

**THIRD INTERNATIONAL
MATHEMATICS AND SCIENCE STUDY
Second National Report
Part 2**



Wendy Keys, Sue Harris and Cres Fernandes

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**Patterns of Mathematics and Science teaching
in upper primary schools in England and
eight other countries**

Wendy Keys, Sue Harris and Cres Fernandes

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SUMMARY

1. Introduction

England is one of 26 countries which took part in the survey of nine-year-olds and their teachers as part of the Third International Mathematics and Science Study (TIMSS), a large-scale international comparative study of educational performance. TIMSS was organised by the International Association for the Evaluation of Educational Achievement (IEA). The study in England was funded by the Department for Education and Employment (DfEE) and carried out by the National Foundation for Educational Research (NFER).

Part 1 of the Second National Report on TIMSS (Harris *et al.*, 1997) compared the mathematics and science performance of nine-year-old pupils (Years 4 and 5 in England) with that of pupils of the same age in other countries. Its main finding was that pupils in England achieved relatively high mean scores in science and relatively low mean scores in mathematics.

Part 2 of the Second National Report extends the findings of the first part of the report. Its main purpose is to compare the responses to the TIMSS questionnaires of pupils, teachers and headteachers in England with those of their counterparts in eight other countries: Canada; Hungary; Japan; the Netherlands; Norway; Scotland; Singapore and the United States. The results for Year 5 are described below; those for Year 4 were similar.

2. Main findings

Time spent in mathematics and science lessons

- ◆ In England, the mean times spent by Year 5 pupils in mathematics and science lessons were:
 - 4.6 hours per week for mathematics
 - 2.2 hours per week for science.
- ◆ The mean time per week spent by Year 5 pupils in England in mathematics lessons was *amongst the highest* in the nine countries selected for comparison, although pupils in Singapore and the Netherlands, two of the higher scoring countries, spent more time than those in England.
- ◆ The mean time per week spent by Year 5 pupils in England in science lessons was *amongst the highest* in the nine countries selected for comparison, although pupils in the United States spent slightly more time than those in England.

- ◆ Across countries, there was a slight positive association between mean time spent on science and mean science score, although the pattern was not consistent over all countries. This pattern was not repeated for mathematics.
- ◆ The mean time spent on science in upper primary schools in England has increased since the Second International Science Study was carried out in 1984. No comparative information was available for mathematics.

Class size

- ◆ The mean size of Year 5 classes for mathematics and science in England (28 pupils) tended to be:
 - *larger than* those in Canada, Hungary, the Netherlands, Norway, Scotland and the United States (19 to 26 pupils)
 - *smaller than* those in Japan and Singapore (32 and 39 pupils, respectively).
- ◆ Within England, the ten per cent of pupils in classes of 20 or less achieved a slightly higher mean mathematics score than those in larger classes. This pattern was not repeated in science.
- ◆ On average, Year 5 mathematics and science classes in England were *larger than* those for Year 9.¹

Classroom organisation

- ◆ The study found that the emphasis placed on different teaching practices and activities varied between the countries selected for comparison.

MATHEMATICS

- ◆ In most countries taking part in TIMSS, the two most frequent forms of classroom organisation for mathematics were for pupils to *work individually with the assistance of the teacher* and for pupils to *work as a class with the teacher teaching the whole class*.
- ◆ In England, the most frequent form of classroom organisation in mathematics was for pupils to *work individually with the assistance of the teacher*. Other approaches were used much less frequently.
- ◆ Whole-class teaching in mathematics was *less frequent* in Year 5 mathematics classes in England and Scotland than in any of the other countries selected for comparison.

¹ KEYS, W., HARRIS, S. and FERNANDES, C. (1997). *Third International Mathematics and Science Study, First National Report, Part 2: Patterns of Mathematics and Science Teaching in Lower Secondary Schools in England and Ten Other Countries*. Slough: NFER.

- ◆ Across countries, there was a *slight positive association* between pupils' mean mathematics scores and the extent to which pupils worked together as a class with the teacher teaching the whole class. This pattern was not repeated for science.
- ◆ Across countries, there was a *slight negative association* between the frequency of small-group work and mean mathematics scores.

SCIENCE

- ◆ In science, the most frequent form of classroom organisation in England was for pupils to work in pairs or small groups.

Practical activities in science

- ◆ Practical activities were an important feature of science lessons for Year 5 pupils in England.
- ◆ Although experiments or practical investigations were undertaken *more frequently* in Year 5 science classes in England than in most of the other countries selected for comparison, they were said by pupils to be even more frequent in Japan (the highest-scoring of the countries selected for our comparisons).

The use of calculators in mathematics

- ◆ Calculators were used *more frequently* in Year 5 mathematics classes in England and Scotland than in most of the other countries selected for comparison.
- ◆ Across countries, there was a *slight negative association* between the frequency with which pupils used calculators for routine computation and pupils' mean mathematics scores.

Homework

- ◆ Year 5 teachers in England set mathematics and science homework *less frequently* than their counterparts in most of the other countries selected for comparison.
- ◆ The mean times per week spent on mathematics and science homework by Year 5 pupils in England were 0.6 hours and 0.3 hours, respectively.²

² This mean is based on the responses of all pupils, including those who said they never did homework.

Teachers' attitudes

- ◆ About a third of the primary school teachers in England said they would like to change to another career, given the chance.
- ◆ Fewer than 20 per cent of the teachers in England believed that society appreciated their work.
- ◆ These responses, which were *more negative* than those of teachers in most of the other countries that asked these questions, are similar to those which were made by the mathematics and science teachers of Year 9 pupils in England.

Teachers' school-related activities out of school hours

- ◆ Compared with their counterparts in most of the 26 countries taking part in TIMSS, teachers in England tended to spend:
 - *more time* reading and marking pupils' work; only teachers in Singapore spent more time on this activity; teachers in the Netherlands spent the same amount of time as those in England
 - *more time* on administration; the only other country in which teachers spent as much time on the activity was New Zealand
 - *less time* preparing tests; the only country in which teachers spent less time was Scotland.

Pupils' out-of-school activities

- ◆ Year 5 pupils in England spent, on average, about 1.8 hours a week on homework in all subjects.³
- ◆ The other out-of-school activities of Year 5 pupils in England (in order of frequency) were:
 - watching television or videos
 - playing sports
 - socialising with friends
 - playing computer games
 - reading for pleasure
 - helping at home.

³ This figure is based on the responses of all pupils including those who said they never did homework.

Pupils' attitudes

- ◆ Our comparisons between the responses of pupils in the eight countries selected for comparison show that pupils in England were mid-ranking in terms of their liking for mathematics and science.
- ◆ Pupils in England held more positive perceptions of their ability in mathematics than in science despite the fact that, compared with pupils in other countries, their relative performance was better in science than in mathematics.

CHAPTER 1

Introduction to the Study

The structure of this report

- ◆ This chapter provides brief descriptions of the design and administration of TIMSS and the content covered by the school, teacher and pupil questionnaires.
- ◆ Chapter 2 focuses on the primary schools taking part in TIMSS in England and compares school-level mathematics and science provision in England and the other eight countries selected for comparison.
- ◆ Chapter 3 describes primary school teachers' perceptions of mathematics lessons and provides information on the teaching approaches adopted in England and the other eight countries.
- ◆ Chapter 4 describes the Year 5 pupils' perceptions of mathematics lessons and provides further information on teaching approaches and learning activities in mathematics.
- ◆ Chapters 5 and 6 provide similar information about science lessons.
- ◆ Chapter 7 focuses on the professional background and attitudes of the primary school teachers.
- ◆ Chapter 8 focuses on pupil and home background factors, and pupils' out-of-school activities .
- ◆ Chapter 9 describes pupils' attitudes towards mathematics and science.
- ◆ Annex A provides additional tables to support the results described in the text.

Part 1 of this report (Harris *et al.*, 1997) compared the performance of nine-year-olds in England on the TIMSS mathematics and science tests with the performance of pupils of the same age in other countries. A companion volume of technical appendices (Keys *et al.*, 1996b) provides more detailed information on the design and administration of the study.

1.1 Preface

England is one of 26 countries which took part in the survey of nine-year-olds and their teachers as part of the Third International Mathematics and Science Study (TIMSS), a large-scale international comparative study of educational performance. TIMSS was organised by the International Association for the Evaluation of Educational Achievement (IEA). The study in England was funded by the Department for Education and Employment (DfEE) and carried out by the National Foundation for Educational Research (NFER).

Part 1 of the Second National Report on TIMSS (Harris *et al.*, 1997) compared the mathematics and science performance of nine-year-olds (Years 4 and 5 in England) with that of pupils of the same age in other countries. Its main finding was that nine-year-old pupils in England achieved relatively *high mean scores in science* and relatively *low mean scores in mathematics*. This pattern was also found in the results for 13-year-olds in England, which were reported in Keys *et al.* (1996a).

Part 2 of the Second National Report on TIMSS extends the findings of the first part of the report. Its main purpose is to compare the responses to the TIMSS questionnaires (described in Section 1.3 below) of pupils, teachers and headteachers in England with those of their counterparts in a small number of other countries in order to identify any factors or patterns of behaviour which might differentiate between high- and low-scoring countries.

Much of the information contained in this report has been drawn from the international reports on the TIMSS surveys of nine-year-olds (Martin *et al.*, 1997 and Mullis *et al.*, 1997). Additional sources of information are unpublished analyses carried out by the International Study Center and analyses carried out by NFER on the TIMSS national dataset. Where appropriate, comparisons have been made with the results of previous large-scale comparisons of achievement.

In order to provide clear and coherent comparisons, it was decided to focus many of the comparisons in this report on the following nine countries whose results were described in detail in Part 1 of this report.

- | | |
|---------------|-------------|
| ● Canada | ● Norway |
| ● England | ● Scotland |
| ● Hungary | ● Singapore |
| ● Japan | ● USA |
| ● Netherlands | |

These countries represent the four main groups of countries taking part in TIMSS: Western European countries; English-speaking countries; Eastern European countries; and countries for the (Asian) Pacific Rim. These countries' mean scores on the TIMSS tests illustrate very clearly the wide range of mean scores achieved by the industrialised nations taking part in TIMSS.

1.2 Design and administration of TIMSS

The international research focused on three different stages of education: upper primary (nine-year-olds), lower secondary (13-year-olds) and pupils in their final year of schooling (mainly 17-year-olds). England participated in the survey of two age groups only — nine-year-olds (Years 4 and 5 in England) and 13-year-olds (Years 8 and 9 in England) — and in the Performance Assessment (practical activities) for 13-year-olds. A brief summary of the design and administration of the TIMSS survey of nine-year-olds (TIMSS Population 1), which forms the subject of this report, is given below. Full details can be found in the companion volume of appendices (Keys *et al.*, 1996b), which gives information on the design and administration of TIMSS in England.

Age groups

The TIMSS Population 1 sample was drawn from pupils in all maintained and independent schools (excluding special schools) who were in international third and fourth grades (equivalent to Years 4 and 5 in England). The two grades selected included the highest proportion of nine-year-olds in most participating countries. At the time of testing (early March 1995) the age of the Population 1 pupils taking part in the study in England ranged from eight years seven months to ten years six months.

The school and pupils

The randomly selected samples of schools and pupils taking part in TIMSS in each country were required to conform to rigorous procedures. Each country's sampling plans and all details of samples had to be documented and approved by an independent sampling referee. A total of 134 schools took part in the study (96 first-choice schools and 38 replacement schools) in England. The response rate for Population 2 was 88 per cent including replacement schools (64 per cent from first-choice schools). The characteristics of the schools taking part in TIMSS closely reflected the national pupil population in terms of type of school, size and background characteristics (Keys *et al.*, 1996b). Tests and questionnaires were completed by 6,142 pupils, 259 teachers and 126 headteachers. The tests and questionnaires were administered in schools by teachers in early March 1995.

1.3 The tests and questionnaires

The tests of mathematics and science

The TIMSS curriculum frameworks for mathematics and science were developed from analyses of the science and mathematics curricula in participating countries (Robitaille, 1993). These frameworks provided a structure which ensured that the tests were as relevant as possible to the curricula of the countries taking part in the study. A further check of curricular relevance, the Test-curriculum Matching Analysis, was carried

out in each country. Full details are given in the volume of appendices to the national reports (Keys *et al.*, 1996b).

Each pupil completed a total of 54 minutes of testing in two sessions. Mathematics and science items were included in both testing sessions. A mathematics and science test score was computed for each pupil.

Mean mathematics and science scores

The mean mathematics and science scores given in this report have each been expressed in terms of a scale with a mean of 500 and a standard deviation of about 100 based on the performance of pupils in two year groups (equivalent to Years 4 and 5 in England) in all participating countries. The international mean mathematics scores were: 470 for Year 4; and 529 for Year 5. The international mean science scores were: 473 for Year 4, and 524 for Year 5. Further information is given in the volume of appendices to the national reports (Keys *et al.*, 1996b) and in the international reports (Martin *et al.*, 1997 and Mullis *et al.*, 1997).

The school questionnaires

The school questionnaire sought general background information on the schools taking part in the study. Information provided by schools included:

- ◆ **General background information:** location; length of school week and teaching week; admissions criteria.
- ◆ **Teaching staff:** stability of teaching staff.
- ◆ **Pupils:** number of boys and girls on roll; number of pupils eligible for free school meals, from ethnic minorities, needing English as a second language (ESL) support and with statements of special educational needs; stability of pupil population; rates of absenteeism.
- ◆ **Organisational features:** existence of written curriculum plans for mathematics and science; teaching time per week for mathematics and science; learning support and/or enrichment provision in mathematics and science.

The teacher questionnaires

The teacher who taught mathematics and science to the pupils taking the TIMSS tests (in most cases this was their class teacher) completed background questionnaires designed to collect biographical details and information on teaching and learning approaches. Information collected included:

- ◆ **Biographical details:** age, gender, educational background, teaching experience.

- ◆ **How they spent their time:** lesson preparation time and other school-related activities.
- ◆ **Teaching approaches and resources:** size of classes; extent of whole-class, group and individual work; setting homework; use of textbooks and schemes of work; use of calculators and computers.
- ◆ **Teachers' attitudes:** views on teaching as a career.

The pupil questionnaires

Each pupil also completed a questionnaire, designed to obtain background information. Information collected from the pupils in England included:

- ◆ **The pupils themselves:** age; gender; country of birth; language spoken at home; out-of-school activities, including time spent on homework; perceived ability in mathematics and science.
- ◆ **Home background:** parents' country of birth; perceptions of parental interest; surrogate measures to provide an indication of the educational status of the family, such as the approximate number of books in the home.
- ◆ **Pupils' attitudes:** liking for mathematics and science.
- ◆ **Perceptions of mathematics and science lessons:** teaching approaches used by teachers; activities undertaken by pupils, including practical work and the use of calculators and computers.

1.4 Interpreting the results

This report draws upon the wealth of data collected by means of the school, teacher and pupil questionnaires and selects those responses which best illustrate the similarities and differences between teaching practices in different countries.

