘secure’ or better at Level A (i.e. gaining at least 65% of the marks on their Level A task) and over half were also secure at Level B; over 80% of the P5 pupils were estimated to be secure at Level B and over half were also secure at Level C.
- Between P7 and S2 there is similarly clear evidence of continued stage progression, particularly at Levels D and E. At P7, 80% of the pupils were estimated to be secure at Level C, 60% at Level D and just over 15% at Level E. Corresponding proportions for S2 are 85%, just under 75% and just under 30%.
- There were significant gender differences in reading attainment at P3, P7 and S2, the girls generally outperforming the boys, and with strong evidence of topic effects.

A comparison with core skills reading in social subjects and science surveys (2002 and 2003 respectively) can be made, although any conclusions must be tentative because of statistical errors which may be high when task to task variation is properly taken into account. However the data suggest that, in comparison with previous surveys, where core skills in reading were assessed, pupils’ performance has been stable across surveys for P3 at Level B. Slight improvement is noted, from that observed in the 2003 Science survey<sup>15</sup>, for the P5 pupils at Levels B and C. For P7 pupils, slight improvements from the science survey at Levels C and D are reported, but for S2 a more mixed profile is observed with an improvement at Level D but a slight decline at Level E compared with the surveys in social subjects<sup>16</sup> and science (2002 and 2003 respectively).

#### 7.3.2 Writing

Pupils attempting reading tasks were also invited to produce a piece of writing, with the reading task content as stimulus material. In total, over 3000 pieces of writing were evaluated using a ‘best fit’ scheme, the scripts having been drawn at random from a larger set. Three independent teacher-raters evaluated each script, with around 80% of the scripts classified in the same way by at least two raters. This process represents a significant improvement on previous surveys where results were based on single evaluators and as such has provided

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<sup>15</sup> Assessment of Achievement Programme. *Sixth Survey of Science 2003*, Chapter 4. Edinburgh: Scottish Executive Education Department, 2005.

<sup>16</sup> *Report on the First Survey of Social Subjects (2002)*. Chapter 4. Scottish Executive Education Department, 2004

more reliable data. There was an expected stage progression evident in the resulting attainment decisions:

- The proportions of scripts judged to be at Level B or higher rose from almost 40% at P3 through around 75% at P5 and just over 85% at P7 to over 90% at S2. Around a quarter of the S2 pupils were judged to be at Level D and just fewer than 10% at Level E.
- There were significant gender differences in writing quality at all stages, with the girls tending to produce the better writing.

Minimal change has been noted over time in the core skill of writing. An improvement at P5 in Level B is noted; where figures of 57% and 56% were reported in the Science and Social Subjects surveys, but the three surveys all report a similar experience in S2 – not an encouraging situation with less than 10% of the cohort meeting the expected Level E over the period 2002-2004 in subject-based writing.

### 7.3.3 ICT skills

Over 1300 pupils in over 340 schools participated in the assessment of ICT skills: 250-400 pupils per stage. Pupils undertook their tasks individually, using a laptop computer supplied by an observing field officer. The findings show clear evidence of age-related progression, with the majority of P7 and S2 pupils competent in most aspects.

- High proportions of the pupils at all stages (typically 90%+) claimed familiarity with use of keyboard and mouse. Familiarity was also high for P7 and S2 with respect to the operating system (PC/Windows) used for the assessments, but markedly lower at P5 and P3.
- High proportions of P7 and S2 pupils were also familiar with Word, proportions dropping to a third for P3 pupils
- Familiarity with Excel was much lower, from over half the S2 pupils to almost none of those at P3.
- The majority of pupils at P7 and S2 were competent when using the technology (opening a folder, scrolling a file, saving text under a new name, etc), the proportions being lower for P5 and lower still for P3, with variation depending on the specific task.
- Text handling and graphic manipulation ('creating and presenting') were also well done in general by most pupils at P7 and S2. Justifying text, creating two or more columns of text, bulleting and wrapping text were the most challenging tasks.
- Table handling ('collecting and analysing') proved more difficult than text handling and graphic manipulation in general, but again there was very clear evidence of skills development with age.



The use of a spreadsheet is an explicit target from Level D onwards, so the fact that spreadsheets were less well developed is a matter of concern. Indeed, there is not much of a progression across the stages as can be seen from the specific tasks reported in Table 4.17 (page 46).

The ability to interpret a chart is stronger than the other aspects assessed. This is probably not to do with the use of ICT *per se*, but more a consequence of this type of activity being explored through conventional texts and other resources.

The quality of resources and availability of ICT is high, but this does not appear to have had a direct impact on pupils' opportunities or performance in using spreadsheets.

When invited to rate the quality of various resources, differences in the rating patterns of primary head teachers and S2 principal teachers frequently reached statistical significance, with primary head teachers being the more positive. School managers certainly report a positive picture of ICT resources (internet and computer access) being available for staff, with 90% of primary teachers and nearly 70% of secondary teachers having 'Good' or 'Very good' quality of provision. Pupil access is less favourable, according to their questionnaire responses, but nearly 80% of primary pupils and over 60% of secondary pupils are nevertheless well placed to access ICT resources in their learning.

Comparing this provision of ICT with actual use, as reported by class teachers and pupils, it is evident that pupils rarely work at the computer on their own or with a partner. In S2 this accounts for 50-60% of the pupils, with a further 30% gaining termly access. For the primary stages, the picture is slightly stronger with about 50% of the pupils having weekly access and a further 40-45% having termly access. It must be assumed that specific mathematical development using spreadsheets does not feature highly in the time devoted to ICT.

It was interesting to note the way pupils' responses did not seem to be adversely affected by the fact they completed the tasks on a PC base when they were used to working on a Macintosh system. One of the most frequent criticisms from field officers was the fact that pupils were often using unfamiliar equipment and software. This highlights the pupils' ability to be very adaptable when it comes to technology, with a brief laptop familiarisation being sufficient introduction before successfully completing the various tasks. Home resources will also play a part in this confident use of ICT, with 65-80% of the pupils reporting computer access at home.

