THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY
First National Report
Part 1

Wendy Keys, Sue Harris and Cres Fernandes

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Achievement in Mathematics and Science at Age 13 in England

Wendy Keys, Sue Harris and Cres Fernandes

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SUMMARY

1. Introduction

England is one of over 40 countries taking part in the Third International Mathematics and Science Study (TIMSS), a large-scale international comparative study of educational performance. TIMSS is organised by the International Association for the Evaluation of Educational Achievement (IEA). The study in England is funded by the Department for Education and Employment (DfEE) and carried out by the National Foundation for Educational Research (NFER).

The First National Report on TIMSS, Part 1, compares the performance of 13-year-old students in England on the TIMSS mathematics and science tests with that of students of a similar age in other countries.[1]

2. Main findings

- Students in England achieved relatively high mean scores in science but relatively low mean scores in mathematics.

- The mean overall mathematics scores of Year 9[2] students in England were:
  - significantly **lower** than those of students in about half of the countries taking part in TIMSS
  - not significantly different from those in about a quarter of the countries
  - significantly **higher** than those of students in about a quarter of the countries.

- The mean overall science scores of Year 9[2] students England were:
  - significantly **lower** than those of students in only four of the other countries taking part in TIMSS
  - not significantly different from those in about a quarter of the countries
  - significantly **higher** than those of students in nearly two-thirds of the countries.

---

[1] *With the exception of the sections concerning overall comparisons, the First National Report, Part 1, focuses mainly on the mathematics and science performance of students in England and ten other countries: Canada; France; Germany; Hungary; Japan; Scotland; Singapore; Sweden; Switzerland; and the United States.*

[2] *The patterns were similar for Year 8.*

3. Other important findings

Mathematics

- The relative position of England in mathematics appears to have deteriorated since previous comparative studies were carried out.
- Students in England scored above the international means for Years 8 and 9 in: *Data representation, analysis and probability.*
- Students in England scored below the international means for Years 8 and 9 in: *Fractions and number sense*; *Geometry*; *Algebra*; *Measurement*; and *Proportionality*.
- In most of the countries taking part in TIMSS, the mathematics scores of boys and those of girls were not significantly different. There was only one statistically significant difference in England: in Year 8, boys achieved a higher mean overall mathematics score than girls.

Science

- The relative position of England in science appears to have improved since previous comparative studies were carried out.
- About one in six of the students in England were in the international top ten per cent in both year groups. Similar proportions were found in Japan.
- Students in England scored above the international mean in all five science content areas: *Earth science*; *Life science*; *Physics*; *Chemistry*; and *Science and environment.*
- Overall, the data suggest that there may have been an improvement in England's relative position in all five science areas compared with other countries in terms of students' performance since the IAEP2 study in the early 1990s.
- Boys' overall mean science scores were significantly higher than those of girls in England and in about three-quarters of the countries taking part in TIMSS. Although the scores of boys in England were higher than those of girls in all the science topic areas, only one of these differences was statistically significant: *Chemistry* (Year 8 students).

CHAPTER 1
Introduction to the study

The structure of this report

- This chapter provides a brief description of the design and administration of the study.
- Chapter 2 describes the students' overall performance on the mathematics test.
- Chapter 3 focuses on their performance on different mathematics content areas.
- Chapters 4 and 5 provide similar information about students' performance on the science tests.
- The final chapter previews the topics to be covered in Part 2 of this report and in subsequent national reports on TIMSS.
- Appendix I lists the members of the TIMSS National Steering Group for England
- Appendix II provides information on the countries participating in different components of TIMSS.

A companion volume (Keys, Harris and Fernandes, 1996) contains additional appendices giving more detailed information on the design and administration of the study.

1.1 Preface

England is one of over 40 countries taking part in the Third International Mathematics and Science Study (TIMSS), a large-scale international comparative study of educational performance. TIMSS is organised by the International Association for the Evaluation of Educational Achievement (IEA). The study in England is funded by the Department for Education and Employment (DfEE) and carried out by the National Foundation for Educational Research (NFER).

This is the first national report on TIMSS.[1] Its main purpose is to compare the performance on the TIMSS mathematics and science tests of 13-year-old students in England with the performance of students of the same age in other countries. Most of the information contained in this report has been drawn from the first international reports on TIMSS (Beaton *et al.*, 1996a, 1996b), which provide a broad brush picture of comparisons between the mathematics and science performance of 13-year-olds (TIMSS Population 2) in over 40 educational systems. Where appropriate, comparisons have been made with the results of previous large-scale international studies of achievement, the most important of which are listed in Chapter 2 (mathematics) and Chapter 4 (science).