In some chapters, we have indicated that there were systematic associations between a particular variable and pupils' mathematics or science scores. It is important to remember that such associations do not necessarily imply that the variable concerned is a causal factor in raising pupils' achievement.

It is also important to remember that 26 countries took part in the TIMSS survey of nine-year-olds. These countries vary a great deal in terms of a number of factors including the age at which pupils start school and the extent of differentiation by ability. Details of the ways in which mathematics and science teaching are organised in the education systems taking part in TIMSS are given in Robitaille (1997), which is required reading for those interested in understanding and interpreting the TIMSS data.

Translations were carefully validated in TIMSS, and the International Study Center provided guidance notes on the intended meaning of each question in the questionnaires so that researchers could add explanatory sentences where necessary. Nevertheless, it is possible that some questions may have been interpreted in different ways in different countries or cultures. Even within a country, some questions may have been interpreted differently in different schools. For example, pupils could have interpreted the word *test* in many ways; some pupils may have thought of a brief test of mental mathematics, others of a teacher-made short answer test, and so on. In a self-completion questionnaire, it is simply not possible to cover a wide range of topics *and* follow up every question in order to identify the precise meaning of every response while keeping the questionnaire to an acceptable length.

For these reasons, the TIMSS self-completion questionnaires can only provide a broad-brush picture of what happens in mathematics and science classrooms. More in-depth research, drawing on classroom observations and interviews with teachers and pupils, is required to build up a detailed understanding of teaching and learning in mathematics and science.

CHAPTER 2

Mathematics and Science in Schools

Summary of main points

- ◆ In England, the mean times spent by Year 5 pupils on classwork in mathematics and science were:
 - 4.6 hours per week for mathematics
 - 2.2 hours per week for science.
- ◆ The mean time per week spent on mathematics work in class by Year 5 pupils in England was amongst the highest in the nine countries selected for comparison, although pupils in Singapore and the Netherlands, two of the higher-scoring countries, spent more time than those in England.
- ◆ The mean time per week spent on science work in class by Year 5 pupils in England was amongst the highest in the nine countries, although pupils in the United States spent more time than those in England.
- ◆ Across countries, there was a slight positive association between mean time spent on science and mean science score, although the pattern was not consistent over all countries. This pattern was not repeated for mathematics.
- ◆ The mean time spent on science in the upper primary school has increased since the Second International Science Study (SISS) was carried out in 1984. No comparative information was available for mathematics.
- ◆ On average, Year 5 mathematics and science classes in England (28 pupils) were:
 - larger than those in Canada, Hungary, the Netherlands, Norway, Scotland and the United States (19 to 26 pupils)
 - smaller than those in Japan and Singapore (32 and 39 pupils, respectively).

- ◆ Within England, the ten per cent of pupils in classes of 20 or less achieved a slightly higher mean mathematics score than those in larger classes. This pattern was not repeated in science.
- ◆ Across countries, however, there was no association between either mathematics or science mean scores and class size.
- ◆ On average, Year 5 mathematics and science classes (which were in primary schools) in England were larger than those for Year 9 pupils (in secondary schools).
- ◆ Schools in England were more likely to have their own written statements of the curriculum content to be covered in mathematics and science than any of the eight other countries selected for comparison.

2.1 Preface

The purpose of this chapter is to describe and compare the ways primary schools organise mathematics and science teaching in England and the eight other countries selected for comparison. Topics covered include: time allocations for mathematics and science; class size; and the provision of learning support and enrichment. Main sources of information were the background questionnaires completed by the schools and teachers taking part in the study.

In interpreting the results described in this chapter, it should be remembered that TIMSS selected probability samples of pupils, not schools or teachers. The schools taking part in TIMSS were not, therefore, a true random sample of schools but the schools attended by a probability sample of pupils. Similarly, the teachers' responses should be regarded as the responses of teachers of a probability sample of pupils. Thus, this chapter does not describe the characteristics of a sample of schools but instead describes the school characteristics experienced by a probability sample of pupils. Similarly, Chapters 3, 5 and 7 describe the characteristics of the teaching and teachers experienced by a probability sample of pupils.

2.2 School background factors

Background information on the schools taking part in the study in terms of type of school, size of school and type of community served by the schools is shown in Table A2.1 in Annex A. Information is also provided in Annex A on school background factors, such as the proportion of pupils eligible for free school meals and from ethnic minorities, pupil and staff stability, absenteeism and admissions criteria (Tables A2.1 and A2.2 in Annex A).

In most of the schools taking part in TIMSS in England, nine-year-old pupils were taught mathematics and science by their own class teachers. This was also the case in most of the other countries taking part in the study (Mullis *et al.*, 1997).

2.3 Information provided by primary school teachers: *time allocations for mathematics and science*

The average times allocated to mathematics and science lessons for pupils in grades equivalent to Year 5 in England and other countries selected for comparison are shown in Table 2.3.1. The average times in England for Year 5 were:

- ◆ 4.6 hours per week for mathematics
- ◆ 2.2 hours per week for science.

Table 2.3.1 Information provided by teachers: *time allocations for mathematics and science in Year 5*

COUNTRY	Mathematics		Science	
	Mean score	Average hours per week	Mean score	*Average hours per week
Singapore	625	5.5	547	2.0
Japan	597	3.7	574	2.2
Netherlands	577	4.7	557	1.3
Hungary	548	3.3	536	1.9
United States	545	4.2	564	2.7
Canada	532	4.4	549	2.2
Scotland	520	4.3	536	1.3
England	513	4.6	551	2.2
Norway	502	3.0	530	0.8

Sources: Mullis *et al.*, 1997; Martin *et al.*, 1997

*Note: In the international report (Martin *et al.*, 1997), average hours per week was given separately for pupils taught science as a separate subject and those to whom it was not taught in this way; the entry in this table for each country is a weighted average of the two values given in the international report.

Comparisons with other countries

MATHEMATICS

Year 5 pupils in England spent, on average, slightly more time per week in mathematics lessons than their counterparts in most of the other countries selected for comparison. However, pupils in Singapore and the Netherlands, two of the higher-scoring countries, spent more time than those in England. Across countries, there was no association between mean scores in mathematics and time spent in mathematics lessons.

SCIENCE

Pupils in five of the nine countries (including England) spent, on average, two hours or more each a week on science work in lesson time. Pupils in the remaining four countries spent less time. Across countries, there was a slight positive association between time spent on science and mean science score, although the pattern was not consistent over all countries. Pupils in the Netherlands, for example, who spent a relatively small amount of time per week on science had relatively high mean science scores.

Comparisons with previous studies

MATHEMATICS

The only previous study to include comparisons of mathematics performance at the upper primary level (Lapointe *et al.*, 1992a) did not publish information on time allocations for mathematics.

SCIENCE

As Table 2.3.2 shows, there has been an increase in the average time spent on science in England in the upper primary school since 1984, when the Second International Science Study was carried out (Keeves, 1992).

Table 2.3.2 Comparisons with previous studies: average curriculum time per week for science in upper primary schools in England

Date of testing	Study	Hours/week
1984	Keeves (1992)	1.7
1995	TIMSS	2.2

2.4 Information provided by primary school teachers: size of mathematics and science classes in Year 5

MATHEMATICS

Nine per cent of the pupils taking the TIMSS tests in England were in mathematics classes containing 20 or fewer pupils; 56 per cent were in classes of 21-30 pupils; and 35 per cent were in classes of 31-40 pupils. The average size of mathematics classes for Year 5 pupils in England was 28 pupils (Table 2.4.1). On average, Year 5 mathematics classes in England were larger than those for Year 9 (for which the median size¹ was 26 pupils (Keys *et al.*, 1997)).

Within England, the ten per cent of pupils in classes of 20 or less achieved a slightly higher mean score than those in larger classes (Mullis *et al.*, 1997).

Table 2.4.1 Comparisons between nine countries: teachers' reports on mathematics class size in international fourth grade (Year 5 in England)

COUNTRY	Mean mathematics score	1-20 Year 5 pupils %	21-30 Year 5 pupils %	31-40 Year 5 pupils %	41 or more Year 5 pupils %	Average No. of pupils
Singapore	625	0	2	68	30	39
Japan	597	3	29	67	1	32
Netherlands	577	29	52	19	0	24
Hungary	548	38	58	4	0	22
United States	545	23	67	9	1	24
Canada	532	18	75	6	0	24
Scotland	520	15	70	14	1	26
England	513	9	56	35	0	28
Norway	502	59	41	0	0	19

Source: Mullis *et al.*, 1997

¹Median class sizes for Year 9 were calculated from the grouped data provided in the international reports (Beaton *et al.*, 1996a, 1996b), which did not give means or medians for class size.

SCIENCE

The average sizes of Year 5 mathematics and science classes in England were almost identical since, in most cases, pupils were taught both subjects by their class teacher in their own classroom: nine per cent of the pupils taking the TIMSS tests were in science classes containing 20 or fewer pupils; 53 per cent were in classes of 21-30 pupils; and 38 per cent were in classes of 31-40 pupils (Table 2.4.2). The average size of science classes in England was 28. On average, Year 5 science classes in England were larger than those for Year 9 (for which the median size was 24 pupils (Keys *et al.*, 1997)).

Within England, there was no association between class size and science achievement (Martin *et al.*, 1997).

Table 2.4.2 Comparisons between nine countries: teachers' reports on science class size in international fourth grade (Year 5 in England)

COUNTRY	Mean science score	1-20 Year 5 pupils %	21-30 Year 5 pupils %	31-40 Year 5 pupils %	41 or more Year 5 pupils %	Average No. of pupils
Japan	574	3	29	67	1	32
United States	565	23	67	9	1	24
Netherlands	557	29	52	19	0	24
England	551	9	53	38	0	28
Canada	549	21	72	7	0	24
Singapore	547	0	2	68	30	39
Scotland	536	15	70	14	1	26
Hungary	532	40	55	5	0	22
Norway	530	57	43	0	0	19

Source: Martin *et al.*, 1997

Comparisons with other countries

MATHEMATICS

On average, Year 5 mathematics classes in England were larger than those in all of the other countries selected for comparison, with the exception of Japan and Singapore.

Across countries, there was no association between mathematics achievement and class size: some of the higher-scoring countries had relatively large classes whilst other higher-scoring countries had relatively small classes. However, *within countries* the relationship between class size and mathematics achievement varied. As Mullis *et al.* (1997) comment: 'the chief effects of smaller classes are often in relation to teacher attitudes and instructional behaviours'. Mullis *et al.* (op. cit.) go on to say: 'Within countries, several show little or no relationship between achievement and

class size, often because students are almost all in classes of similar size. Within other countries, there appears to be a curvilinear relationship, or the students with higher achievement appear to be in larger classes. In some countries, larger classes may represent the more usual situation for mathematics teaching, with smaller classes used primarily for students needing remediation.'

SCIENCE

The average size of Year 5 science classes in England tended to be larger than those in all but two (Singapore and Japan) of the countries selected for comparison. Across countries, there was no association between science achievement and class size.

2.5 Information provided by primary schools: *learning support and enrichment provision in mathematics and science*

Nearly 90 per cent of primary schools in England provided some form of learning support for pupils with learning difficulties in mathematics, compared with about two-thirds for science. In mathematics, this was usually provided by forming groups within normal mathematics classes or, less often, by withdrawing pupils from their normal mathematics classes (Table A2.3 in Annex A). In science, the most usual approach was to form groups within normal science classes (Table A2.6 in Annex A).

About 77 per cent of schools in England provided some form of enrichment or extension teaching for very able pupils in mathematics compared with 42 per cent for science. For both subjects, this was most often provided by forming groups within normal mathematics classes (Tables A2.4 and A2.7 in Annex A).

2.6 Information provided by primary schools: *written statements of curriculum content to be taught in mathematics and science*

Over 90 per cent of Year 5 pupils in England were in primary schools which had their own written statement of the content to be taught in mathematics and science, other than the national or regional curriculum guides (Tables A2.5 and A2.8 in Annex A). (In England, this would be National Curriculum guides or LEA-produced curriculum guides.)

Table 2.6 Information provided by primary schools: *percentage of schools with their own written statement of the curriculum content to be covered in mathematics*

COUNTRY	Mean mathematics score	Mathematics %	Mean science score	Science %
Singapore	625	58	549	55
Netherlands	577	100	557	100
Hungary	548	12	532	15
United States	545	75	565	76
Canada	532	30	549	25
Scotland	520	79	536	33
England	513	91	551	92
Norway	502	25	530	48

Source: analyses provided by the TIMSS International Study Center

Comparisons with other countries

Year 5 pupils in England were more likely than those in all but one (the Netherlands) of the other countries selected for comparison to be in primary schools which had their own written statements of the curriculum content in mathematics and science (Table 2.6). Across countries, there was no association between either mathematics or science mean scores of Year 5 pupils and the prevalence of school-level written statements of the curriculum in these subjects.

CHAPTER 3

Mathematics Lessons: *Teachers' Perspectives*

Summary of main points

- ◆ Whole-class teaching in mathematics was less frequent in Year 5 mathematics classes in England and Scotland than in any of the other countries selected for comparison.
- ◆ Across countries, there was a slight positive association between pupils' mean mathematics scores and the extent to which pupils worked together as a class with the teacher teaching the whole class, although the pattern was not consistent for all countries.
- ◆ In England, the most frequent form of classroom organisation was for pupils to work individually with assistance from the teacher. Other approaches were used much less frequently.
- ◆ Comparisons between the countries selected for comparison reveal that pupils working individually with assistance from the teacher was least frequent in Singapore and Japan and most frequent in Hungary and Norway.
- ◆ Year 5 teachers in England set mathematics homework less frequently than their counterparts in most of the other countries selected for comparison.
- ◆ Calculators were used more frequently in Year 5 mathematics classes in England and Scotland than in most of the other countries selected for comparison.
- ◆ Across countries, there was a slight negative association between how often pupils used calculators for routine computations and mean mathematics scores.

3.1 Preface

The purpose of this chapter is to provide information on the teaching approaches and learning activities in mathematics in primary schools and their associations with achievement. It focuses on the questionnaire responses of teachers in England and the other countries selected for comparison. The results will be examined in order to answer three key questions:

- ◆ Which teaching approaches were used most frequently in England?
- ◆ Across countries, were there any associations between particular teaching approaches and pupils' mean mathematics scores, i.e. were there any similarities between the rank order of countries in terms of pupils' mean mathematics scores and their rank order in terms of the extent to which teachers in a country used a particular teaching approach?
- ◆ Were there any common factors or patterns within the high-scoring countries which differentiated their teaching approaches from those used in England?

In order to answer these questions, the chapter describes the responses of primary school teachers in England to a range of questions concerned with teaching approaches in mathematics, and compares their responses with those of teachers in the other countries selected for comparison.

In most of the questions reported in this chapter, teachers were asked to respond on a four-point scale: *never/almost never; some lessons; most lessons; and every lesson*. In most cases, their responses have been reported in terms of the combined percentage opting for *most lessons and every lesson*.