Given such familiarity and confidence in the pupils' use of ICT, staff could exploit the wealth of ICT resources to greater effect. The survey reports up to 74% of the S2 pupils not usually or never having access to a computer to do their work during mathematics lessons. Slightly fewer pupils in P7 and P5 registered such limitations, with 67% and 70%, respectively, falling into the same category. There are likely to be staff development issues here in raising staff confidence to use the available technology to best effect. Recent research has indicated that many teachers lack the confidence to take the risk of using technology in their subject areas, although they have reasonable facilities at school and they use computers at home. As staff use increases, it might be reasonable to expect this will filter through to enhance pupils' opportunity to access ICT.

As pointed out in Insight 20 (2005)<sup>17</sup>, reporting on the impact of ICT in Scottish schools, availability of hardware and software is not of itself enough to progress the use of technology in classrooms. There is a lot more to integrating ICT into the educational experience of pupils than ensuring there are networked machines and that the recommended ratio of computers to pupils is met. Staff development is a high priority in this core skill, making high demands on time – time for staff to learn new skills, to find out about resources and technologies, to plan and try out new approaches to teaching and learning, and to reflect upon and consolidate their experiences. It is unlikely that the ICT initiatives can be sustained through individual enthusiasts alone. The profession needs to move forward together, in a suitably supported manner to ensure that pupils experience a level of ICT they are becoming accustomed to in other areas, in particular the home environment that for many is of a higher quality than that currently experienced in schools. The use of word processing packages is currently good, but there is scope for further development of spreadsheets within the mathematics activities. There was no indication in the performance data of any difference in the ICT skills of boys and girls.

#### 7.4 Key issues for consideration

The findings from the survey highlight a number of issues relevant to future developments in learning and teaching mathematics in primary and lower secondary school. There are clearly positive messages to be taken from this survey but it also raises issues for staff development and review of provision within the 5-14 stages.

- The current review of the curriculum could usefully reconsider levels and expectations, based on experiences over multiple AAP surveys and other evidence that might guide such a review, so that realistic expectations are made of pupils at each of the key stages. The reference group acknowledged the need to strive for ‘secure’ knowledge and ‘considerable strengths’, favouring depth of treatment in the earlier stages over any pushing on prematurely. This calls for teachers at all stages to interpret the 5-14 guidelines in the fullest way to challenge the pupils in their care.
- The pace of pupils’ learning needs to be reviewed and consolidation of study is required to ensure that ‘secure’ knowledge and understanding or ‘considerable strengths’ can be demonstrated across the different attainment outcomes at each stage.
- Pupils’ enthusiasm for mathematics learning decreases with increasing age, yet the majority of pupils across all stages considered mathematics to be important and they wanted to do well.
- Problem solving is an area that continues to need attention, particularly at the S2 stage.
- The picture of attainment in mental mathematics is a positive one, although this has not as yet significantly affected other aspects of mathematics as suggested in the report on the 2000 AAP mathematics survey.
- There are significant gender differences in reading attainment and in the quality of writing across most stages, with girls tending to outperform boys.

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<sup>17</sup> Insight 20 - The impact of Information Communication Technology in Scottish Schools: Phase 3, Scottish Executive Education Department, September 2005.

- Core skills of reading and writing are the only aspects that have shown a gender difference in favour of girls. As all teachers have a responsibility to promote literacy, perhaps the model explored in the core skills part of this survey could be pursued more widely in mathematics classrooms. Books ‘about mathematics’ are not widely accessed by pupils, or strongly identified as a positive motivator, but they could provide a link with literacy, something that is currently missing. Such activity might close the gender gap through more regular exposure to mathematical texts with the opportunity to write about them within a supported framework. Pupils have not reported a lot of interesting topics or investigations in their study of mathematics and it is clear that problem solving continues to be a matter for concern. It is worth considering what scope there is for broadening pupils’ experiences within the level of study, embracing more problem solving, mathematical literacy tasks and generally consolidating knowledge, skills and understanding to gain secure status and considerable strengths in preference to any premature acceleration, that may be a factor in the declining standards evidenced in the S2 profiles.
- Mathematics literacy tasks provide contexts that potentially support problem solving and in turn pupils’ general mathematical attainment.
- High quality ICT provision is under-utilised. Class teachers and pupils report limited use of ICT in mathematics classes yet home access is good, suggesting scope for fuller use within subject teaching. Use of spreadsheets seems to be particularly limited.
- Pupils’ appreciation of the importance of mathematics and their enthusiasm for learning needs to be capitalised upon to ensure they remain motivated as they move through the stages. Given the high quality of ICT reported as being in schools, it is important to fully utilise these resources with pupils in the classroom. Pupils appear to be confident in their use of ICT, increasingly gaining access at home, so it clearly makes sense to capitalise on this ever-expanding learning resource in a more formal capacity.
- There is scope for more inventive and extensive interpretation of the guidelines when it comes to reviewing ‘examples’ within any strand e.g. Time, Fractions & Percentages. The aim should be for ‘secure’ knowledge and understanding or ‘considerable strengths’ to be demonstrated within strands and attainment outcomes.
- Staff development opportunities will need to be supported – an aspect that appears to be worthy of support is an unpacking of what ‘consolidation’ might entail to ensure staff are comfortable with their interpretation of the guidelines, going beyond the stated targets but working within the level of study and resisting the temptation to accelerate towards the higher levels. Another staff development opportunity would be within the ICT domain, providing support for staff to extend their personal knowledge (subject and pedagogical) and confidence with their use of ICT to maximise the classroom use of the resources that are now reported to be in schools.

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# Appendix A: The Survey Design Team and the Mathematics Reference Group

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## The Survey Design Team

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## Appendix B: Sampling, task distribution and attainment estimation

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### B.1 School and pupil sampling

The 2004 mathematics survey was designed to assess the mathematics and core skills attainment pupils at P3, P5, P7 and S2 in mainstream schools in Scotland – including educational authority, self-governing, grant-aided and independent schools. Special schools and Gaelic Medium schools were excluded from the sampling frame.