In order to provide clear and coherent comparisons it was decided to focus many of the comparisons in this report on the following 11 countries.

- Canada
- England
- France
- Germany
- Hungary
- Japan
- Scotland
- Singapore
- Sweden
- Switzerland
- USA

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

[1] *Details of the topics covered in Part 2 of the report and in subsequent national reports on TIMSS are given in Chapter 6.*

1.2 Design and administration of TIMSS

The international research focused on three different stages of education: upper primary (mainly nine-year-olds), lower secondary (mainly 13-year-olds) and students in their final year of schooling (mainly 17-year-olds). England participated in the survey of two age groups: 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 summary of the design and administration of the TIMSS survey of 13-year-olds (TIMSS Population 2), which forms the subject of this report, is given below. Appendix III, which is included in the companion volume to this study (Keys, Harris and Fernandes, 1996) gives full details of the design and administration of TIMSS in England.

1.2.1 Age groups

The TIMSS Population 2 sample was drawn from students in all schools who were in international seventh and eighth grades (equivalent to Years 8 and 9 in England).[2] At the time of testing (early March 1995), the age of the Population 2 students taking part in the study in England ranged from 12 years seven months to 14 years six months.

1.2.2 The schools and students

The samples of schools and students 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. The sample design in England involved the selection of an initial sample of 150 schools and two matching sets of 150 replacement schools which were selected at the same time. All three samples were representative of schools in England in terms of type of school, size and background characteristics (including GCSE results) and each school in the initial sample was matched with two schools (one in each of the replacement samples) which were as similar as possible to the initial school in terms of type of school, size and background characteristics. If a school in the initial sample declined to participate, it was replaced by a matched school from one of the replacement samples. This ensured that the final sample of schools taking part in TIMSS remained representative of schools in England irrespective of whether any individual school was from the initial or replacement samples.[3] Full details are given in Appendices III and V (Keys, Harris and Fernandes, 1996).

---

[2] *In the tables in this report, year groups are identified as 'international seventh grade (Year 8 in England) and international eighth grade (Year 9 in England), as appropriate. In the text, year groups are normally referred to in this way at the beginning of each main section, and as Year 8 or Year 9, or as lower or upper grades as appropriate, thereafter.*

[3] *The sample of schools from England met the TIMSS sampling requirements, as did those in eight of the other countries on which this report focuses. The samples from Germany (both grades tested) did not meet the age/grade specifications: the mean ages of the German samples were about eight months older than those of English samples for both of the international grades included in TIMSS Population 2 (and about six months older than the median age for all countries). The sample from Scotland (upper grade only) just failed to satisfy the TIMSS requirements on sample participation rates.*

Once a school agreed to participate in the Population 2 study, 16 students were randomly selected by NFER from each year group (Year 8 and Year 9), making a total of 32 students in each school. A total of 127 schools took part in the study (85 first-choice schools and 42 replacement schools). The response rate for Population 2 was 85 per cent including replacement schools (57 per cent from first-choice schools). Tests and questionnaires were completed by 3,579 students.[4]

1.2.3 Administration

The tests and questionnaires were administered in schools by teachers in early March 1995. The tests were subject to strict time limits which were common to all participating countries. These time limits were set so as to allow the majority of students to finish the test. The student questionnaires had no time limit, but teachers were advised to allow sufficient time for all students to complete the whole questionnaire (roughly 20 minutes). Teachers and headteachers were also asked to fill in questionnaires.

To ensure that the survey was administered under the same conditions in all countries, the administration manual (which included a script for the teacher administering the tests and questionnaires and details of time limits) followed the same general pattern in all countries. Each country's manuals had to be agreed with the international co-ordinator. In England, the tests and questionnaires were returned to NFER for marking, coding and data processing. In addition, the International Study Centre set up a quality control programme, involving visits by independent scrutineers to a sub-set of schools, to monitor the conduct of the study in each country.