3.2 Primary school teachers' reports: *classroom organisation for mathematics*

It has been suggested (Reynolds and Farrell, 1996, for example) that one of the reasons that pupils in other countries out-perform those in England is that teachers in high-performing countries tend to adopt a 'whole-class interactive' approach to teaching mathematics. The teachers taking part in TIMSS were asked to indicate how frequently they used various types of classroom organisation, including whole-class, group and individual teaching. Teachers were asked to respond in terms of *never, some lessons, most lessons or every lesson*. Thus, information about the proportion of each lesson teachers devoted to each approach was not available. Table 3.2 shows the teachers' responses on the most frequent ways pupils were grouped for mathematics in the nine countries in most/every lesson(s). Full details of the responses of teachers in England are given in Table A3.1 in Annex A.

In England, the most frequent form of classroom organisation was for pupils to *work individually with the assistance of the teacher*; this approach was experienced in most/every lesson(s) by just over half of the Year 5 pupils taking part in the study. Other approaches, including whole-class teaching, were used much less frequently.

Whole-class teaching, however, was used by the majority of teachers in England in at least *some lessons* (Table A3.1 in Annex A).

Teachers in England were asked to say how frequently they divided their Year 5 class into groups for teaching mathematics. About 18 per cent said they always did so; 35 per cent did so for about three-quarters of the time; 21 per cent for about half the time; and 23 per cent for about a quarter of the time; four per cent never divided their class into groups for teaching mathematics.

Table 3.2 Comparisons between nine countries: teachers' reports on how pupils were grouped in class for most/every lesson(s) in mathematics in international fourth grade (Year 5 in England)

COUNTRY	Mean mathematics score	Work together as a class		Work individually		Work in pairs or small groups	
		with pupils responding to each other %	with the teacher teaching the whole class %	with assistance from the teacher %	without assistance from the teacher %	with assistance from the teacher %	without assistance from the teacher %
Singapore	625	23	68	37	41	25	10
Japan	597	50	78	34	25	7	2
Netherlands	577	34	60	56	44	5	5
Hungary	548	10	53	78	40	16	6
United States	545	32	54	55	15	20	11
Canada	532	18	37	49	23	24	10
Scotland	520	2	3	44	17	25	6
England	513	10	11	55	12	21	7
Norway	502	18	64	77	7	16	5

Row percentages do not sum to 100 since teachers could use more than one approach in most of their lessons.

Source: Mullis et al., 1997

Comparisons with other countries

Pupils working together as a class with the teacher teaching the whole class was *less frequent* in England and Scotland than in any of the other countries selected for comparison (Table 3.2).

Across countries, there was a slight positive association between pupils' mean mathematics scores and the extent to which pupils worked together as a class with the teacher teaching the whole class in most/every lesson(s), although the pattern was not consistent for all countries.

Working as a class with pupils responding to each other (which could, possibly, be considered to be similar to whole-class interactive teaching) was also *much less frequent* in England and Scotland than in most of the other countries. Teachers in Japan used this strategy more frequently than those in any of the other countries selected for comparison.

3.3 Primary school teachers' reports: *use of mathematics textbooks*

Virtually all of the teachers in England used mathematics textbooks or published schemes to some extent with their Year 5 pupils (Table A3.3). The main schemes were: Cambridge (used by 30 per cent); Heinemann (27 per cent); Peak (27 per cent); Ginn (25 per cent) and Hesse (11 per cent). Other schemes were each used by fewer than ten per cent of the Year 5 pupils.

Teachers were asked to estimate the percentage of teaching time that was based on textbooks or schemes of work; 23 per cent of Year 5 teachers based more than three-quarters of their teaching time on a textbook or scheme and a further 43 per cent based between half and three-quarters of their teaching time on a textbook or scheme. Twenty-two per cent based between quarter and a half of their teaching time on a textbook or scheme; and 12 per cent based less than a quarter of their teaching time on a textbook or scheme (Table A3.4 in Annex A).

Comparisons with other countries

As in England, textbooks were used by over 90 per cent of Year 5 teachers in the other countries selected for comparison (Mullis *et al.*, 1997).

3.4 Primary school teachers' reports: *use of calculators in mathematics lessons*

Calculators were widely available to pupils in England: the teachers of 73 per cent of the Year 5 pupils said that calculators were available to almost all the pupils during their mathematics lessons (Table A3.5 in Annex A).

Not surprisingly, calculators were used much less frequently by primary school pupils in Year 5 than by secondary school pupils in Year 9 (Keys *et al.*, 1997). Calculators were used for a variety of purposes in Year 5 mathematics classes in England. The frequency with which they were used for each task is given below in terms of the proportion of pupils using calculators *once or twice a week or more* for:

- ◆ checking answers (36 per cent)
- ◆ routine computation (33 per cent)

- ◆ solving complex problems (28 per cent)
- ◆ developing number concepts (24 per cent)
- ◆ tests and exams (four per cent).

Full details are given in Table A3.6 in Annex A.

Table 3.4 Comparisons between nine countries: teachers' reports on percentage of pupils using calculators once or twice a week or more in mathematics in international fourth grade (Year 5 in England)

COUNTRY	Mean mathematics score	Calculators used once or twice a week or more ¹ %
Singapore	625	1
Japan	597	1
Netherlands	577	4
Hungary	548	14
United States	545	39
Canada	532	29
England	513	53
Norway	502	1

Source: Mullis et al., 1997

Comparisons with other countries

Comparisons between the nine countries in terms of how often pupils use calculators are shown in Table 3.4. Pupils in England used calculators more frequently than those in the other countries. Pupils in Singapore, Japan and the Netherlands (the three highest-scoring of the countries selected for comparison) and Norway virtually never used calculators in mathematics lessons.

Across countries, there was a slight negative association between the frequency with which teachers said pupils used calculators and pupils' mean mathematics scores, i.e. pupils in countries where, on average, calculators were used less frequently tended to achieve slightly higher mean mathematics scores than those in countries where pupils used calculators more frequently, but the pattern was not consistent for all countries.

¹ Based on most frequent response for checking answers; tests and exams; routine computations; solving complex problems; and exploring number concepts.

3.5 Primary school teachers' reports: *mathematics homework*

In the questionnaire, teachers were asked how often they set mathematics homework. About 18 per cent of the teachers in England said they never set mathematics homework for their Year 5 pupils; 36 per cent set mathematics homework less than once a week; 42 per cent set mathematics homework once or twice a week; and five per cent set it more frequently.

Within England, there was a positive association between the frequency with which teachers set mathematics homework and pupils' mathematics scores (Table 3.7 in Annex A).

Comparisons with other countries

According to the teachers, homework was set less frequently in England than in all but one (the Netherlands) of the other countries selected for comparison. In Singapore, Japan, Hungary, Norway and the United States, the majority of Year 5 pupils were given mathematics homework at least three times a week (Table 3.5).

Table 3.5 Comparisons between nine countries: teachers' reports on the frequency with which they set mathematics homework to the target class

COUNTRY	Mean mathematics score	Never %	Less than once a week %	Once or twice a week %	Three times a week or more %
Singapore	625	0	2	12	86
Japan	597	1	9	25	64
Netherlands	577	50	36	15	0
Hungary	548	0	1	2	97
United States	545	3	3	22	71
Canada	532	14	9	45	30
Scotland	520	11	29	44	15
England	513	18	36	42	5
Norway	502	0	0	23	76

Sources: Mullis et al., 1997 and additional national analyses

CHAPTER 4

Mathematics Lessons: *Pupils' Perspectives*

Summary of main points

- ◆ Across countries, there were slight negative associations between pupils' mathematics scores and the frequency with which they undertook the following activities in mathematics lessons:
 - using calculators
 - working in pairs or small groups
 - working on a mathematics project
 although the patterns were not consistent for all countries.
- ◆ Comparisons indicate that the above activities were more frequent in mathematics classes in England than in most of the other countries selected for comparison.
- ◆ Across countries, there were no associations between pupils' mean mathematics scores and the frequency with which the following teaching approaches/activities were used in mathematics lessons:
 - tests
 - pupils copying notes from the board
 - pupils working with textbooks or workcards on their own.
- ◆ Computers were used more frequently in England and Scotland than in the other countries selected for comparison.

4.1 Preface

The purpose of this chapter is to provide further evidence on the teaching approaches and learning activities associated with high achievement in mathematics. It draws upon the pupils' responses to the questionnaire in order to supplement the teachers' reports described in Chapter 3. Pupils' perceptions of their mathematics lessons are described and the responses of pupils in England are compared with those of their counterparts in the other countries selected for comparison.

Topics covered include: small-group and project work; the use of work cards or textbooks; calculators and computers; homework; and testing. The main source of information was the pupils' responses to a question focusing on the range of teaching approaches and activities they experienced in their mathematics lessons. Pupils were presented with a list of approaches and activities and asked to estimate how often each took place in their mathematics classes, using a three-point scale: *most lessons*; *some lessons*; and *never*.

Comparisons between the responses of pupils in different countries have been made in terms of either the percentage responding *most lessons* or the combined percentages responding *most lessons* and *some lessons*. It should be remembered that the information provided in this chapter is based on pupils' perceptions, and that it provides a broad-brush picture of school mathematics lessons in England and elsewhere. It should also be remembered that pupils in different countries may have interpreted some of the questions in different ways.

4.2 Year 5 pupils' reports: *small-group and project work in mathematics*

Pupils were asked about teaching and learning approaches involving small-group or project work (Table 4.2). These approaches were *relatively frequent* in mathematics lessons in England. Nearly 90 per cent of the Year 5 pupils in England said that they worked in pairs or small groups in *some* (72 per cent) *or most* (17 per cent) *mathematics lessons*. A similar proportion said they worked on mathematics projects *in some* (41 per cent) *or most* (46 per cent) *lessons*. Full details of the responses of pupils in England are given in Table A4.1 in Annex A.

Comparisons with other countries

Working in small groups was *more frequent* in England and Scotland than in the other countries selected for comparison; project work was *more frequent* in England and Scotland than in all but one (Hungary) of the other eight countries.

Across countries, there was a slight negative association between the frequency of working in pairs or small groups and pupils' mean mathematics scores, i.e. small-group work was slightly less frequent in the higher-scoring of the selected countries. There was a similar negative association between frequency of project work and pupils' mathematics scores.

Table 4.2 Comparisons between nine countries: percentages of Year 5 pupils agreeing that they worked in (a) small groups; and (b) on mathematics projects in at least some lessons

COUNTRY	Mean mathematics score	In at least some lessons	
		Small groups %	Projects %
Singapore	625	70	35
Japan	597	72	44
Netherlands	577	67	54
Hungary	548	47	90
United States	545	86	66
Canada	532	84	72
Scotland	520	93	75
England	513	89	88
Norway	502	81	61

Source: analyses provided by the TIMSS International Study Center

4.3 Year 5 pupils' reports: use of textbooks and copying from the board in mathematics

Fifty five per cent of the Year 5 pupils in England said that they worked from workcards or textbooks on their own in *most mathematics lessons* and about a third said that they did so in *some lessons*.

Copying notes from the board was used less frequently: 17 per cent of the Year 5 pupils in England said that they copied notes from the board in *most mathematics lessons* although a further 35 per cent said that they did so in *some lessons*.

Full details of the responses of pupils in England are given in Table A4.1 in Annex A.

Comparisons with other countries

Analyses of the pupils' responses given in Table 4.3 show that copying notes from the board, which was *relatively infrequent* in England, was also

relatively infrequent in Singapore, the highest-scoring country. On the other hand, it was *relatively frequent* in Japan, another high-scoring country.

Working on their own from workcards or textbooks was fairly frequent in six of the nine countries selected for comparison, with between 55 and 65 per cent of students saying that they did so in *most lessons*. Working on their own from workcards or textbooks was, however, *relatively infrequent* in Japan, with only 12 per cent of students doing so in *most lessons*. Across countries, there was no obvious association between the extent to which this approach was used and pupils' mean mathematics scores.

Table 4.3 Comparisons between nine countries: percentages of Year 5 pupils agreeing that they (a) copied notes from the board; and (b) used textbooks or workcards in most mathematics lessons

COUNTRY	Mean mathematics score	In most lessons	
		Copy notes from the board %	Work on own from textbooks or workcards %
Singapore	625	21	43
Japan	597	57	12
Netherlands	577	4	59
Hungary	548	50	59
United States	545	32	57
Canada	532	28	65
Scotland	520	20	62
England	513	17	55
Norway	502	20	40

Source: analyses provided by the TIMSS International Study Center

4.4 Pupils' reports: use of things from everyday life in mathematics

About 70 per cent of the pupils in England used things from everyday life in *at least some of their mathematics lessons*. Within England, the association between mathematics achievement and the use of things from everyday life when solving mathematics problems was weak and non-linear (Table A4.1 in Annex A).

Comparisons with other countries

As Table 4.4 shows, using things from everyday life was a technique used *fairly frequently* in mathematics lessons for nine-year-olds in all the countries selected for comparison. Across countries, there was no association between the extent to which teachers used this technique and pupils' mean mathematics scores.

Table 4.4 Comparisons between nine countries: percentages of Year 5 pupils agreeing that they used things from everyday life in their mathematics work in at least some lessons

COUNTRY	Mean mathematics score	In at least some lessons
		Using things from everyday life to solve problems %
Singapore	625	83
Japan	597	80
Netherlands	577	70
Hungary	548	69
United States	545	85
Canada	532	83
Scotland	520	89
England	513	70
Norway	502	68

Source: Mullis et al., 1997

4.5 Pupils' reports: use of calculators and computers in mathematics

Pupils were asked to indicate approximately how frequently they used calculators and computers in their mathematics lessons.

Eleven per cent of the pupils in England said that they used calculators in *most mathematics lessons*; and nearly three-quarters said they did so in *some lessons*. About 15 per cent *never* used calculators. Within England, there was no association between the frequency with which calculators were used and pupils' mathematics scores (Table 4.5.1).

Table 4.5.1 Year 5 pupils' reports: frequency of using calculators in mathematics lessons

ACTIVITY	Never	Some lessons	Most lessons
We use calculators	15%	74%	11%
Mean mathematics score	510	524	474

Source: Mullis et al., 1997

Nearly 90 per cent of the pupils in England and Scotland indicated that they had a computer at home (Beaton et al., 1996a). However, it is possible that this is an overestimate since about 60 per cent of the households with dependent children aged 5-16 had a home computer in 1992 (Central Statistical Office, 1994). Some pupils who did not have a computer at home may have misclassified a computer games machine as a computer. Similar results were found in our survey of 13-year-olds (Keys et al., 1997).

Computers were used in *at least some* mathematics lessons by about 60 per cent of the pupils in England, although the proportion using them frequently (*most lessons*) was only about nine per cent. Pupils in England who used computers in mathematics lessons appeared to enjoy doing so (Table A9.4 in Annex A).