Representative pupil samples were selected for testing using two-stage proportionate stratified sampling, with an overall sampling fraction of 4-5% of the pupil population at each stage. Separate school samples were drawn for the four pupil stages. Before school sampling began, the population of schools was first stratified by education authority grouping, roll size and percentage free school meals entitlement. The 32 education authorities were classified into four groups for this purpose (maintained schools only), based on their general population densities (see Table B.1). In addition, maintained schools were grouped into two size bands (primary schools: under 280 pupils on roll, and 280 or more on roll; secondary schools: under 150 S2 pupils on roll, and 150 or more S2 pupils on roll) and two bands for free school meals entitlement (primary schools: <10%, and 10% or more; secondary schools: <15%, and 15% or more). School size and free school meals entitlement classifications were based on the most recent school census data available at the time, *viz.* census data at September 2002 and at January 2003, respectively. Independent schools formed a separate national stratum.

**Table B.1**  
**Education authority groupings**  
*(Based on general population density)*

<i>Group 1</i>	<i>Group 2</i>	<i>Group 3</i>	<i>Group 4</i>
Aberdeen City	East Dunbartonshire	Clackmannanshire	Aberdeenshire
Dundee City	East Renfrewshire	East Ayrshire	Angus
Edinburgh City	Falkirk	East Lothian	Argyll & Bute
Glasgow City	Inverclyde	Fife	Dumfries & Galloway
	North Lanarkshire	Midlothian	Eilean Siar
	Renfrewshire	North Ayrshire	Highland
	West Dunbartonshire	South Ayrshire	Moray
	West Lothian	South Lanarkshire	Orkney Islands
			Perth & Kinross
			Scottish Borders
			Shetland Islands
			Stirling

Schools were selected from within strata, without replacement, with probability proportional to stage size. At each stage, between 200 and 300 schools were selected and invited to participate in the survey. Of these, at each primary stage around 90% of the invited schools agreed to participate, with 80% of the secondary schools agreeing for S2 (see Table B.2).

The sample pupils were selected in a second stage of sampling, from within those schools that had agreed to participate. Wherever possible, i.e. in those schools with sufficient numbers of pupils available in the stage concerned, 22 pupils were randomly selected within each primary – 10 for involvement in the assessment of mathematics, six (at P3 and P5) or nine (at P7) for involvement in the assessment of reading and writing, and six (or three) reserve pupils, to act as substitutes for pupils absent on the assessment days. In very small schools mathematics assessment took priority over the assessment of reading and writing. In other words, where schools had fewer than 16 pupils available in the relevant stage, 10 would do mathematics assessments and the remainder would take reading tasks and produce writing. Where schools had 10 or fewer pupils available at the relevant stage all of these would take mathematics assessments and none would be subject to the assessment of reading and writing. There were thus some primary schools in the survey sample that would take part in mathematics assessment only. In secondary schools 32 S2 pupils were randomly selected, 20 for mathematics assessment, nine for reading/writing assessment, and three reserves. Again, where schools had fewer than 20 pupils in their samples then there would be no reading/writing assessment.

**Table B.2**  
**School participation in the written assessments**

	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Schools invited to participate	248	247	298	210
Schools agreeing to participate	222	230	265	166
Schools returning completed test booklets	212	221	243	159
<i>% participation rate for mathematics</i>	<i>85</i>	<i>89</i>	<i>82</i>	<i>76</i>
Schools eligible for reading/writing assessment	208	216	255	164
Schools returning completed test booklets	197	206	234	157
<i>% participation rate for reading/writing among eligible agreeing schools</i>	<i>95</i>	<i>95</i>	<i>92</i>	<i>96</i>

Where pupils with special educational needs were selected in school samples, these were included in the test sessions at the head teacher's discretion. Pupils who were not withdrawn for any reason but were absent on the day of testing were replaced with 'reserve' pupils.

In a subset of the schools the 'mathematics' pupils also took part in the assessment of practical skills, while the 'reading/writing' pupils took part in the assessment of ICT skills or other practical activities. Although the 'practical' schools were drawn from across the country, they were not selected entirely at random: two important criteria for involvement were (i) that the school should have sufficient pupils at the stage concerned to justify a day visit by two field officers, and (ii) that it should be within easy travelling distance of the field officers' home bases. In the event, just over 45% of the schools that participated in the survey were involved in the practical assessments (see Table B.3).

**Table B.3**  
**School participation in the practical assessments**

	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Mathematics practical tasks	86	100	113	74
Mathematics literacy tasks (written assessment)	89	99	116	79
ICT tasks	83	88	102	62

## B.2 Task distribution

### Mathematics

In order to assess pupils' mathematics knowledge and skills, and to report attainment in terms of the 5-14 levels, 1504 different level-specific test items were administered in this survey: 1120 in written mode and 384 delivered orally by class/subject teachers. The 'written' items were drawn from all four mathematics outcomes – *Information Handling, Number, Money & Measurement, Shape, Position & Movement* and *Problem Solving & Enquiry*; 84-100 items at each of Levels C, D and E had been used in the 2000 survey at P7 and S2, and formed the basis for an attainment comparison between 2000 and 2004. All the 'mental' items related to *Number, Money & Measurement*. Table B.4 shows how the items distributed across the 5-14 mathematics framework.

**Table B.4**  
**Distribution of the 1504 test items**  
**over outcomes, strands and levels**

<b>'Pencil and paper' items</b>	<i>Level</i>					
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
<i>Outcome/strand</i>						
<i>Number, Money &amp; measurement:</i>	40	60	60	60	80	80
- Add & subtract	10	15	10	10	10	10
- Multiply & divide		15	10	10	10	10
- Fractions, % & ratio			10	10	10	10
- Functions & equations/algebra					20	20
- Other strands	30	30	30	30	30	30
<i>Information handling:</i>	40	40	40	40	40	60
- Interpreting information	25	25	25	25	25	25
- Probability						20
- Other strands	15	15	15	15	15	15
<i>Shape, Position &amp; Movement: All strands</i>	40	40	40	40	40	40
<i>Problem Solving &amp; Enquiry: Problem solving</i>	40	40	40	40	40	40
<i>Total number of written items</i>	<b>160</b>	<b>180</b>	<b>180</b>	<b>180</b>	<b>200</b>	<b>220</b>
<b>'Mental' items</b>						
<i>Number, Money &amp; measurement:</i>						
- Add & subtract	37	21	20	15	15	9
- Multiply & divide		22	16	15	15	12
- Fractions, % & ratio		3	6	7	9	15
- Other strands	27	18	22	27	25	28
<i>Total number of mental items</i>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>

A multiple matrix sampling strategy was adopted for distribution of items to pupils, in that the items were distributed among several different and unique test booklets, each with the same general composition, and booklets were randomly allocated to pupils.

There were 20 different written test booklets in total at each stage, comprising 17 items at P3 (8 Level A items and 9 Level B items), 27 at P5 (9 items at each of Levels B, C and D), 28 at P7 (9 items at each of Levels C and D and 10 items at Level E), and 30 at S2 (9 items at Level D, 10 at Level E and 11 at Level F). These booklet lengths are all within those proposed by the Mathematics Reference Group as appropriate at the different stages, assuming testing times of 30-40 minutes at P3, 40-50 minutes at P5, and 50-60 minutes at P7/S2.



The order of presentation of items within a booklet was randomised, so that pupils did not face a string of items at the same level or from the same outcome, and booklets were produced in two versions, the second version simply reversing the order of item presentation. Booklets at the different stages overlapped, in the sense that the items at a particular level in one stage booklet were carried across to represent that level in a booklet at the next stage.

The 384 mental test items were distributed among 16 different mental tests at each stage. At P3, tests were eight items long, with four items representing each of Levels A and B. At the other stages tests were 12 items long, with four items from each of three consecutive levels (Levels B, C and D at P5, Levels C, D and E at P7 and Levels D, E and F at S2). An answer page was included at the front of every written test booklet for pupils to use when responding to their mental test.

Test booklets were randomly assigned to survey pupils, two different booklets per pupil, before being despatched to participating schools. In any one school different pupils were allocated different written test booklets (see Table B.5 for the allocation scheme). In this way, all the booklets were distributed across the maximum number of survey schools, thus minimising any possible school effect on the attainment results: within a primary school just one pupil would attempt any particular booklet, whilst in secondary schools two pupils at most would do so.

**Table B.5**  
**The distribution scheme for allocating written test booklets to pupils**

<i>Block*</i>	<i>Booklet pair</i>	<i>Booklet 1</i>	<i>Booklet 2</i>
I	1	1	20
I	2	2	19
I	3	3	18
I	4	4	17
I	5	5	16
I	6	6	15
I	7	7	14
I	8	8	13
I	9	9	12
I	10	10	11
II	1	11	1
II	2	12	2
II	3	13	3
II	4	14	4
II	5	15	5
II	6	16	6
II	7	17	7
II	8	18	8
II	9	19	9
II	10	20	10

*\* Primary schools were sent up to 10 of the booklet combinations in either Block I or Block II, while secondary schools were sent all booklet combinations in both blocks.*

Since mental testing requires oral delivery of items, it would clearly not be feasible to expect teachers to deliver numerous different mental tests to their pupils. Every school was, therefore, randomly allocated two different mental tests, each to be delivered to the whole pupil group before the pupils embarked on their individualised written test booklets.

The written and mental assessment sessions were organised by the schools themselves, within the period mid-May to mid-June, with teachers in the schools delivering the mental tests and supervising the written testing. Completed scripts were returned to SQA for marking.

The 15 multi-item maths literacy tasks, three per level for Levels A to E, were administered by the itinerant field officers responsible for the practical assessments in mathematics, to a subsample of the pupils in the subsample of 'practical' schools at each stage. At P3 pupils attempted tasks at Levels A and B, at P5 at Levels B and C, at P7 at Levels C and D, and at S2 Levels D and E.

Arrangements for the mathematics practical tasks are described below.

#### *Reading and writing*

There were 15 reading tasks in total, three at each of Levels A to E. Each task comprised a text and associated test questions, and was expected to take the same time to complete as a mathematics booklet at the stage concerned. At all levels writing tasks were devised that were loosely linked to the reading tasks: each writing task focused on the same source material as one of the reading tasks, but the source material was not required reading for the purpose of producing an appropriate piece of writing. P3 pupils were assessed at Levels A and B, P5 pupils at Levels B and C, and P7 and S2 pupils at Levels C, D and E.

Again, a multiple matrix sampling scheme was employed to allocate tasks to pupils. At each stage a number of different task pairings were created (six at P3/P5 and nine at P7/S2), each pair comprising tasks from two different levels. Task pairs were then randomly allocated to the pupils in each school that had agreed to participate in the survey and that had pupils available for reading assessment. In this way every task would have been attempted by similar numbers of pupils across the survey, in similarly representative subsamples, and no more than two pupils would attempt the same task in any particular school.

#### *Practical mathematics skills and ICT skills*

Four practical mathematics tasks were administered in the survey, along with six ICT tasks. The pupils who undertook mathematics practical tasks were drawn from those included in the written mathematics assessment in the 'practical' schools, whereas those pupils who attempted ICT tasks were drawn from among those involved in the assessment of reading and writing in these same schools. Within these groups, tasks were allocated to pupils at random.

In the majority of the schools that participated in assessment in this area, four pupils were assessed for their mathematics practical skills and a further four for ICT skills.

### **B.3 Achieved pupil sample sizes**

Almost 15500 pupils were assessed in the survey, around two-thirds of them in mathematics and one-third in reading and writing. A subsample of around 15% of the 'mathematics' pupils attempted practical mathematics tasks and/or mathematical literacy tasks, while a

subsample of around a quarter of the reading/writing pupils also attempted ICT tasks. Table B.6 provides details of the final analysis samples.