In England, there was a negative association between the extent of computer use and pupils' mathematics scores. Computers appeared to be used more frequently with lower-achieving pupils (Table A4.1 in Annex A). Possibly this is because of the relatively widespread availability of specially designed software for low attainers in mathematics. A similar phenomenon was identified in our survey of 13-year-olds (Keys *et al.*, 1997).

Table 4.5.2 Comparisons between nine countries: percentages of Year 5 pupils agreeing that they (a) used calculators; (b) used computers in at least some lessons

COUNTRY	Mean mathematics score	In at least some lessons	
		Calculators used %	Computers used %
Singapore	625	4	39
Japan	597	12	11
Netherlands	577	10	49
Hungary	548	10	9
United States	545	66	41
Canada	532	49	38
Scotland	520	95	67
England	513	85	60
Norway	502	11	29

Source: Mullis *et al.*, 1997

Comparisons with other countries

The use of calculators in primary schools has been put forward as one of the reasons for children in England performing badly in mathematics (Reynolds and Farrell, 1996). The study did, indeed, find that calculators were used *more frequently* in mathematics lessons in England and Scotland than in any of the other countries selected for comparison; but, *within* England, there was no association between frequency of calculator use and pupils' mathematics score (Table 4.5.1).

Across countries, there was a negative association between frequency of calculator use in mathematics lessons and pupils' mean mathematics scores. Although the pattern was not consistent for all countries, the five highest-scoring countries used calculators much less frequently than most of the lower-scoring countries (Table 4.5.2).

Computers were used *more frequently* in mathematics lessons in England and Scotland than in any of the other countries selected for comparison (Table 4.5.2).

4.6 Year 5 pupils' reports: homework in mathematics

Pupils were asked to estimate how long they spent each week on mathematics homework. Just over a third of the Year 5 pupils in England said they did not do mathematics homework; nearly half spent less than an hour a week; and 20 per cent spent more than an hour (Table 4.6).

Table 4.6 Year 5 pupils in England: hours per week spent on mathematics homework

HOURS/WEEK	%	Mean mathematics score
no time	35	507
less than 1 hour	45	526
1 - 2 hours	16	520
3 hours or more	4	511

Pupils were also asked to say how often their teachers gave them mathematics homework. Their responses are very consistent with those described in the previous paragraph: about 28 per cent of the pupils in England said that their teachers *never* gave them mathematics; about half said their teachers gave them mathematics homework in some lessons and about 20 per cent said homework was given *in most lessons* (Table A4.1 in Annex A).

4.7 Year 5 pupils' reports: assessment in mathematics

Pupils were asked to say how frequently they were given a test in their mathematics lessons. As Table 4.7.1 shows, about 20 per cent of the Year 5 pupils in England said that they were given mathematics tests in most lessons and nearly three-quarters said they were given mathematics tests in *some lessons*. Within England, there was no association between the frequency of testing in mathematics classes and pupils' mean mathematics scores (Table 4.7.1).

Table 4.7.1 Year 5 pupils' reports: frequency of tests in mathematics classes

ACTIVITY	Most lessons	Some lessons	Never
We have a test	19%	74%	7%
Mean mathematics score	481	527	495

Table 4.7.2 Comparisons between nine countries: percentages of Year 5 pupils agreeing that they had tests in most mathematics lessons

COUNTRY	Mean mathematics score	Tests in most lessons %
Singapore	625	26
Japan	597	7
Netherlands	577	11
Hungary	548	14
United States	545	48
Canada	532	32
Scotland	520	19
England	513	19
Norway	502	15

Source: information provided by TIMSS International Study Center

Comparisons with other countries

As Table 4.7.2 shows, there was a fairly wide range of practice in the countries selected for comparison. Compared with England and Scotland, testing was *more frequent* in three countries (United States, Canada and Singapore), and less frequent in four countries (Hungary, the Netherlands, Norway and Japan). Across countries, there was no association between the frequency of testing in mathematics lessons and pupils' mean mathematics scores.

In interpreting these results, it is important to remember that no information was available about the types of testing used in different countries. Pupils in different countries may have interpreted the word *test* differently. Some may be referring to a short test of mental arithmetic, others to teacher-made written tests, others to standardised multiple-choice tests, and so on.

CHAPTER 5

Science Lessons: *Teachers' Perspectives*

Summary of main points

- ◆ In England, science was taught as a separate subject to about three-quarters of the Year 5 pupils.
- ◆ Science was taught as a separate subject to the majority of pupils in most of the other countries selected for comparison. Exceptions were Scotland and Norway.
- ◆ Practical activities were an important feature of primary school science classes in England. Virtually all the Year 5 pupils did practical work in science, with about 75 per cent doing so for half or more of their time in science lessons.
- ◆ The most frequently used form of classroom organisation for science was for pupils to work in pairs or small groups with assistance from the teacher, which was used in most/every lesson by about a third of teachers. Other forms of classroom organisation were used less frequently.
- ◆ Working in pairs or small groups was more frequent in England, Canada and Singapore than in most of the other countries selected for comparison.
- ◆ In England and Scotland, it was relatively uncommon for pupils to work together as a class with the teacher teaching the whole class. This approach was used most frequently in the Netherlands and Hungary.
- ◆ In England and Scotland, it was relatively uncommon for pupils to work together as a class responding to each other. This approach was used more frequently in Japan and the Netherlands.
- ◆ Across countries, there were no associations between the teaching approaches used and pupils' mean science scores.

5.1 Preface

The purpose of this chapter is to provide information on the teaching approaches and learning activities associated with high achievement in science. It focuses on the questionnaire responses of primary school teachers' in England and ten other countries. The results will be examined in order to answer three key questions:

- ◆ Which teaching approaches were used most frequently in science lessons in England?
- ◆ Across countries, were there any associations between particular teaching approaches and pupils' mean science scores?
- ◆ Were there any common factors or patterns within the higher-scoring countries (such as England) which differentiated their teaching approaches from those used in lower-scoring countries?

In order to answer these questions, the chapter will describe the responses of primary school teachers in England to a range of questions concerned with teaching approaches used in science and compare their responses with those of teachers in the other countries selected for comparison. Teachers were not asked any questions about homework in science.

In most of the questions reported in this chapter, teachers were asked to respond using a four-point scale: *never/almost never; some lessons; most lessons; every lesson*. In most cases, their responses have been reported in terms of the combined percentage opting for *most/every lesson(s)*.

5.2 Primary school teachers' reports: *classroom organisation for science lessons*

Primary school teachers were asked to indicate how frequently they used each of the types of classroom organisation shown in Table 5.2. They were asked to respond in terms of a scale: *every lesson; most lessons; some lessons; never or almost never*. They were not asked about the proportion of each lesson for which they used each type of classroom organisation.

Table 5.2 shows the teachers' responses on the most frequent ways pupils were grouped for science in the nine countries. In England, there was no clear pattern: none of the approaches was used by more than 34 per cent of the teachers.

- ◆ The most frequently used approach, pupils working in pairs or small groups with the assistance of the teacher, was used in most or every science lesson by about a third of the teachers in England.

- ◆ Pupils working in pairs or small groups without assistance from the teacher was much less common.
- ◆ Pupils working together as a class was not a common form of classroom organisation in science lessons in England, either with the teacher teaching the whole class or with pupils responding to each other.
- ◆ Working individually with or without the assistance of the teacher was also relatively uncommon.

Full details of the responses of primary school teachers in England are given in Table A5.1 in Annex A.

Table 5.2 Comparisons between nine countries: teachers' reports on how the Year 5 pupils were grouped in class for most/every lesson(s) in science

COUNTRY	Mean science score	Work together as a class		Work individually		Work in pairs or small groups	
		with pupils responding to each other	with the teacher teaching the whole class	with assistance from the teacher	without assistance from the teacher	with assistance from the teacher	without assistance from the teacher
Japan	574	51	68	18	4	24	12
United States	565	35	47	20	6	26	10
Netherlands	557	47	75	17	9	8	9
England	551	18	17	14	4	34	7
Canada	549	21	36	18	5	35	14
Singapore	547	21	67	51	15	43	18
Scotland	536	5	15	5	4	29	7
Hungary	532	19	77	43	8	16	4
Norway	530	38	57	20	1	19	6

Row percentages do not sum to 100 since teachers could use more than one approach in most of their lessons.

Source: Martin et al., 1997

Comparisons with other countries

Within most of the countries selected for our comparisons, pupils experienced a range of different approaches. However, the predominant approach varied between countries. Across countries, there were no associations between the teaching approaches used and pupils' mean science scores (Table 5.2).

- ◆ Working in pairs or small groups with the assistance of the teacher was used most frequently in Singapore, followed by Canada, England and Scotland. This was the predominant approach in England and Scotland but not in the other two countries.

- ◆ Working as a class with the teacher teaching the whole class was much less frequent in England and Scotland than in most of the other countries selected for comparison. It was most frequent in Japan, the Netherlands, Singapore and Hungary; in all four countries, this was the predominant approach.
- ◆ Working as a class with the pupils responding to each other was used most frequently in Japan, followed by the Netherlands. It was used least frequently in Scotland. This was not the predominant approach in any of the countries selected for our comparisons.

5.3 Primary school teachers' reports: *whether science was taught mainly as a separate subject*

About three-quarters of the Year 5 pupils in England were taught science mainly as a separate subject (Martin *et al.*, 1997). The mean time devoted to science each week in England was similar whether or not science was taught as a separate subject.

Comparisons with other countries

In most of the nine countries selected for comparison, the proportion of pupils in grades equivalent to Year 5 who were taught science as a separate subject ranged from 68 to 100 per cent. Exceptions were Norway, where science was never taught as a separate subject, and Scotland, where only 18 per cent of the pupils were taught science as a separate subject (Martin *et al.*, 1997).

5.4 Primary school teachers' reports: *use of science textbooks*

About 78 per cent of the primary school teachers in England used textbooks or published schemes to some extent with their Year 5 pupils (Table A5.3 in Annex A).

Main resources used were teacher- or school-made materials. These were used by 64 per cent and 36 per cent of the teachers, respectively. Textbooks and published schemes were used less frequently. The following textbooks/schemes were each used with 10-20 per cent of the Year 5 pupils: Ginn; New Horizons; non-BBC TV; BBC Primary Science; and Collins.

Primary school teachers were not asked to estimate the amount of science teaching time they based on science textbook(s).

5.5 Practical activities in science

Primary school teachers in England were asked to estimate the proportion of their Year 5 pupils' time in science lessons was spent on practical activities on their own or in small groups. Virtually all of the Year 5 pupils did practical work in science lessons: 24 per cent for three-quarters of their time or more; 48 per cent for half the time; and 27 per cent for a quarter of the time (Table A5.4 in Annex A). This question was not part of the international version of the questionnaire, so it is not possible to make comparisons with other countries.

CHAPTER 6

Science Lessons: *Pupils' Perspectives*

Summary of main points

- ◆ Comparisons suggest that the following activities were more frequent in Year 5 science classes in England than in most of the other countries selected for comparison:
 - pupils doing experiments
 - pupils working in pairs or small groups
 - pupils doing science projects
 - pupils using things from everyday life to solve science problems.
- ◆ Although experiments or practical investigations were undertaken more frequently in Year 5 science classes in England than in most of the other countries, they were even more frequent in Japan (the highest-scoring of the countries selected for our comparisons).
- ◆ Across countries, there were no associations between mean science scores and the frequency of the following teaching approaches or activities:
 - pupils doing experiments
 - pupils working in pairs or small groups
 - pupils doing science projects
 - pupils copying notes from the board
 - pupils working from workcards or textbooks on their own
 - pupils using things from everyday life to solve science problems
 - pupils being given tests in science lessons.

6.1 Preface

The purpose of this chapter is to provide further evidence on the teaching approaches and learning activities associated with high achievement in science. It draws upon the pupils' responses to the questionnaire in order to supplement the teachers' reports described in Chapter 5. In this chapter:

- ◆ the pupils' perceptions of their science lessons are described
- ◆ the responses of pupils in England are compared with those of their counterparts in the other eight countries selected for comparison.

Topics covered in this chapter include: experiments and practical investigations, small-group and project work, the use of workcards or textbooks, homework, and testing. Main sources of information were the pupils' responses to a question focusing on the range of teaching approaches and activities they experienced in their science lessons. Pupils were asked to estimate how often each of a list of teaching approaches or activities took place in their science classes, using a three-point scale: *most lessons*; *some lessons*; and *never*.

In most cases, comparisons between the responses of pupils in different countries have been made in terms of the combined percentages responding *most lessons* and *every lesson*. It should be remembered that the information provided in this chapter is based on pupils' perceptions of the activities which took place in their science lessons, and that it provides a broad brush picture of primary school science lessons in England and elsewhere. It should also be remembered that pupils in different countries may have interpreted some of the questions in different ways.

6.2 Year 5 pupils' reports: *experiments and practical investigations in science*

Nearly 90 per cent of the Year 5 pupils in England said that they did experiments or practical investigations *in at least some science lessons*. About 80 per cent said their teacher demonstrated an experiment in *at least some science lessons*. The responses of Year 4 pupils were similar. Full details of the pupils' responses are given in Table A6.1 in Annex A.

Comparisons with other countries

Table 6.2.1 shows the responses of pupils in the nine countries selected for comparison. Although experiments or practical investigations were undertaken *more frequently* in Year 5 science classes in England than in most of the other countries selected for comparison, they were even more frequent in Japan (the highest-scoring of the selected countries). In Hungary and the Netherlands, demonstrations of experiments by teachers were more frequent than practical activities for pupils. Across countries, there was no association between the frequency of practical work and mean science scores.

Table 6.2.1 Comparisons between nine countries: percentage of Year 5 pupils agreeing that they did experiments in at least some of their science lessons

COUNTRY	Mean science score	In at least some lessons	
		Do experiments %	Teacher demonstrates an experiment %
Japan	574	97	93
United States	565	70	85
Netherlands	557	57	74
England	551	88	78
Canada	549	74	81
Singapore	547	80	98
Scotland	536	73	83
Hungary	532	40	76
Norway	530	84	89

Source: analyses provided by TIMSS International Study Center

Pupils were asked about teaching and learning approaches involving small-group and/or project work.

- ◆ Over 90 per cent of the Year 5 pupils in England said that they worked in pairs or small groups in *at least some science lessons*.
- ◆ A similar proportion said they worked on science projects in *at least some science lessons*.

Full details of the responses of pupils in England are given in Table A6.1 in Annex A.

Comparisons with other countries

Practical investigations in science are frequently carried out in pairs or small groups, so it is scarcely surprising that pupils in England, who did more practical work than those in most other countries, were *more likely* to say that they worked in pairs or small groups than those in other countries. Working in pairs or small groups was *fairly frequent* in most of the other countries selected for comparison.

Project work was *most frequent* in England, the United States and Hungary. It was least frequent in Japan.

Across countries, there were no associations between mean science scores and the frequency of small-group or project work.