**Table B.6**  
**Pupil numbers involved in analysis**  
*(rates of pupil substitution in brackets)*

	<i>P3</i>	<i>P5</i>	<i>P7</i>	<i>S2</i>
Mathematics	2047 (10)	2106 (10)	2345 (7)	2969 (8)
Mental mathematics	2041 (10)	2106 (10)	2326 (7)	2964 (8)
Reading	1135 (12)	1166 (9)	1931 (7)	1273 (7)
Writing*	885 (11)	523 (8)	899 (8)	803 (7)
<i>Practical sessions:</i>				
Maths Literacy (within practical sessions)	923 (12)	1045 (12)	1215 (<1)	835 (<1)
Mathematics practical	343 (9)	393 (8)	444 (<1)	285 (<1)
ICT	326 (8)	340 (8)	394 (1)	260 (<1)

\* These were scripts randomly sampled for evaluation from the larger numbers submitted.

In total, over 9900 pupils were involved in the written and mental mathematics assessment, drawn from the 835 participating schools. Just under 9% of the pupils were ‘reserve’ pupils, substituted on the day for pupils who had left the school since the pupil sample was drawn, or who were simply absent on the day of testing. Just over 4000 pupils attempted a mathematics literacy task; 12% of these pupils were substituted reserve pupils at P3 and P5, with fewer than 1% in this category at P7 and S2.

Typically, each mathematics test booklet, and hence every ‘pencil and paper’ test item, was attempted by 200-250 pupils at P3, P5 and P7 and 250-300 pupils at S2. The mental tests were each attempted by 250-300 pupils at the primary stages and 350-400 pupils at S2. Each mathematics literacy task was attempted by 150-200 pupils, the numbers varying by stage.

In total, reading assessment data were analysed for 5505 pupils and writing assessment data were analysed for a total of 3110 pupils (the writing produced by these pupils having been randomly selected for evaluation from all of that submitted). Again just under 9% of the pupils were substitute pupils. Individual reading tasks were attempted by over 350 pupils at P3/P5, over 400 at P7 and over 250 at S2.

Performance data were analysed for a total of almost 1500 pupils for mathematics practical skills and over 1300 for ICT skills; substitution of ‘reserve’ pupils was as high at P3 and P5 as in the written assessments, but there were virtually no substitutions at P7 and S2. The number of pupils who undertook any particular task varied from stage to stage: 150-200 pupils per stage for maths literacy, and 70-100 for maths practical tasks and ICT.

#### **B.4 Attainment estimation**

In mathematics and reading total scores were first computed for pupils, for each of their level-based ‘tests’. In mathematics these ‘tests’ comprised those items at the same level across the two test booklets that a pupil attempted: 16 items at Level A, 18 items at each of Levels B to D, 20 items at Level E and 22 items at Level F. In reading, the level-based tests were the tasks themselves: comprising 21 items at Level A, 24 items at each of Levels B and C, 27 items at Level D and 30 items at Level E.

Cut-off scores were then applied, and pupils classified into one or other of three attainment groups on the basis of these: 'basic skills', 'secure attainment' or 'considerable strengths'<sup>18</sup>. The proportions of pupils classified into the three groups at relevant levels were calculated separately for every booklet pair in mathematics, and for every reading task, with the attainment data weighted appropriately to adjust for imbalances in sample representation caused by the non-participation of some schools. The resulting proportions were then simply averaged over pairs of mathematics booklets (20 pairs per stage) or reading tasks (three per level) to produce the population attainment estimates reported in Chapters 2 and 4, respectively.

Margins of error for the attainment estimates arising from a single booklet pair in mathematics would be a maximum of around six to seven percentage points, reducing to a maximum of around one and a half percentage points for the final averaged population estimates at a level. Margins of error for the attainment estimates deriving from a single reading task would be a maximum of five to six percentage points, reducing to a maximum of one and a half to three and a half percentage points for the final population estimates at a level. It should be noted that these figures cannot take account of any measurement error that will have arisen from the possible incorrect classification of individual pupils, for some of whom the decisions made might have been different had the pupils concerned been assessed on a different day or on the same day with a different reading task or pair of mathematics booklets (test reliabilities – alpha values – are typically in the range 0.7-0.9 for each mathematics 'test', and 0.8-0.9 for each reading task). Neither do they take account of the measurement error that will have arisen from the fact that the tasks and items used in this survey are merely representative of all the similar tasks and items that might have been developed and used in their place.

In the case of writing, practising teachers evaluated pupils' scripts and allocated level judgments. As always with extended writing, judgements of quality were subjective to some extent, as the inter-rater agreement study described in Chapter 4 confirms: the average 'majority' agreement rate when applying a 'best fit' evaluation scheme (i.e. at least two of the three independent raters agreeing the same level) was 82%. With this in mind, the resulting writing attainment data have been presented in Chapter 4 as sample statistics only.

Given the nature of the practical assessment tasks – which were novel in nature and which did not lend themselves to pupil classification by level – no attempt has been made to produce weighted estimates of practical skills attainment on this occasion. School and pupil questionnaire findings are also presented in this report as sample statistics rather than formal population estimates.

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<sup>18</sup> In the 2001 survey of English Language, cut-off scores of 50%, 65% and 80% were agreed by subject specialists as appropriate indicators of 'basic skills', 'secure attainment' and 'considerable strengths' at a level. These general criteria were applied here, with minimal adjustment to allow for integer mark correspondences.



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## Appendix C: Field officer guidance for practical mathematics assessment

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The practical tasks are designed to be progressive, with each pupil given the opportunity to work through a series of tasks as far as they can manage.

There are four different practical tasks (task 1.1 to 1.4). Each of the four pupils in a school will do a different task.

One field officer should take the pupil through the task and the other field officer should observe the interaction and record the pupil's responses.

### Conducting the assessment

- introduce the practical activity and explain to the pupil what you are going to do. You may wish to carry out an introductory activity to put the pupil at ease. This is not assessed. (Such an activity is likely to be more appropriate with younger pupils.)
- for older pupils you may wish to explain that some of the activities you will be asking them to do may seem very easy/simple; say that you want to find out how older pupils do things and to compare that to how younger pupils do the same thing. Try to make them aware that what you are asking them to do is not trivial.
- work through the sequence of tasks from the start until you feel that the pupil has done as much as he/she can do
- you may offer support to encourage a pupil to complete an activity
- through your questioning, try to explore the pupil's mathematical understanding, asking for clarification if necessary
- you may terminate the activity at any time if a pupil is obviously struggling or in any way distressed

### Recording the results

- use the recording grid specific to the task
- make sure you complete the details at the top of **each sheet**
- for each sub-task you should record the pupil response (Y, N, ? = correct/incorrect/don't know) and also the degree of support given (0/1/2 = minimum/some/considerable)
- under 'mathematical language' make a note of the language used to express mathematical ideas – circle those given and add any others used
- under 'explanation' note the pupil's responses to the questions such as 'how did you work that out?' etc. Try to record the actual words/expressions used by the pupil. The aim is to gain a better understanding of how children think mathematically and how they express mathematical ideas.
- if a pupil has used any mathematical equipment, make a note of what was used and how competent they were (rated 2/1/0 from most to least).

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## Appendix D: The pupil questionnaires

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There were four different questionnaires used at each stage – the same four at every stage. One set of questions was common to all four versions, while other enquiries, such as lesson activity frequencies and importance of mathematics for jobs were distributed across the four versions. For illustration purposes version 2 is shown here.

**Assessment of Achievement programme  
2004 Mathematics Survey**

**Questionnaire for Pupils in S2. (S2/2)**

Please read the questions carefully and answer by writing in the space provided or ticking the box.

--

**ABOUT YOU AND YOUR FAMILY**

1. Which language(s) do you mostly use at home to talk with members of your family?	First language (the one you use most):	Second language:	Other languages:

2. Which of the following do you have at home to help with study and homework? (tick)	Quiet place to study	Computer	Access to the internet	Mobile phone
	TV/video	Calculator	Dictionary	Atlas

3. How much time do you spend <u>at home</u> doing homework in a normal week?	Hours	Minutes

4. Do you go to any club or group activities outside school hours? (list name(s) of clubs / groups)	Clubs or groups:

5. What kind of job would you like to do when you leave school or college? (Leave the box blank if you don't know)	
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**HOW OFTEN DO YOU SPEND TIME WITH A PARENT, CARER OF OTHER ADULT FAMILY MEMBER OUTSIDE SCHOOL IN THE FOLLOWING WAYS?**

<i>(Tick <u>one</u> of the boxes)</i>	Most days	Most weeks	About once a month	Two or three times each year	Hardly ever
6. ....watching TV or videos					
7. ....at the cinema					
8. ....talking about films or TV programmes					

**WHAT ARE MATHEMATICS LESSONS LIKE?**

<i>(Tick <u>one</u> of the boxes)</i>	Yes, always	Mostly	Not usually	Definitely not	Don't know
9. I get behind with the work in Mathematics					
10. We go through the work too slowly for me in Mathematics					
11. We get interesting topics and investigations to do in Mathematics					
12. Learning in Mathematics lessons is about asking 'Why?' and 'What if...?'					
13. Most of the assessment in Mathematics is done in short tests					
14. Everyone is expected to work hard in our Mathematics class					
15. We get regular homework in Mathematics					
16. Pupils get extra help with Mathematics when they need it					

**IN MATHEMATICS LESSONS, HOW OFTEN DO YOU SPEND YOUR TIME.....**

<i>(Tick <u>one</u> of the boxes)</i>	During most lessons	Most weeks	Once or twice each term	Once a year or less
17. ....working quietly on your own				
18. ....working at a computer with partner/small group				
19. ....working at a computer on your own				
20. ....reading textbooks or reference books				

**HOW IMPORTANT IS MATHEMATICS FOR THE PEOPLE WHO WORK AS ...**

	Very important	Quite important	Not very important	Not at all important
21. ....Mechanics				
22. ....Hairdressers				
23. ....Doctors				
24. ....Musicians				
25. ....Architects				



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## Appendix E: Selected pupil questionnaire results

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**Table E.1**  
**Learning activities within mathematics lessons**  
*(% pupils giving each response:*  
*around 1000 primary pupils and 600-700 S2 pupils per question)*

<i>Activity...</i>	<i>Stage</i>	<i>Most lessons</i>	<i>Most weeks</i>	<i>Each term</i>	<i>Rarely</i>
..writing in jotter/file	S2	89	9	1	1
	P7	89	9	1	1
	P5	82	14	3	1
..working quietly alone	S2	70	23	5	2
	P7	63	25	9	3
	P5	64	23	8	5
..reading text/reference books	S2	53	28	12	7
	P7	69	24	5	2
	P5	65	25	6	5
..completing worksheets	S2	26	43	28	3
	P7	36	54	10	<1
	P5	43	48	8	1
..talking about topic with others	S2	19	35	28	19
	P7	29	43	23	5
	P5	29	47	19	5
..making/using maps, diagrams..	S2	10	38	36	16
	P7	19	43	31	7
	P5	20	45	28	7
..working in school grounds	S2	15	7	15	63
	P7	14	16	41	29
	P5	12	17	35	37
..handling objects/artefacts	S2	6	12	40	42
	P7	13	28	48	11
	P5	22	29	38	11
..using tools/instruments to investigate...	S2	13	31	34	22
	P7	17	36	36	12
	P5	14	31	35	20
..working at computer alone	S2	5	11	17	67
	P7	13	30	34	23
	P5	15	31	31	23
..working at computer with partner	S2	2	10	25	63
	P7	13	31	37	19
	P5	15	37	30	18
..watching video/audio tapes	S2	3	6	18	73
	P7	8	17	30	46
	P5	9	28	31	32
..visiting places outside school	S2	2	3	11	84
	P7	4	8	35	53
	P5	6	11	38	45

**Table E.2**  
**Perceptions of the importance of mathematics**  
**for different occupational groups**

*(% pupils giving each response:  
around 1000 primary pupils and 600-700 S2 pupils per question)*