Table 6.2.2 Comparisons between nine countries: percentages of Year 5 pupils agreeing that they worked (a) in small groups; and (b) on science projects in at least some of their science lessons

COUNTRY	Mean science score	In at least some lessons	
		Small groups %	Projects %
Japan	574	80	62
United States	565	88	92
Netherlands	557	76	82
England	551	94	92
Canada	549	86	90
Singapore	547	85	83
Scotland	536	90	85
Hungary	532	51	92
Norway	530	83	76

Source: analyses provided by the TIMSS International Study Center

6.3 Year 5 pupils' reports: use of textbooks or workcards and copying from the board in science

Pupils were asked to say how often they copied notes from the board and worked from textbooks or workcards in science. Analyses of the pupils' responses revealed that:

- ◆ Twenty-three per cent of the Year 5 pupils in England said that they worked from workcards or textbooks on their own in *most science lessons* and about 37 per cent said that they did so in *some lessons*.
- ◆ Thirty one per cent of the Year 5 pupils in England said that they copied notes from the board in *most science lessons* and a further 57 per cent said that they did so in *some lessons*.

Full details of the responses of pupils in England are given in Tables A6.1 in Annex A.

Comparisons with other countries

Copying notes from the board was *less frequent* in science lessons in England than in about half of the other countries selected for comparison. It was most frequent in Japan.

Pupils in England worked on their own from workcards and textbooks in science lessons *less frequently* than pupils in all but two (Japan and the Netherlands) of the countries selected for comparison. Working from workcards or textbooks was *most frequent* in science classes in the United States, followed by Canada.

Across countries, there were no associations between mean science score and the frequency of copying notes from the board or using textbooks.

Table 6.3 Comparisons between countries: percentages of Year 5 pupils agreeing that they (a) copied notes from the board; and (b) used textbooks or workcards in most science lessons

COUNTRY	Mean science score	In most lessons	
		Copy notes from the board %	Work on own from textbooks or workcards %
Japan	574	52	8
United States	565	44	42
Netherlands	557	13	10
England	551	31	23
Canada	549	43	38
Singapore	547	35	35
Scotland	536	24	33
Hungary	532	39	35
Norway	530	27	30

Source: analyses provided by the TIMSS International Study Center

6.4 Year 5 pupils' reports: use of things from everyday life in science

Pupils were asked to say how often they used things from everyday life in their science lessons. About 80 per cent of the pupils in England said that they used things from everyday life in *at least some lessons* (Table 6.4).

Comparisons with other countries

Using things from everyday life to solve problems in their science lesson was a technique used *most frequently* in Singapore, Scotland and England, although this appeared to be quite a common practice in all the countries selected for comparison.

Table 6.4 Comparisons between seven countries: percentages of Year 5 pupils agreeing that they used things from everyday life in solving problems in at least some science lessons

COUNTRY	Mean science score	In at least some lessons
		Using things from everyday life to solve problems %
Japan	574	76
United States	565	79
Netherlands	557	66
England	551	80
Canada	549	76
Singapore	547	85
Scotland	536	83
Hungary	532	72
Norway	530	64

Source: analyses provided by TIMSS International Study Center

6.5 Year 5 pupils' reports: homework in science

The pupils' responses reveal that:

- ◆ About 40 per cent of the Year 5 pupils said they spent some time each week doing science homework, with the majority spending less than one hour (Table 6.5.1).
- ◆ About half of the pupils in England said that their teachers gave them science homework in at least some lessons (Table 6.5.2).

Table 6.5.1 Year 5 pupils in England: hours per week spent on science homework

HOURS/WEEK	%	Mean science score
no time	60	552
less than one hour	31	571
1-2 hours	8	563
3 hours or more	2	505

Comparisons with other countries

Science homework was given less frequently to Year 5 pupils in England than in all of the other countries selected for comparison (Table 6.5.2). Across countries, there was no association between the frequency with which science homework was set and pupils' mean scores.

Table 6.5.2 Comparisons between nine countries: percentages of Year 5 pupils agreeing that their teacher gave them homework in at least some science lessons

COUNTRY	Mean science score	In at least some lessons
		Our teacher gives us homework %
Japan	574	76
United States	565	87
Netherlands	557	59
England	551	49
Canada	549	79
Singapore	547	98
Scotland	536	69
Hungary	532	95
Norway	530	87

Source: analyses provided by TIMSS International Study Center

6.6 Year 5 pupils' reports: assessment in science

As Table 6.6.1 shows, about 12 per cent of the Year 5 pupils in England said that they were given tests in *most science lessons*, and a further 59 per cent said they were given tests in *some lessons*.

Table 6.6.1 Year 5 pupils in England: frequency of tests in science classes

ACTIVITY	Most lessons	Some lessons	Never
We have a test	12%	59%	29%
Mean science score	496	556	573

Comparisons with other countries

As Table 6.6.2 shows, pupils in England were given science tests less frequently than those in most of the countries selected for comparison. Testing was most frequent in Singapore, followed by the United States. Across countries, there was no association between frequency of testing in science classes and pupils' mean science score. In interpreting these results, however, it is important to remember that no information was available from the pupils about the types of tests they were given.

Table 6.6.2 Comparisons between nine countries: *percentages of Year 5 pupils agreeing that they had tests in at least some of their science lessons*

COUNTRY	Mean science score	Tests given in at least some lessons %
Japan	574	85
United States	565	94
Netherlands	557	75
England	551	71
Canada	549	87
Singapore	547	96
Scotland	536	76
Hungary	532	67
Norway	530	62

Source: analyses provided by TIMSS International Study Center

CHAPTER 7

Primary School Teachers: *Background Information*

Summary of main points

- ◆ About 65 per cent of the teachers teaching Year 5 pupils in England were aged 40 or over. Only two of the other countries selected for comparison (Canada and Norway) had higher proportions of older teachers. The lowest proportions were in Japan and Hungary.
- ◆ About 75 per cent of the teachers teaching Year 5 pupils in England were female. The proportion of female teachers in England was slightly lower than in many of the other countries. Exception were the Netherlands (where 35 per cent of the teachers were female) and Japan (61 per cent).
- ◆ About 58 per cent of the teachers teaching mathematics and science to Year 5 pupils in England were graduates. The proportion of graduates teaching these subjects to Year 4 pupils was similar.
- ◆ The majority of Year 5 teachers in England were class teachers teaching both mathematics and science to their own class. The proportions were similar in most of the other countries selected for comparison. Exceptions were Hungary and Singapore, where about half of the pupils were taught mathematics and science by teachers other than their class teachers.
- ◆ About a third of the primary school teachers in England said they would like to change to another career, given the chance.
- ◆ Fewer than 20 per cent of the teachers in England believed that society appreciated their work.
- ◆ Compared with their counterparts in most of the other 25 countries taking part in TIMSS at the upper primary level, teachers in England tended to spend more time marking pupils' work, more time on administration and less time preparing tests.

7.1 Preface

The purpose of this chapter is to provide background information on the primary school teachers of the pupils who took part in the study. The first section of the questionnaire completed by the teachers sought background information, including: biographical details; particulars of teachers' subject-related backgrounds; and their time spent on school-related activities outside the classroom. Where appropriate, comparisons have been made with teachers in the other countries selected for comparison.

7.2 Biographical details

About 65 per cent of teachers of both subjects were aged 40 or over. Their length of teaching experience matched their age profiles: about two-thirds had over ten years' teaching experience. The majority (96 per cent) of the Year 5 teachers in England were full-time (Table A7.2). Three-quarters of the teachers were female (Table A7.1). About 59 per cent of the teachers teaching Year 5 pupils in England were graduates. The remaining 41 per cent held teachers' certificates (Table A7.1 in Annex A).

Table 7.2 Comparisons between nine countries: proportions of female teachers teaching mathematics and science to Year 5 pupils

COUNTRY	Mean mathematics score	Mean science score	Female teachers	
			mathematics %	science %
Singapore	625	547	82	78
Japan	597	574	61	61
Netherlands	577	557	35	35
Hungary	548	532	91	90
United States	545	565	86	86
Canada	532	549	80	74
Scotland	520	536	92	92
England	513	551	75	75
Norway	502	530	78	78

Source: Martin *et al.*, 1997; Mullis *et al.*, 1997

Note: Differences in the proportions of female teachers teaching mathematics and science in some countries may have arisen because some schools have specialist teachers for one or both subjects.

Comparisons with other countries

The proportions of teachers aged 40 or more in the other countries selected for comparison ranged from 50 per cent (Singapore and Hungary) to 79 per cent (Norway) (Mullis *et al.*, 1997).

The proportion of female teachers in England was slightly lower than in many of the other countries; in five of these countries, the proportions of

female teachers teaching mathematics to Year 5 pupils were 80 per cent or more. Exceptions were the Netherlands, where 35 per cent of the teachers were female; and Japan, 61 per cent.

7.3 Teaching mathematics and science

The majority (89 per cent) of Year 5 pupils in England were taught both mathematics and science by their class teacher.

Comparisons with other countries

The proportions of pupils taught both subjects by their class teacher in the nine countries selected for comparison are shown below.

• Japan	100%
• Netherlands	100%
• Scotland	100%
• United States	94%
• England	89%
• Canada	88%
• Norway	77%
• Singapore	50%
• Hungary	47%

7.4 Attitudes towards teaching as a career

The questionnaires for teachers included sections focusing on teachers' attitudes towards teaching as a career (Table A7.3 in Annex A).

- ◆ The majority (about 80 per cent) of teachers teaching Year 5 pupils in England said that teaching had been their first choice of career.
- ◆ About a third of the teachers in England indicated that they would change to another career if they were given the opportunity.
- ◆ Less than 20 per cent of the teachers in England thought that society appreciated their work.
- ◆ Nearly 90 per cent of the teachers in England said they thought that their pupils appreciated their work.

When asked to rank a randomly presented list of nine occupations in order of social status/prestige, the teachers ranked the occupations in the following order:

- equal { Lawyer
- Doctor
- Senior civil servant
- Accountant
- Engineer
- Secondary school teacher
- Primary school teacher
- Nurse
- Unskilled manual worker

Table 7.4. Teachers teaching mathematics¹ to Year 5 pupils: views about teaching as a career in England compared with teachers in three other countries

COUNTRY	Teaching first choice %	Would change to another career %	Believes society appreciates his/her work %	Believes pupils appreciate his/her work %
England	80	33	19	88
Hungary	94	15	8	95
Netherlands	83	19	—	—
Canada	76	24	57	92

Source: analyses provided by the TIMSS International Study Center

These questions were not asked in the other five countries.

¹ The responses of teachers teaching science to Year 5 pupils were very similar (since most, but not all, of the teachers taking part in the study taught both subjects to their class).

Comparisons with other countries

Only three of the other countries selected for comparison asked this set of questions of primary school teachers. In common with those in England, the majority of teachers in these countries said that teaching had been their first choice of career and believed that their pupils appreciated their work. However, compared with their counterparts in these countries, teachers in England were:

- ◆ *more likely* to say that they would change to another career if they had the opportunity
- ◆ *less likely* than those in Canada (but more likely than those in Hungary) to believe that society appreciated their work.

Teachers in Hungary were far more negative about this issue. It is pertinent to note that teaching in Hungary is not a high status profession and that teachers are amongst the lowest paid of government employees (Krolopp and Vari, 1997).

7.5 How teachers spend their time

The teachers were asked to indicate approximately how many hours per week, on average, they spent on each of a range of school-related activities outside the formal school day (i.e. before and after school and at weekends). They were asked to respond using a five-point scale: *none; less than one hour; one to two hours, three to four hours; more than four hours*. Means were calculated from these grouped data for the international report. The mean amount of time spent by teachers of Year 5 pupils in England, together with the range of means for all the 26 countries taking part in the study, are shown in Table 7.5.

Table 7.5 Comparisons between 26 countries: the responses of teachers teaching mathematics to Year 5 pupils on the average time per week spent on various school-related activities outside the formal school day

ACTIVITY	Mean hours per week spent on various activities	
	Teachers in England	Range in 26 countries
Preparing and marking pupils' tests or exams	1.0	0.8–2.7
Reading and marking pupils' other work	4.0	1.6–4.2
Planning lessons by self	3.4	1.6–3.8
Seeing pupils outside class time (e.g. additional help with work, guidance)	1.0	0.2–2.3
Seeing parents	0.8	0.4–1.7
Professional reading and development activities (e.g. courses, conferences)	1.2	0.6–2.2
Keeping pupils' records up to date	1.5	0.4–1.7
Administrative tasks including staff meetings (e.g. photocopying, displaying pupils' work)	3.2	1.0–3.3
*Involvement in school clubs, sports, orchestras, etc.	1.1	N/A

Source: Mullis et al., 1997

Mean hours based on: no time=0; less than one hour=0.5; one-to-two hours=1.5; two-to-three hours=2.5; three-to-four hours=3.5; more than four hours=5.

*This question was not asked in other countries

Note: the majority of these teachers also taught science to the Year 5 pupils

Comparisons with other countries

Compared with their counterparts in most of the 26 countries taking part in TIMSS, teachers in England tend to spend

- ◆ *more time* reading and marking pupils' work; only teachers in Singapore spent more time on this activity; teachers in the Netherlands spent the same amount of time as those in England;
- ◆ *more time* on administration, illustrated internationally as photocopying and displaying pupils' work; the only other country in which teachers spent as much time on the activity was New Zealand;
- ◆ *less time* preparing tests; the only country in which teachers spent less time was Scotland.

On average, primary school teachers in England spent 1.1 hours a week on activities related to school, clubs, sports and orchestras, etc. This question was not asked in other countries.

In about two-thirds of the 26 countries taking part in the TIMSS survey of nine-year-olds (including England) teachers of the majority of Year 5 pupils met with colleagues to discuss and/or plan curriculum or teaching approaches at least once a week for mathematics (Mullis *et al.*, 1997) and science (Martin *et al.*, 1997). For both subjects, meetings for this purpose were more frequent in England than in most other countries.

CHAPTER 8

Pupils' Background

Summary of main points

- ◆ Over 6,100 pupils took part in the study in England. Approximately half were in Year 4 and half in Year 5. The proportions of boys and girls were about equal.
- ◆ Within England, there was a positive association between the proxy measure for the educational/cultural level of the home (number of books at home) and pupils' mathematics and science scores.
- ◆ The out-of-school activities, other than homework, of Year 5 pupils in England (in order of frequency) were:
 - watching television or videos
 - playing sports
 - playing with friends
 - playing computer games
 - reading for pleasure
 - helping at home.
- ◆ The responses of the Year 4 pupils in England were quite similar to those of the Year 5 pupils.

8.1 Preface

This chapter draws upon the information collected from pupils by means of the questionnaire completed by all the pupils taking part in TIMSS. The purpose of this chapter is to describe the responses of the pupils who took part in the study about themselves, their home background, and their out-of-school activities.

The Year 5 pupils' responses to the background questions are summarised below. In most cases, the results were similar for Year 4. Tables A8.1 and A8.2 in Annex A give full details of the responses of pupils in Years 4 and 5.