	<i>Stage</i>	<i>How important is mathematics?</i>			
		<i>Very</i>	<i>Quite</i>	<i>Not very</i>	<i>Not at all</i>
Accountants	S2	95	4	1	1
	P7	85	13	2	1
	P5	76	18	5	2
Architects	S2	64	25	8	3
	P7	57	26	14	4
	P5	47	29	15	10
Doctors	S2	56	33	9	2
	P7	55	30	12	3
	P5	58	25	14	4
Lawyers	S2	46	41	12	1
	P7	46	38	14	1
	P5	54	31	13	3
Secretaries	S2	48	44	7	1
	P7	52	38	8	2
	P5	45	41	11	4
Builders	S2	53	32	12	3
	P7	51	32	12	5
	P5	45	31	15	9
Pilots	S2	49	41	9	2
	P7	40	41	17	2
	P5	38	35	23	6
Engineers	S2	49	33	16	2
	P7	34	40	23	3
	P5	34	35	24	7
Mechanics	S2	34	45	19	2
	P7	27	46	24	3
	P5	34	36	23	6
Waiters/waitresses	S2	32	38	25	5
	P7	39	36	22	3
	P5	34	37	22	7
Plumbers	S2	34	44	19	2
	P7	28	42	24	5
	P5	34	34	23	10
Bakers	S2	32	40	23	5
	P7	34	40	21	5
	P5	32	31	24	13
Painters/decorators	S2	21	35	35	9
	P7	21	38	33	8
	P5	22	29	35	14

*Continued...*

**Table E.2 (Continued)**  
**Perceptions of the importance of mathematics**  
**for different occupational groups**  
*(% pupils giving each response:*  
*around 1000 primary pupils and 600-700 S2 pupils per question)*

	<i>Stage</i>	<i>How important is mathematics?</i>			
		<i>Very</i>	<i>Quite</i>	<i>Not very</i>	<i>Not at all</i>
Musicians	S2	13	29	42	16
	P7	15	28	42	15
	P5	15	30	36	19
Hairdressers	S2	7	22	48	23
	P7	11	30	42	18
	P5	11	33	39	17
Actors	S2	5	15	62	18
	P7	9	23	54	14
	P5	19	30	39	13

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## Appendix F: The teacher questionnaires

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Two questionnaires are reproduced here: the questionnaire for primary head teachers and the questionnaire for P5 class teachers. The questionnaire for secondary principal teachers was identical to the questionnaire for primary head teachers, save for a focus on S2 rather than P7. The class/subject teachers' questionnaires at P7 and S2 were also identical to the questionnaire included here for P5, save for a re-focus on the appropriate stage, references to 'department' in the S2 version in place of 'school' in the primary versions, and additional space in the S2 version for a third 'subject taught' and for information about class sizes and contact hours for up to four classes rather than one.

## **ASSESSMENT OF ACHIEVEMENT PROGRAMME 2004: MATHEMATICS**

### **QUESTIONNAIRE FOR PRIMARY HEAD TEACHERS**

Your school agreed to participate in this year's national survey of Mathematics. As part of the survey some of your P7 pupils recently took two written tests. We are grateful to you for collaborating with us in this way.

Now that the pupil testing is over, we very much hope that you will be prepared to help us further, this time by completing the attached questionnaire. The questionnaire has been designed to gather information about the organisation, emphasis and coverage of Mathematics in Scottish schools at the P7 stage. This information will prove a rich and informative background against which the results of the pupil testing can be reviewed. Taken together, the questionnaire information and the test results will provide a full picture of teaching and learning in Scotland in this general area of the curriculum, which will be of as much interest and value to schools as to others involved in the educational process.

Your personal responses to the questionnaire will be known only to those members of the survey team responsible for data analysis, and they will be treated as confidential. Neither you nor your school will be individually identified in the survey report or elsewhere when findings are presented and discussed. Your contribution to the general picture, however, will be invaluable. We urge you to give us the modest amount of time you will need to complete the questionnaire, and we thank you very sincerely for this further assistance with this innovative survey.

School name:

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School number:

--



**ABOUT MATHEMATICS IN YOUR SCHOOL**

1. In which year was your current P7 Mathematics programme introduced?

Year:

2. Is your P7 Mathematics programme being revised at present? (Circle Yes or No)

Yes / No

3. What is the basis of the P7 programme used in your school in 2002-2003? (Tick any as appropriate)

Commercial text-books/resource packs	National 5-14 guidelines	Local authority 5-14 guidelines
Materials from teachers' group or association	Materials from another school	The school's own materials
Another authority's 5-14 guidelines		
Other (please specify)		

4. On what basis does the school report progress in Mathematics to parents? (Tick any as appropriate)

5-14 Levels	% marks in end of unit tests	% mark in end of year test or exam
Comment bank	Marks or grades for effort	Teacher's own comments
Other (please specify)		

**PLEASE GIVE YOUR VIEWS ON THE QUALITY OF THE FOLLOWING:**

	<i>Very good</i>	<i>Generally good</i>	<i>Fair</i>	<i>Unsatisfactory</i>
The availability of learning support or 'enrichment', for individual pupils in Mathematics				
Resources available in the school for teaching and learning in Mathematics				
The number and availability to teachers of computers in the school				
The number and availability to pupils of computers in the school				
Internet access for teachers in the school				
Internet access for pupils in the school				
The school's accommodation				
Pupils' attendance				
The behaviour of pupils in Mathematics lessons				
The extent to which parents support their children's learning in Mathematics				

**HOW WOULD YOU EVALUATE THE FOLLOWING?**

	<i>Very high</i>	<i>Moderately high</i>	<i>Fair</i>	<i>Low</i>
The motivation of pupils to learn in Mathematics				
The expectations teachers have of pupils to achieve in Mathematics				
The morale of teachers in your school				

**IF YOU WOULD LIKE TO MAKE ANY FURTHER COMMENTS, PLEASE DO SO IN THE SPACE BELOW :**

**ASSESSMENT OF ACHIEVEMENT PROGRAMME 2004: MATHEMATICS****QUESTIONNAIRE FOR TEACHERS IN P5: MATHEMATICS**

Your school agreed to participate in this year's national survey of Mathematics. As part of the survey some of your P5 pupils recently took two written tests. We are grateful to you for collaborating with us in this way.