8.2 The pupils

The 6,142 pupils taking part in TIMSS at Population 2 were born between 1 September 1984 and 31 August 1986. At the time of testing, their ages ranged from eight years seven months to ten years six months; just over half were in Year 4 and just under half in Year 5. The proportion of girls was about 51 per cent. About 93 per cent were born in the United Kingdom and 96 per cent said they *always* or *almost always* spoke English at home (Table A8.1 in Annex A). The proportion of pupils who always or almost always spoke the language of the test at home was higher in England than in most of the other countries taking part in the TIMSS survey on nine-year-olds; in only two countries, the Czech Republic and Portugal, were the percentages higher (Mullis *et al.*, 1997).

8.3 The pupils' home background

The pupils' families

About 85 per cent of the pupils said that their mothers had been born in the UK. A similar proportion had fathers born in the UK. Just over three-quarters of the pupils lived with both natural parents and about 20 per cent with their mother only or with their mother and a stepfather. The majority (about 93 per cent) of the pupils lived in homes containing up to six people (which might include themselves, their parents, brothers, sisters, other relatives or non-relatives); homes containing four people were the most usual (Table A8.1 in Annex A).

Number of books in the home

The number of books in the home has been used in many previous studies as a proxy measure for the educational/cultural level of the home (Comber and Keeves, 1973; Keys, 1987; Cresswell and Gubb, 1987; Robitaille and Garden, 1989; Keys and Fernandes, 1993). A question asking pupils to indicate the approximate number of books in the home was included in the

TIMSS questionnaire for the same purpose (Table 8.3.1). As in previous studies, there were positive associations between the number of books in the home and the pupils' mathematics and science scores; pupils who said there were more books in their homes tended to achieve higher scores than pupils with fewer books.

Table 8.3.1 Year 5 pupils' responses in England: *number of books in the home*

NO. OF BOOKS	%	Mean mathematics score	Mean science score
0-10 books	7	451	474
11-25 books	13	475	505
26-100 books	26	505	542
101-200 books	23	533	569
more than 200 books	31	537	586

Source: Martin et al., 1997; Mullis et al., 1997

Educational aids in the home

Pupils were asked to indicate which of four educational aids (calculator, computer, study desk/table, and dictionary) they had in their homes. The responses of Year 5 pupils are shown in Table 8.3.2. The proportion of Year 4 pupils having each of these educational aids at home was slightly lower (Table A8.1 in Annex A).

Table 8.3.2 Year 5 pupils' responses in England: *educational aids in the home*

ITEM	Year 5 %
Calculator	93
Computer	88
Study desk/table	80
Dictionary	93

This question was included in the pupil questionnaires in every country taking part in TIMSS. In the international analysis, a composite variable, based on the possession of three of these items (dictionary, study desk/table and computer), was derived. About two-thirds of the Year 5 pupils in England had all three educational aids. This was one of the highest proportions amongst the 26 countries taking part in TIMSS at this level. However, as noted in Chapter 4, the proportions of pupils in England and Scotland indicating that they had computers in their homes were much higher than in most other countries and did not accord with national statistics. It seems possible that pupils in England and Scotland who did not have a computer at home may have misclassified a computer games machine as a computer.

8.4 Out-of-school activities

Pupils were asked to indicate approximately how much time they spent on a range of out-of-school activities. For some activities, they were asked to respond in terms of hours a day and, for others, in terms of hours a week (*no time; less than an hour; one to two hours; three to four hours; more than four hours*). All the means given in this section have, therefore, been calculated from grouped data. The responses of pupils in England are given in full in Table A8.2 in Annex A.

Homework

Pupils were asked how much time they spent *each week* doing homework in mathematics, science and other subjects. Year 5 pupils in England spent, on average, about 1.8 hours¹ a week doing homework in all subjects². Pupils' responses relating to mathematics and science homework are shown in Chapters 4 and 6, respectively.

Only about four per cent of the pupils said that they spent time going to mathematics and science clubs. About 15 per cent of Year 5 pupils said they received extra lessons in mathematics and six per cent in science (Tables A4.3 and A6.3 in Annex A). The proportions for Year 4 were slightly higher. Pupils having extra lessons in mathematics tended to achieve lower scores than those who did not (Table A4.3 in Annex A). A similar pattern was found for science (Table A6.3 in Annex A). It is probable that the majority of pupils receiving extra lessons were those who had difficulties with their normal school work.

Pupils were also asked about their other out-of-school activities. Mean time spent, in terms of hours per day, has been calculated for each activity. These mean times should not be regarded as additive, since some activities (for example, watching television or videos and playing with friends) can be carried out concurrently. Details of the responses of pupils in England and other countries can be found in Mullis *et al.*, (1997) and Martin *et al.*, (1977).

Reading a book for pleasure

Over 80 per cent of the Year 5 pupils in England said that they read a book for fun on most school days; in most cases pupils read for up to two hours each day, although a small proportion spent longer (Table A8.2 in Annex A). The pattern was similar for the Year 4 pupils. The mean time spent reading for pleasure was about 1.0 hours a day. Mean time spent on reading for pleasure each day in the 26 countries taking part in the TIMSS survey of nine-year-olds ranged from 0.8 – 1.6 hours a day, with the majority in the range 1.0 – 1.3 hours. Although not amongst the lowest, the mean time spent by pupils in England was lower than in about half of the countries.

¹ These figures are based on the responses of all pupils, including those who never did homework.

² Direct comparisons with other countries of pupils' reports on time spent on homework are not possible since the international questions asked about time spent each day on homework in mathematics, science and other subjects.

Watching television and videos

The most widespread out-of-school activity in England was watching television and videos. Almost all of the Year 5 pupils said they usually spent some time each school day watching television or videos: nearly a quarter for less than an hour; just over a third for one to two hours; about 16 per cent for three to four hours; and about 18 per cent for more than five hours (Table A8.2 in Annex A). The mean time spent was about 2.2 hours a day. Means in the 26 countries ranged from 1.1 – 2.5 hours a day. The mean time spent by pupils in England was one of the highest. Pupils in Hungary, Latvia and Israel spent the most time per day watching television and videos.

Playing with friends

Another popular activity was playing with friends. About 80 per cent of the Year 5 pupils in England spent some time each day in this way: nearly half of these (39 per cent of all pupils) spent less than an hour; 18 per cent spent one to two hours; about ten per cent spent three to four hours; and about 14 per cent spent more than four hours each day (Table A8.2 in Annex A). The mean time spent was about 1.5 hours per day. Means in the 26 countries ranged from 0.7 - 3.0 hours a day. The mean time spent by pupils in England was mid-ranking. Pupils in Austria, the Netherlands and Norway spent the most time playing with friends, and those in Hong Kong spent the least time.

Sports

Many pupils said they participated regularly in sporting activities. About 80 per cent said they played some sort of sport most days: mean time spent was about 1.7 hours a day. Means in the 26 countries ranged from 0.7 – 2.0 hours a day. The mean time spent by pupils in England was mid-ranking. Pupils in the United States and Israel spent the most time each day playing sports; those in Korea spent the least time.

Playing computer games

Playing computer games was less popular with pupils in England than watching television, and slightly less popular than playing with friends or playing sports. Nevertheless, about three-quarters of the Year 5 pupils spent some time most days playing computer games; the majority of these spent less than an hour a day (Table A8.2 in Annex A). Mean time spent was 1.2 hours a day. Means in the 26 countries ranged from 0.2 – 1.2 hours a day. The mean time spent by pupils in England was the highest of all the 26 countries.

Doing jobs at home

The majority of pupils said they helped regularly with jobs at home. Nearly 80 per cent of the Year 5 pupils said they spent some time each day doing jobs at home: the majority of these (about half of all the pupils) spent less than an hour a day (Table A8.2 in Annex A). The mean time spent was about 0.9 hours a day. Means in the 26 countries ranged from 0.7 - 1.8 hours a day. The mean time spent by pupils in England was amongst the lowest. Pupils in Hungary spent the most time doing jobs at home; those in Korea spent the least time.

CHAPTER 9

Pupils' Attitudes to Mathematics and Science

Summary of main points

- ◆ Mathematics and science were liked/liked a lot by over 80 per cent of Year 5 pupils in England.
- ◆ Comparisons between the responses of pupils in the nine countries selected for comparison show that pupils in England were mid-ranking in terms of their liking for mathematics and science.
- ◆ Pupils in England held more positive perceptions of their ability in mathematics than of their ability in science despite the fact that, compared with pupils in other countries, their relative performance was better in science than in mathematics.
- ◆ Across countries, there was a slight negative association between pupils' perceptions of their achievement and their mathematics scores: students in the four higher-scoring countries were, on average, slightly less likely than those in the lower-scoring countries to say that they usually did well in mathematics. No such pattern was observed for science.

9.1 Preface

The purpose of this chapter is to describe the pupils' attitudes towards mathematics and science. It draws upon the questionnaire for pupils, which contained a number of questions designed to elicit pupils' attitudes towards both subjects.

As in previous chapters, the responses of Year 5 pupils are described. The responses of pupils in Years 4 and 5 are shown in Tables A9.1 to A9.8 in Annex A, together with the mean mathematics and science scores, as appropriate, for the groups of pupils selecting each response.

9.2 Liking for mathematics and science

Both mathematics and science were *liked* or *liked a lot* by the majority (84 per cent and 81 per cent, respectively) of Year 5 pupils in England (Tables A9.1 and A9.5 in Annex A).

Table 9.2 Comparisons between nine countries: Year 5 pupils' liking for mathematics and science

COUNTRY	Mathematics		Science	
	mean score	like/like a lot %	mean score	like/like a lot %
Singapore	625	92	547	91
Japan	597	71	574	85
Netherlands	577	64	557	67
Hungary	548	84	532	84
United States	545	84	565	85
Canada	532	89	549	80
Scotland	520	84	536	82
England	513	84	551	81
Norway	502	77	530	78

Sources: Mullis et al., 1997; Martin et al., 1997

Comparisons with other countries

Comparisons between the responses of students in the nine countries shown in Table 9.2 show that Year 5 pupils in England were mid-ranking in terms of their liking for both mathematics and science. Pupils in Singapore held more positive attitudes towards mathematics and science than those in England, and those in the Netherlands held less positive attitudes towards both subjects.

In most countries, pupils' mean ratings were similar in both subjects. However, as Table 9.2 shows, pupils in Japan held more positive attitudes towards science than mathematics, whereas those in Canada held more positive attitudes towards mathematics.

9.3 Pupils' perceptions of their ability in mathematics and science

Pupils in England held more positive perceptions of their ability in mathematics than in science: 90 per cent of the Year 5 pupils *agreed* or *strongly agreed* that they usually did well in mathematics compared with 82 per cent in science. Full details of pupils' responses are given in Tables A9.2 and A9.6 in Annex A.

Table 9.3 Comparisons between nine countries: Year 5 pupils' self perceptions about usually doing well in mathematics and science

COUNTRY	Mathematics		Science	
	mean score	agree/agree a lot %	mean score	agree/agree a lot %
Singapore	625	77	547	71
Japan	597	74	574	78
Netherlands	577	85	557	82
Hungary	548	84	532	87
United States	545	91	565	91
Canada	532	94	549	88
Scotland	520	90	536	81
England	513	90	551	82
Norway	502	91	530	85

Sources: Mullis et al., 1997; Martin et al., 1997

Comparisons with other countries

Comparisons with the responses of pupils in other countries (Table 9.3) suggest that pupils in England were amongst the most likely to believe that they usually did well in mathematics, despite the fact that their scores were, on average, below those of pupils in many other countries.

Across countries, there was a slight negative association between pupils' perceptions of their achievement and their mathematics scores: pupils in the four highest-scoring countries were, on average, slightly less likely to say that they usually did well in mathematics. No such pattern was observed for science.

Pupils in England tended to hold less positive perceptions of their achievements in science than in mathematics despite the fact that, compared with those in the other countries selected for comparison, their relative performance was better in science than in mathematics.

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APPENDIX I

National Steering Committee

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APPENDIX II

Countries Taking Part in Different Components of TIMSS

Continental Western Europe

			PERFORMANCE ASSESSMENT		
	Population 1	Population 2	Population 1	Population 2	Population 3
Austria	●	●			●
Belgium (<i>Flemish</i>)		●			
Belgium (<i>French</i>)		●			
Cyprus	●	●	●	●	●
Denmark		●		●	●
France		●			●
Germany		●			●
Greece	●	●			●
Iceland	●	●			●
¹ Italy		●			
Netherlands	●	●			●
Norway	●	●	●	●	●
Portugal	●	●	●	●	
Spain		●		●	
Sweden		●			●
Switzerland		●		●	●

English-speaking

Australia	●	●	●	●	●
Canada	●	●	●	●	●
England	●	●		●	
Ireland	●	●			
New Zealand	●	●	●	●	●
Scotland	●	●		●	
United States	●	●	●	●	●

¹ Argentina, Italy and Indonesia were unable to complete the steps necessary for their data to appear in this report. Because the characteristics of its school sample are not completely known, achievement results for the Philippines are not included in the main tables of the international report. Mexico chose not to release its results for the international report.

Eastern Europe

			PERFORMANCE ASSESSMENT		
	Population 1	Population 2	Population 1	Population 2	Population 3
Bulgaria		●			
Czech Republic	●	●	●	●	●
Hungary	●	●	●	●	●
Latvia	●	●			●
Lithuania		●			●
Romania		●		●	
Russian Federation		●			●
Slovak Republic		●			
Slovenia	●	●		●	●
Ukraine		●			

Asia and Pacific Region

Hong Kong	●	●	●	●	
¹ Indonesia	●	●			
Japan	●	●			
Korea	●	●			
¹ Philippines		●			
Singapore	●	●	●	●	
Thailand	●	●			

Other Countries

¹ Argentina		●			
Colombia		●		●	
Iran	●	●	●	●	
Israel	●	●	●	●	●
Kuwait	●	●			
¹ Mexico	●	●			●
South Africa		●			●

¹ Argentina, Italy and Indonesia were unable to complete the steps necessary for their data to appear in this report. Because the characteristics of its school sample are not completely known, achievement results for the Philippines are not included in the main tables of the international report. Mexico chose not to release its results for the international report.

ANNEX A

Additional tables to support the text

Percentages in the tables may not always sum to 100. This is because all percentages have been rounded to the nearest whole number.

Treatment of missing data

For each question they analysed, the TIMSS International Study Center based the percentages of respondents selecting each option on the number of respondents who answered that question. In order to ensure comparability, we have followed the same practice in our national analyses. The proportions of respondents in England who omitted to answer particular questions were very low. Omissions rates, which ranged from zero to 13 per cent, were less than four per cent for the majority of questions in the student, teacher and school questionnaires.

¹ There was one exception. The omission rates for the questions shown in Table A2.2 were about 25 per cent. This should be taken into account when interpreting the figures in this table.

Table A2.1 Responses from schools containing Year 5 pupils: *background criteria*

CATEGORY	YEAR 9 (international eighth grade)		
	%	Mean mathematics score	Mean science score
SCHOOL SIZE (NO. OF PUPILS)			
<= 200	16	548	567
201–300	36	503	548
301–400	31	505	545
> 400	17	517	554
NO. OF YEAR 4 PUPILS			
< 31	21	536	565
31–60	49	507	548
61–90	25	512	548
> 91	5	524	572
NO. OF YEAR 5 PUPILS			
< 31	16	536	562
31–60	47	508	547
61–90	24	513	551
> 91	13	515	562
NO. OF FULL TIME EQUIVALENT TEACHERS			
<= 10.00	30	522	556
10.01–12.00	25	511	551
12.01–17.00	22	509	550
> 17.000	24	509	549
TYPE OF COMMUNITY			
village or rural (farm) area	7	550	598
one on the outskirts of a town/city	54	525	565
one close to the centre of a town/city	39	491	525
PERCENTAGE OF PUPILS ELIGIBLE FOR FREE SCHOOL MEALS			
up to 5%	19	548	590
6 – 10%	16	526	577
11 – 15%	13	514	553
16 – 20%	11	511	553
21 – 100%	41	486	520
PERCENTAGE OF PUPILS NEEDING ENGLISH AS A SECOND LANGUAGE SUPPORT			
up to 2%	66	517	561
3 – 5%	7	535	560
6 – 10%	5	479	506
11 – 100%	22	489	524
PERCENTAGE OF PUPILS ABSENT ON A NORMAL SCHOOL DAY			
up to 4%	52	525	566
5 – 9%	42	506	544
10 – 100%	6	489	505
PERCENTAGE OF PUPILS TRANSFERRING INTO SCHOOL EACH YEAR			
up to 2%	37	530	568
3 – 5%	38	511	551
6 – 100%	26	494	531
PERCENTAGE OF STAFF IN SCHOOL FOR LESS THAN FIVE YEARS			
up to 30%	11	533	570
31 – 40%	23	502	543
41 – 50%	17	501	540
51% or more	49	515	556
PERCENTAGE OF PUPILS REMAINING IN SCHOOL FOR WHOLE YEAR			
less than 97%	48	501	538
98%	26	522	564
99%	27	528	566

Table A2.2 Responses from schools containing Year 5 pupils: *admissions criteria*

ADMISSIONS CRITERIA	YEAR 5 (international fourth grade)		
	%	Mean mathematics score	Mean science score
RESIDENCE IN AREA			
yes	91	510	549
no	9	542	572
ACADEMIC PERFORMANCE			
yes	3	598	608
no	97	511	550
INTERVIEW WITH PUPIL			
yes	10	546	571
no	90	509	549
INTERVIEW WITH PARENTS			
yes	17	537	561
no	83	508	549
FAMILY MEMBERS AT SCHOOL			
yes	65	515	552
no	35	509	550
PRIORITY TO EARLY APPLICANTS			
yes	17	528	551
no	84	510	552
TEACHER RECOMMENDATION			
yes	1	501	501
no	99	513	552
PUPILS FROM PARTICULAR SCHOOL			
yes	7	515	544
no	93	513	552
FORMER PUPIL'S CHILD			
yes	4	606	609
no	96	509	549
STANDARDISED TEST			
yes	1	620	591
no	99	512	551
ENTRANCE EXAMINATION			
yes	2	584	596
no	98	512	551
ORAL EXAMINATION			
yes	1	575	538
no	100	513	552
OTHER			
yes	27	523	561
no	74	509	548

Note: The omission rate for these questions was about 25 per cent. This should be taken into account when interpreting the figures in this table.

Table A2.3 Responses from schools containing Year 5 pupils: *extent of learning support for pupils with learning difficulties in mathematics*

LEARNING SUPPORT	YEAR 5 (international fourth grade)	
	%	Mean mathematics score
LEARNING SUPPORT IN MATHS		
yes	89	513
no	11	517
If yes:		
GROUPS IN NORMAL CLASSES		
yes	80	515
no	20	506
GROUPS WITHDRAWN FROM CLASSES		
yes	37	507
no	63	517
EXTRA TUITION BEFORE OR AFTER SCHOOL		
yes	3	472
no	98	515
OTHER ARRANGEMENTS		
yes	27	519
no	73	512

Table A2.4 Responses from schools containing Year 5 pupils: *extent of enrichment activities for very able pupils in mathematics*

ENRICHMENT ACTIVITIES	YEAR 5 (international fourth grade)	
	%	Mean mathematics score
ENRICHMENT ACTIVITIES IN MATHS		
yes	77	515
no	23	509
If yes;		
GROUPS IN NORMAL CLASSES		
yes	86	513
no	14	530
GROUPS WITHDRAWN FROM CLASSES		
yes	8	491
no	92	517
EXTRA TUITION BEFORE OR AFTER SCHOOL		
yes	4	495
no	96	516
OTHER ARRANGEMENTS		
yes	21	531
no	79	511

Table A2.5 Responses from schools containing Year 5 pupils: schools' own written curriculum guide in mathematics

CURRICULUM GUIDE	YEAR 5 (international fourth grade)	
	%	Mean mathematics score
SCHOOL HAS OWN WRITTEN CURRICULUM CONTENT GUIDE FOR MATHEMATICS		
yes	91	513
no	9	522

Table A2.6 Responses from schools containing Year 5 pupils: extent of learning support for pupils with learning difficulties in science

LEARNING SUPPORT	YEAR 5 (international fourth grade)	
	%	Mean science score
SCIENCE LEARNING SUPPORT		
yes	66	555
no	34	547
If yes;		
GROUPS IN NORMAL CLASSES		
yes	82	559
no	18	537
GROUPS WITHDRAWN FROM CLASSES		
yes	9	534
no	91	558
EXTRA TUITION BEFORE OR AFTER SCHOOL		
yes	1	495
no	99	556
GROUPS OTHER ARRANGEMENTS		
yes	25	548
no	75	558

Table A2.7 Responses from schools containing Year 5 pupils: *extent of enrichment activities for very able pupils*

ENRICHMENT ACTIVITIES	YEAR 5 (international fourth grade)	
	%	Mean science score
ENRICHMENT ACTIVITIES IN SCIENCE		
yes	42	554
no	58	551
If yes;		
GROUPS IN NORMAL CLASSES		
yes	90	555
no	10	553
GROUPS WITHDRAWN FROM CLASSES		
yes	1	618
no	99	554
EXTRA TUITION BEFORE OR AFTER SCHOOL		
yes	4	509
no	96	556
OTHER ARRANGEMENTS		
yes	20	562
no	80	552

Table A2.8 Responses from schools containing Year 5 pupils: *schools' own written curriculum guide in science*

CURRICULUM GUIDE	YEAR 5 (international fourth grade)	
	%	Mean science score
SCHOOL HAS OWN WRITTEN CURRICULUM CONTENT GUIDE FOR SCIENCE		
yes	92	549
no	8	575

Table A3.1 Primary school teachers' responses: extent of individual, group and whole class teaching in mathematics

FREQUENCY OF DIFFERENT APPROACHES TO TEACHING AND LEARNING	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
INDIVIDUAL WORK/NO ASSISTANCE FROM TEACHER				
never or almost never	19	468	23	516
some lessons	65	448	65	515
most lessons	14	457	9	507
every lesson	2	501	4	516
INDIVIDUAL WORK/ASSISTANCE FROM TEACHER				
never or almost never	2	415	1	519
some lessons	54	452	44	504
most lessons	40	459	50	523
every lesson	5	460	6	519
WORK TOGETHER/TEACHER TEACHES WHOLE CLASS				
never or almost never	8	452	12	516
some lessons	79	454	76	515
most lessons	11	464	10	499
every lesson	2	421	1	471
WORK TOGETHER/PUPILS INTERACT WITH EACH OTHER				
never or almost never	18	456	15	522
some lessons	73	453	74	513
most lessons	8	467	8	513
every lesson	8	436	2	467
WORK IN GROUPS/NO ASSISTANCE FROM THE TEACHER				
never or almost never	19	441	19	522
some lessons	75	457	74	514
most lessons	5	455	5	487
every lesson	1	445	2	519
WORK IN GROUPS/ASSISTANCE FROM THE TEACHER				
never or almost never	4	447	2	528
some lessons	79	455	77	515
most lessons	15	453	21	511
every lesson	2	424	0	–

Table A3.2 Primary school teachers' responses: *extent to which pupils were divided into groups for mathematics*

DIVIDE INTO TEACHING GROUPS	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
never	3	506	4	528
about a quarter of the time	16	470	23	515
about half of the time	20	454	21	513
about three quarters of the time	37	447	35	507
always	24	450	18	525

Table A3.3 Primary school teachers' responses: *use of textbooks/published schemes*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
yes	100	452	100	515
no	0	–	0	–

Table A3.4 Primary school teachers' responses: *proportion of mathematics teaching based on a textbook*

PROPORTION OF TEACHING BASED ON A TEXTBOOK	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
0–25%	13	437	12	488
26–50%	25	464	22	509
51–75%	45	450	43	515
76–100%	17	465	23	530

Table A3.5 Primary school teachers' responses: *proportion of class having access to calculators during mathematics lessons*

PROPORTION OF CLASS	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
almost all	59	457	73	517
about three quarters	2	449	2	499
about half	10	480	7	511
about one quarter	16	436	10	493
none	13	441	9	520

Table A3.6 Primary school teachers' responses: *how calculators are used in mathematics*

FREQUENCY OF DIFFERENT USES	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
CHECKING ANSWERS				
almost every day	7	461	6	515
once or twice a week	27	449	30	515
once or twice a month	39	461	40	513
never, or hardly ever	27	449	24	520
TESTS AND EXAMS				
once or twice a week	1	484	4	553
once or twice a month	5	477	14	508
never, or hardly ever	94	451	83	514
ROUTINE COMPUTATION				
almost every day	2	445	5	508
once or twice a week	22	455	29	518
once or twice a month	37	460	43	516
never, or hardly ever	39	445	24	514
COMPLEX PROBLEMS				
almost every day	1	435	5	548
once or twice a week	26	459	23	517
once or twice a month	49	455	49	515
never, or hardly ever	25	454	23	511
DEVELOPING NUMBER CONCEPTS				
almost every day	1	435	3	560
once or twice a week	22	455	21	510
once or twice a month	53	454	46	515
never, or hardly ever	25	449	30	515

Table A3.7 Primary school teachers' responses: *frequency of setting mathematics homework*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
never	29	435	18	493
less than once a week	39	455	36	510
once or twice a week	30	463	42	522
3 or 4 times a week	3	535	5	572

Table A4.1 Pupils' reports: *different approaches/activities used in mathematics lessons*

FREQUENCY OF DIFFERENT APPROACH/ACTIVITY	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
THE TEACHER SHOWS US HOW TO DO MATHS PROBLEMS				
Most lessons	56	452	58	510
Some lessons	41	470	39	523
Never	3	427	3	485
WE COPY NOTES FROM THE BOARD				
Most lessons	24	431	17	479
Some lessons	56	471	65	523
Never	20	464	18	526
WE HAVE A QUIZ OR TEST				
Most lessons	24	427	19	481
Some lessons	66	471	74	527
Never	10	465	7	495
WE WORK FROM WORKCARDS OR TEXTBOOKS ON OUR OWN				
Most lessons	50	464	55	524
Some lessons	37	464	35	511
Never	12	440	11	490
WE WORK ON MATHS PROJECTS				
Most lessons	42	450	41	511
Some lessons	45	466	46	520
Never	13	472	13	519
WE USE CALCULATORS				
Most lessons	13	424	11	474
Some lessons	66	470	74	524
Never	21	457	15	510
WE USE COMPUTERS				
Most lessons	13	402	9	457
Some lessons	51	464	51	516
Never	37	477	40	531
WE WORK TOGETHER IN PAIRS OR SMALL GROUPS				
Most lessons	21	422	17	474
Some lessons	69	471	72	523
Never	10	465	11	526
WE USE THINGS FROM EVERY DAY LIFE IN SOLVING MATHEMATICS PROBLEMS				
Most lessons	15	422	11	472
Some lessons	55	469	59	526
Never	31	463	31	511
THE TEACHER GIVES US HOMEWORK				
Most lessons	18	444	21	513
Some lessons	45	469	51	520
Never	36	458	28	508

Table A4.2 Pupils' reports: *time spent on homework in mathematics (hours per week)*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
no time	43	458	35	507
less than 1 hour	39	465	46	526
1-2 hours	13	465	16	520
3-4 hours	2	448	2	535
more than 4 hours	2	432	1	469

Table A4.3 Pupils' reports: *extra lessons in mathematics*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
yes	20	440	15	489
no	80	464	85	520

Table A4.4 Pupils' reports: *participation in mathematics clubs (no equivalent in previous report)*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
yes	5	429	4	450
no	95	464	97	520

Table A5.1 Primary school teachers' responses: extent of individual, group and whole class teaching in science

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
INDIVIDUAL WORK/NO ASSISTANCE FROM TEACHER				
never or almost never	47	493	39	556
some lessons	51	496	57	548
most lessons	2	483	3	558
every lesson	1	576	1	606
INDIVIDUAL WORK/ASSISTANCE FROM TEACHER				
never or almost never	14	506	13	551
some lessons	74	491	73	548
most lessons	10	497	13	580
every lesson	2	524	1	491
WORK TOGETHER/TEACHER TEACHES WHOLE CLASS				
never or almost never	6	518	5	561
some lessons	79	493	78	555
most lessons	13	501	14	536
every lesson	2	451	3	523
WORK TOGETHER/PUPILS INTERACT WITH EACH OTHER				
never or almost never	14	483	10	552
some lessons	73	494	71	556
most lessons	12	519	16	542
every lesson	2	480	2	515
WORK IN GROUPS/NO ASSISTANCE FROM TEACHER				
never or almost never	24	484	23	548
some lessons	70	496	71	551
most lessons	7	529	7	575
every lesson	0	–	0	–
WORK IN GROUPS/ASSISTANCE FROM TEACHER				
never or almost never	0	–	0	–
some lessons	63	494	66	545
most lessons	37	497	34	565
every lesson	0	–	0	–

Table A5.2 Primary school teachers' responses: *use of textbooks in science*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
yes	78	494	78	554
no	22	497	22	552

Table A5.3 Primary school teachers' responses: *whether science was taught as a separate subject*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
yes	75	493	75	553
no	25	502	25	548

Table A5.4 Primary school teachers' responses: *proportion of time spent on practical activities in science*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
never	0	–	1	576
quarter of time	21	493	27	538
half the time	58	492	48	556
three quarters of the time	20	507	24	558

Table A6.1 Pupils' reports: *different approaches/activities used in science lessons*