Now that the pupil testing is over, we very much hope that you will be prepared to help us further, this time by completing the attached questionnaire. The questionnaire has been designed to gather information about the organisation, emphasis and coverage of Mathematics in Scottish schools at the P5 stage. This information will prove a rich and informative background against which the results of the pupil testing can be reviewed. Taken together, the questionnaire information and the test results will provide a full picture of teaching and learning in Scotland in this general area of the curriculum, which will be of as much interest and value to schools as to others involved in the educational process.

Your personal responses to the questionnaire will be known only to those members of the survey team responsible for data analysis, and they will be treated as confidential. Neither you nor your school will be individually identified in the survey report or elsewhere when findings are presented and discussed. Your contribution to the general picture, however, will be invaluable. We urge you to give us the modest amount of time you will need to complete the questionnaire, and we thank you very sincerely for this further assistance with this innovative survey.

School name:

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School number:

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**ABOUT YOU AND YOUR TEACHING IN P5**

Are you male or female?  
(Tick)

<i>Male:</i>	<i>Female:</i>
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How long have you been teaching?

<i>Years:</i>	<i>Months:</i>
---------------	----------------

How long have you been in your current post?

<i>Years:</i>	<i>Months:</i>
---------------	----------------

What were the main subject(s) of your first degree?

<i>Subject 1</i>	<i>Subject 2</i>
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What were the main subject(s) of your teaching degree?

<i>Subject 1</i>	<i>Subject 2</i>
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How many pupils are there in your P5 class?

<i>Number</i>
---------------

How many hours do you spend on Mathematics in a typical week?

<i>Hours</i>
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How much time in session 2002-2003 did you spend on Mathematics topics?

<i>Hours</i>
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About how much time do you spend on preparation and marking for Mathematics each week?

<i>Hours</i>
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How often do you meet with other teachers to talk about professional issues in Mathematics? (Tick one box)

<i>More than once a week</i>	<i>Weekly</i>	<i>Once or twice a month</i>	<i>Once or twice a term</i>	<i>Once or twice a year</i>	<i>Hardly ever</i>
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How much professional development have you had in Mathematics in the last 2 years?

<i>Days</i>	<i>Hours</i>
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How well motivated do you think your P5 pupils are to learn in Mathematics? (Tick one box)

<i>Very well motivated</i>	<i>Well motivated</i>	<i>Not very well motivated</i>	<i>Not motivated at all</i>
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**IN MATHEMATICS TOPICS, HOW OFTEN DO YOUR PUPILS SPEND TIME.....**

	<i>During most lessons</i>	<i>Most weeks</i>	<i>Once or twice each term</i>	<i>Once a year or less</i>
13. ...with the whole class being taught by you				
14. ...in a small group being taught by you				
15. ...talking on their own with you				
16. ...working in a group on a shared task				
17. ...working with a partner on a shared task				
18. ...working quietly on their own				
19. ... working at a computer with partner/small group				
20. ...working at a computer on their own				
21. ...reading textbooks or reference books				
22. ...writing in their jotters or files				
23. ...completing worksheets				
24. ...talking with other pupils about a topic				
25. ...making or using maps, pictures or diagrams				
26. ...handling objects or artefacts				
27. ...watching and responding to TV, radio, video or audio tapes				
28. ...using tools and instruments to investigate things				
29. ...working in the school grounds				
30. ...visiting places outside the school				

In teaching Mathematics topics to your P5 class, how much use do you make of.....

31. ...commercial textbooks / resource packs				
32. ...national 5-14 guidelines				
33. ...your own local authority 5-14 guidelines				
34. ...materials produced by another local authority				
35. ...materials produced by a teachers' group or association				
36. ...materials produced by another school				
37. ...the school's own materials				
38. ...materials you have written yourself				



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## Appendix G: Teachers' reports on lesson activities

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**Table F.1**  
**Activities within mathematics lessons\***  
 (% teachers indicating each frequency: 239 primary teachers and 52 S2 teachers)

<i>Activity...</i>	<i>Stage</i>	<i>Most lessons</i>	<i>Most weeks</i>	<i>Each term</i>	<i>Rarely</i>
..taught as a whole class	S2	83	15	2	0
	P3/P5/P7	53	38	6	4
..writing in jotter/file	S2	90	10	0	0
	P3/P5/P7	81	19	0	0
..working with a partner	S2	2	27	52	19
	P3/P5/P7	9	60	29	2
..working quietly alone	S2	73	25	2	0
	P3/P5/P7	79	20	1	0
..completing worksheets	S2	14	39	39	8
	P3/P5/P7	31	63	6	0
..reading text/reference books	S2	47	12	0	41
	P3/P5/P7	53	39	4	4
..making/using maps, diagrams, ...	S2	10	45	31	14
	P3/P5/P7	5	46	49	1
..talking about topic with others	S2	22	33	22	24
	P3/P5/P7	22	58	18	2
..working in a group	S2	4	19	42	35
	P3/P5/P7	11	61	25	3
..talking one-to-one with teacher	S2	46	28	10	16
	P3/P5/P7	40	56	6	1
..handling objects/artefacts	S2	0	6	29	65
	P3/P5/P7	2	31	55	13
..using tools/instruments	S2	0	31	37	31
	P3/P5/P7	3	40	50	6
..taught in small group	S2	6	25	33	36
	P3/P5/P7	71	27	2	0
..watching video/audio tapes	S2	0	2	20	78
	P3/P5/P7	0	18	33	49
..working at computer alone	S2	4	21	29	46
	P3/P5/P7	2	46	42	10
..working at computer with partner	S2	4	8	29	59
	P3/P5/P7	3	48	44	4
..working in school grounds	S2	0	4	2	94
	P3/P5/P7	0	1	61	37
..visiting places outside school	S2	0	4	0	96
	P3/P5/P7	0	0	17	83

\*See Appendix E for the exact wording of the activity descriptions





**SCOTTISH EXECUTIVE**

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