FREQUENCY OF DIFFERENT APPROACH/ACTIVITY	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
THE TEACHER SHOWS HOW TO DO SCIENCE PROBLEMS				
most lessons	59	502	60	555
some lessons	38	505	36	554
never	4	493	4	528
WE COPY NOTES FROM THE BOARD				
most lessons	30	500	31	554
some lessons	57	503	57	553
never	13	514	12	560
WE HAVE A QUIZ OR TEST				
most lessons	17	450	12	496
some lessons	55	505	59	556
never	28	537	29	573
WE WORK ON SCIENCE PROJECTS				
most lessons	41	501	45	557
some lessons	49	508	47	554
never	10	500	8	542
WE WORK FROM WORKSHEETS ON OUR OWN				
most lessons	26	478	23	532
some lessons	37	505	37	549
never	37	520	40	572
WE USE CALCULATORS				
most lessons	10	446	6	484
some lessons	39	502	38	548
never	52	516	56	568
WE USE COMPUTERS				
most lessons	10	439	7	488
some lessons	44	498	45	546
never	46	522	48	574
WE USE THINGS FROM EVERYDAY LIFE IN SOLVING SCIENCE PROBLEMS				
most lessons	24	493	20	553
some lessons	54	515	59	562
never	22	492	20	536
WE WORK TOGETHER IN PAIRS OR SMALL GROUPS				
most lessons	29	485	28	551
some lessons	64	512	66	557
never	7	494	6	534
THE TEACHER GIVES HOMEWORK				
most lessons	7	453	6	519
some lessons	33	505	42	565
never	60	509	51	551
THE TEACHER DEMONSTRATES AN EXPERIMENT				
most lessons	17	484	20	545
some lessons	57	510	58	560
never	26	507	22	554
WE DO EXPERIMENTS OR PRACTICAL INVESTIGATIONS IN CLASS				
most lessons	30	500	31	561
some lessons	55	512	57	558
never	16	486	12	524

Table A6.2 Pupils' reports: *time spent on homework in science (hours per week)*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
no time	68	505	60	552
less than 1 hour	23	513	31	571
1-2 hours	7	501	8	563
3-4 hours	2	488	1	519
more than 4 hours	1	450	0	–

Table A6.3 Pupils' reports: *extra lessons in science*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
yes	8	457	6	503
no	92	508	94	559

Table A6.4 Pupils' reports: *participation in science clubs (no equivalent in previous report)*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
yes	5	462	4	485
no	95	506	97	558

Table A7.1 Primary school teachers' responses: *biographical details*

TEACHERS TEACHING MATHEMATICS *	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
AGE OF TEACHER				
under 25	10	443	2	510
25-29	10	453	14	510
30-39	19	452	19	513
40-49	42	456	49	512
50-59	16	465	15	529
60 or more	3	469	1	482
SEX OF TEACHER				
female	82	456	75	514
male	18	458	25	515
LEVEL OF EDUCATION COMPLETED				
3 or 4 year training	41	458	42	515
BA/BSc no training	5	491	0	–
BA/BSc training/BEd	54	452	54	516
Higher degree no training	1	562	1	434
Higher degree training	0	–	3	522
YEARS OF TEACHING EXPERIENCE				
0-5 years	27	453	19	504
6-10 years	10	442	14	513
11-20 years	35	458	34	513
> 20 years	29	461	33	521

TEACHERS TEACHING SCIENCE *	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
AGE OF TEACHER				
under 25	9	487	2	557
25-29	10	493	14	555
30-39	21	498	17	554
40-49	41	499	50	549
50-59	16	514	16	563
60 or more	3	459	1	486
SEX OF TEACHER				
female	78	497	75	554
male	22	505	25	546
LEVEL OF EDUCATION COMPLETED				
3 or 4 year training	41	497	43	552
BA/BSc no training	5	525	1	553
BA/BSc training/BEd	54	498	53	555
Higher degree no training	1	587	1	462
Higher degree training	1	476	3	545
YEARS OF TEACHING EXPERIENCE				
0-5 years	27	492	18	555
6-10 years	10	481	16	556
11-20 years	37	507	34	548
> 20 years	26	502	33	553

* In most classes these were the same teachers

Table A7.2 Primary school teachers' responses: *whether part- or full-time*

TEACHERS TEACHING MATHEMATICS *	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
part-time	4	460	4	555
full-time	96	456	96	512

TEACHERS TEACHING SCIENCE *	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
part-time	6	507	4	600
full-time	94	498	97	551

* In most classes these were the same teachers

Table A7.3 Primary school teachers' responses: *attitudes towards teaching as a career*

TEACHERS TEACHING MATHEMATICS *	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
WAS TEACHING FIRST CHOICE OF CAREER?				
yes	80	456	80	516
no	20	449	20	512
WOULD YOU LIKE TO CHANGE CAREER?				
yes	32	449	33	513
no	68	458	67	516
IS YOUR WORK APPRECIATED BY SOCIETY?				
yes	20	466	19	517
no	80	451	81	513
IS YOUR WORK APPRECIATED BY YOUR PUPILS?				
yes	80	458	88	514
no	20	442	12	519

TEACHERS TEACHING SCIENCE *	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
WAS TEACHING FIRST CHOICE OF CAREER?				
yes	81	498	78	552
no	19	489	22	555
WOULD YOU LIKE TO CHANGE CAREER?				
yes	32	493	32	551
no	68	498	68	553
IS YOUR WORK APPRECIATED BY SOCIETY?				
yes	20	505	22	554
no	80	493	78	551
IS YOUR WORK APPRECIATED BY YOUR PUPILS?				
yes	80	500	86	552
no	20	476	14	562

* In most classes these were the same teachers

Table A8.1 Pupils' reports: *pupil and home background*

	YEAR 4 (international third grade)			YEAR 5 (international fourth grade)		
	%	Mean science score	Mean mathematics score	%	Mean science score	Mean mathematics score
PUPILS' SEX						
girl	50	495	452	51	548	511
boy	50	503	460	50	555	515
WERE YOU BORN IN ENGLAND?						
yes	93	503	459	93	555	516
no	8	454	418	7	507	463
HOW OFTEN DO YOU SPEAK ENGLISH AT HOME?						
always or almost always	95	516	481	96	556	510
sometimes	4	472	437	3	522	486
never	1	502	483	0	406	441
WAS YOUR MOTHER BORN IN THE UK?						
yes	84	504	459	85	558	517
no	16	484	451	15	533	504
WAS YOUR FATHER BORN IN THE UK?						
yes	81	506	460	83	561	519
no	19	483	447	18	527	500
PUPIL LIVES WITH MOTHER						
yes	97	500	457	97	552	514
no	3	449	421	3	514	477
PUPIL LIVES WITH FATHER						
yes	80	503	460	79	555	516
no	20	480	440	21	538	498
PUPIL LIVES WITH BROTHER(S)						
yes	59	495	453	59	547	506
no	41	503	459	41	557	521
PUPIL LIVES WITH SISTER(S)						
yes	56	496	454	57	546	511
no	44	502	459	43	557	515
PUPIL LIVES WITH STEPMOTHER						
yes	2	393	398	2	479	448
no	98	501	457	98	553	514
PUPIL LIVES WITH STEPFATHER						
yes	7	452	430	8	515	478
no	93	502	458	92	554	515
PUPIL LIVES WITH GRANDPARENT(S)						
yes	15	456	423	14	496	462
no	85	506	462	87	560	520
PUPIL LIVES WITH OTHER RELATIVE(S)						
yes	12	458	428	10	493	457
no	88	504	460	90	557	518
PUPIL LIVES WITH OTHER(S)						
yes	8	479	440	8	531	491
no	92	500	457	92	553	514
NO. OF PEOPLE LIVING IN HOME						
3 or less	14	503	459	14	557	516
4	41	515	469	41	568	527
5	27	500	456	28	551	511
6	11	471	440	11	529	492
7 or more	7	473	431	7	497	477

continued/

Table A8.1 Pupils' reports: *pupil and home background* (continued)

	YEAR 4 (international third grade)			YEAR 5 (international fourth grade)		
	%	Mean science score	Mean mathematics score	%	Mean science score	Mean mathematics score
COMPUTER AT HOME						
yes	85	502	459	88	552	513
no	15	482	444	12	545	512
STUDY DESK AT HOME						
yes	79	505	462	80	558	518
no	21	477	435	20	522	492
DICTIONARY AT HOME						
yes	89	509	463	93	558	518
no	11	422	399	7	468	442

Table A8.2 Pupils' reports: *out-of school activities*

	YEAR 4 (international third grade)			YEAR 5 (international fourth grade)		
	%	Mean science score	Mean mathematics score	%	Mean science score	Mean mathematics score
HOMEWORK IN SUBJECTS OTHER THAN MATHEMATICS OR SCIENCE (HOURS PER WEEK)						
no time	33	493	453	26	535	498
less than 1 hour	45	516	469	46	561	524
1-2 hours	15	506	462	21	570	527
3-4 hours	4	491	454	4	564	528
more than 4 hours	3	469	439	2	513	482
WATCHING TV OR VIDEOS (HOURS PER DAY)						
no time	8	468	428	4	502	474
less than 1 hour	29	506	459	24	551	511
1-2 hours	35	516	473	38	570	530
3-4 hours	13	521	477	16	571	532
more than 4 hours	15	479	440	18	533	496
PLAY COMPUTER GAMES (HOURS PER DAY)						
no time	28	501	455	25	558	520
less than 1 hour	36	517	476	39	570	530
1-2 hours	18	513	467	20	560	524
3-4 hours	8	503	458	6	539	511
more than 4 hours	10	469	436	9	513	472
SOCIALISING WITH FRIENDS (HOURS PER DAY)						
no time	23	503	466	19	561	526
less than 1 hour	38	510	470	39	557	524
1-2 hours	17	518	473	18	575	531
3-4 hours	7	504	457	10	568	518
more than 4 hours	14	490	438	14	534	489
DOING JOBS AT HOME (HOURS PER DAY)						
no time	26	497	459	21	551	510
less than 1 hour	47	520	474	52	566	529
1-2 hours	17	504	464	19	559	520
3-4 hours	5	488	441	4	539	489
more than 4 hours	5	464	431	4	502	474
PLAYING SPORTS (HOURS PER DAY)						
no time	23	491	450	18	540	501
less than 1 hour	26	509	468	27	567	531
1-2 hours	25	519	476	29	570	529
3-4 hours	12	518	475	12	553	523
more than 4 hours	14	496	447	14	537	494
READING A BOOK FOR PLEASURE (HOURS PER DAY)						
no time	21	482	444	18	532	495
less than 1 hour	46	510	469	49	558	521
1-2 hours	20	518	473	22	575	539
3-4 hours	6	526	474	6	575	519
more than 4 hours	7	510	457	5	557	501

Table A9.1. Pupils' attitudes towards mathematics

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
I LIKE MATHS				
like a lot	61	456	52	512
like	28	466	32	519
dislike	6	461	9	516
dislike a lot	6	443	7	498
I ENJOY LEARNING MATHS				
strongly agree	61	458	53	516
agree	27	468	31	522
disagree	7	466	10	516
strongly disagree	6	450	6	495
MATHS IS BORING				
strongly agree	13	422	14	495
agree	10	443	10	494
disagree	23	464	26	522
strongly disagree	55	475	50	528
MATHS IS AN EASY SUBJECT				
strongly agree	28	442	19	487
agree	31	464	32	528
disagree	30	480	37	530
strongly disagree	12	460	12	504

Table A9.2. Pupils' perceived ability in mathematics

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
I USUALLY DO WELL IN MATHS				
strongly agree	41	454	33	522
agree	49	466	57	517
disagree	7	452	8	486
strongly disagree	3	411	3	457

Table A9.3 Pupils' responses: *the importance of doing well in mathematics*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
MY MOTHER THINKS IT IS IMPORTANT TO DO WELL IN MATHS				
yes	93	502	94	553
no	7	487	6	540
MY FRIENDS THINK IT IS IMPORTANT TO DO WELL IN MATHS				
yes	79	456	78	515
no	21	468	22	516
I THINK IT IS IMPORTANT TO DO WELL IN MATHS				
yes	96	460	97	515
no	4	424	3	494

Table A9.4 Pupils' responses: *how much they like using computers in mathematics lessons*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean mathematics score	%	Mean mathematics score
don't use computers	39	477	44	525
like a lot	40	448	36	506
like	14	453	14	509
dislike	3	443	3	514
dislike a lot	4	427	3	483

Table A9.5 Pupils' attitudes towards science

	YEAR 4 (International third grade)		YEAR 5 (International fourth grade)	
	%	Mean science score	%	Mean science score
I LIKE SCIENCE				
like a lot	42	498	36	553
like	39	509	45	559
dislike	10	511	10	551
dislike a lot	9	487	9	534
I ENJOY LEARNING SCIENCE				
strongly agree	47	499	41	555
agree	31	517	39	560
disagree	11	506	11	551
strongly disagree	11	499	10	536
SCIENCE IS BORING				
strongly agree	14	477	13	523
agree	11	485	11	537
disagree	30	512	34	563
strongly disagree	46	518	43	569
SCIENCE IS AN EASY SUBJECT				
strongly agree	23	474	15	522
agree	31	511	31	560
disagree	29	522	37	570
strongly disagree	17	508	16	547

Table A9.6. Pupils' perceived ability in science

	YEAR 4 (International third grade)		YEAR 5 (International fourth grade)	
	%	Mean science score	%	Mean science score
I USUALLY DO WELL IN SCIENCE				
strongly agree	27	478	21	553
agree	55	520	61	563
disagree	12	500	13	536
strongly disagree	6	472	5	497

Table A9.7 Pupils' responses: *the importance of doing well in science*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
MY MOTHER THINKS IT IS IMPORTANT TO DO WELL IN SCIENCE				
yes	93	502	94	553
no	7	487	6	540
MY FRIENDS THINK IT IS IMPORTANT TO DO WELL IN SCIENCE				
yes	72	497	71	551
no	28	513	29	558
I THINK IT IS IMPORTANT TO DO WELL IN SCIENCE				
yes	93	503	94	554
no	7	482	6	545

Table A9.8 Pupils' responses: *how much they like using computers in science lessons*

	YEAR 4 (international third grade)		YEAR 5 (international fourth grade)	
	%	Mean science score	%	Mean science score
don't use computers	46	524	49	571
like a lot	27	486	28	543
like	17	491	15	542
dislike	4	489	4	531
dislike a lot	5	463	5	507



THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY Second National Report Part 2

Part 1 of this report compared the mathematics and science performance of nine-year old pupils in England with that of their counterparts in other countries. The main finding was that pupils in England performed relatively well in science but relatively badly in mathematics.

Part 2 of the report extends the findings of the first part of the report by comparing the responses of pupils and their teachers to the TIMSS questionnaires. Issues covered include:

- Time allocated to mathematics and science lessons
- Class size
- Classroom organisation (whole class, group and individual teaching)
- Homework
- Use of calculators and computers
- Teachers' and pupils' attitudes
- Teachers' school-related activities out of school hours
- Pupils' out of school activities.

This report is based on a national survey of more than 6,000 nine-year-olds in 134 schools, which was part of a world-wide sample of nearly 175,000 pupils in approximately 4,000 schools in 26 countries. It is essential reading for all those concerned with the teaching of mathematics and science in primary schools: teachers, governors, LEA advisory teams, policy makers and researchers.

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