1.2.4 Test-curriculum Matching Analysis

All countries taking part in TIMSS used the same tests of mathematics and science. Although this ensured that comparisons could be made between different countries in terms of attainment on the same tests, it does not recognise the fact that the curricula for mathematics and science vary from one country to another. The Test-curriculum Matching Analysis was set up to collect information about the relevance of the TIMSS test items to the mathematics and science curricula in countries taking part in the study. In order to identify the relevant sub-sets of items, experts in each country had to consider whether or not each item was covered in the 'intended curriculum' for each of the grades (year groups) separately. In England this was interpreted as:

- whether or not the topic of the item formed part of the National Curriculum for the majority of students (at least 50 per cent) in each year group
- whether or not the content of the item was likely to have been covered by students at the time of testing (in England, early March 1995).

Analyses of students' performance on the sub-set of items which matched the National Curriculum in England are provided in Chapters 2 and 4.

[4] *Details of sample sizes and participation rates in other countries are given in the international reports (Beaton et al., 1996a, 1996b).*

1.3 The tests and questionnaires

1.3.1 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. Categories in the TIMSS mathematics curriculum framework were grouped together to form the mathematics reporting categories used in Chapter 3.

Mathematics	• Fractions and number sense	*(51 items)*
	• Geometry	*(23 items)*
	• Algebra	*(27 items)*
	• Data representation, analysis and probability	*(21 items)*
	• Measurement	*(18 items)*
	• Proportionality	*(11 items)*

Similarly categories from the science curriculum framework were grouped to form the science reporting categories shown below.

Science	• Earth science	*(22 items)*
	• Life science	*(40 items)*
	• Physics	*(40 items)*
	• Chemistry	*(19 items)*
	• Science and environment (and other topics)[5]	*(14 items)*

A relatively large number of items was required in order to achieve broad content coverage of curricula. There were 286 test items for Population 2 (151 focusing on mathematics and 135 on science). Just over 80 per cent of the mathematics items and about three-quarters of the science items were multiple-choice; the remainder were either short answer (requiring the student to write in a single word or number) or extended response items. In order to avoid placing excessive burdens on individual students, eight different versions of the test were prepared for each population, each containing a different combination of items. Some items were included in every version of the test; the remaining items appeared in one, two, three or four version(s) of the test. Any individual student completed one version

[5] *Topics covered in this category include: environmental and resource issues; the nature of scientific knowledge; and the interaction of science and technology. Throughout this report the category is referred to as 'Science and environment', whereas in the international report (Beaton et al., 1996a) the category is referred to as 'Environmental issues and the nature of science'.*

of the test only consisting of about 75 items. Only three or four students in each school attempted the same version of the test. Full details of these procedures are given in Appendix IV (Keys, Harris and Fernandes, 1996).

Each version of the test was divided into two booklets, each of which contained a mixture of multiple-choice, short answer (requiring a single word or number) and extended response items. Each test booklet included both mathematics and science items arranged in clusters. However, a separate mathematics and science score was calculated for each student. There were two testing sessions, giving a total testing time of 90 minutes.

1.3.2 The questionnaires

The questionnaire for students was designed to obtain background information from students about themselves, their home background, their attitudes towards mathematics and science, and their perceptions of lessons in these subjects. The questionnaires for mathematics and science teachers sought information on: teachers' education, training and experience; how they divided their time between teaching and teaching-related activities, their teaching approaches; resources available to them, their attitudes towards mathematics or science as subjects; their views on teaching and learning mathematics or science; and their views on teaching as a career. The questionnaire for schools sought: general background information on the schools; details of organisational features relating to the teaching of mathematics and science; and information on teaching resources and teaching-time devoted to these subjects.

Clearly, the TIMSS research encompassed much more than the mere testing of student attainment. Indeed, to comprehend the data on student attainment, it is essential to take into account fully a whole range of context factors such as those described above. These issues will be examined in Part 2 of this report, which will be published in spring 1997.

CHAPTER 2

The students' overall performance on the mathematics tests

Summary of main points

- **The mean overall mathematics scores of students in England were:**
  - **significantly *lower* than those of students in about half of the countries taking part in TIMSS**
  - **not significantly different from those in about a quarter of the countries**
  - **significantly *higher* than those of students in about a quarter of the countries.**
- **The relative position of England in mathematics appears to have deteriorated since previous comparative studies were carried out.**
- **In most of the countries taking part in TIMSS, the mathematics scores of boys and those of girls were not significantly different. There was only one statistically significant difference in England: in Year 8, boys achieved a higher mean overall mathematics score than girls.**

2.1 Preface

This chapter compares the mean scores on the TIMSS mathematics tests of students in England with students of the same age in other countries. Separate mean scores are provided for two year groups (Years 8 and 9 in England, which are equivalent to international seventh and eighth grades) and for 13-year-olds (i.e. students aged 13.0–13.11 years at the time of testing). Comparisons with other countries are made in terms of:

- students' overall mean[1] scores on the TIMSS mathematics test
- students' mean scores on the sub-set of items identified by curriculum experts in England as being covered by the mathematics curriculum for each year group (the Test-curriculum Matching Analysis)
- ranges of scores in different countries (percentages of students reaching the following international marker levels: top ten per cent, top 25 per cent, top half and bottom 25 per cent of the international distribution)
- differences in mean mathematics scores of students in international seventh and eighth grades (Years 8 and 9 in England)
- differences in mean mathematics scores of boys and girls.

Where appropriate, the results of TIMSS are compared with the results of the following previous large-scale international studies.

Date of testing	Study	References to reports
1964	First International Mathematics Study (FIMS)	Husen (1967) Pidgeon (1967)
1980–82	Second International Mathematics Study (SIMS)	Robitaille and Garden (1989) Cresswell and Gubb (1987)
1988	The first study carried out by the International Association for the Evaluation of Educational Progress (IAEP1)	Travers and Westbury (1989) Lapointe *et al.* (1989) Keys and Foxman (1989)
1991	The second study carried out by the International Association for the Evaluation of Educational Progress (IAEP2)	Lapointe *et al.* (1992a) Foxman (1992)

[1] *Throughout this report the term 'mean' has been used when referring to national and international results, whereas the international report uses the term 'average'.*

In the following discussions previous studies will be referred to by their abbreviations (i.e. FIMS, SIMS, IAEP1 and IAEP2). In comparing the results of previous studies with those of TIMSS, it should be remembered that:

- some of the countries taking part in TIMSS have not participated in any previous international comparative studies
- different sets of countries took part in different studies
- only two countries (England[2] and the United States) have taken part in all four previous large-scale studies
- because of curriculum changes, different tests were used in each study and there are only small numbers of common items between any two studies.

2.2 Overall mean scores on the mathematics test

In this chapter, the overall mean mathematics scores of students in England have been compared with those of students of similar ages in four distinct groups of other countries: continental Western European countries (Table 2.2.1); English-speaking countries (Table 2.2.2); Eastern European countries (Table 2.2.3); and Asian Pacific Rim countries (Table 2.2.4). The information displayed in these tables is derived from Tables 1.1 (Mathematics) and 1.2 (Mathematics) and Figures 1.1 (Mathematics) and 1.2 (Mathematics) from the international report of TIMSS (Beaton *et al.*, 1996b); these tables and figures, which give detailed information on students' mathematics scores in all the countries taking part in TIMSS together with the average age and years of formal schooling for each sample, have been reproduced at the end of this chapter. The international tables and figures include all the countries participating in TIMSS. In the international tables, countries which did not meet the international sampling requirements are shown 'below the line', i.e. the mean scores of their students are not included in the rank orders of results. In the figures, however, these countries are listed in italics but included in the rank ordering of results. The reasons why each country did not meet the sampling requirements are explained in the footnotes to the international tables.

Overall mean mathematics scores (and the overall mean science scores given in Chapter 4) are expressed in terms of a scale with a mean of 500, and a standard deviation[3] of about 100, based on the performance of students in both grades (year groups).

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[2] *In TIMSS and FIMS, samples were selected from schools in England. In SIMS and IAEP2, samples were drawn from England and Wales. In IAEP1 samples were selected from schools in England, Wales and Scotland.*

[3] *This means that about two-thirds of students in both age groups in all participating countries combined achieved scores between 400–600 and about 95 per cent achieved scores between 300–700.*

2.2.1 Overall mean mathematics scores: comparisons between England and continental Western European countries

As Table 2.2.1 shows, students in England achieved overall mean mathematics scores which were similar to or significantly higher than those of seven of the 14 continental western European countries taking part in TIMSS at Year 9 (and eight at Year 8). However, the overall mean mathematics scores of students in England compared unfavourably with those of students in the remaining seven countries. In the highest-scoring continental Western European educational system, Flemish-speaking Belgium, for example, international eighth grade (Year 9 in England) students achieved a mean score which was 59 scale points above the mean score of students in England; this difference is about twice the size of the difference between the international mean scores of Year 8 and Year 9 students (29 scale points). Students in the other five countries outperformed those in England by smaller margins (13–40 scale points).

Table 2.2.1 Overall mean mathematics scores: *comparisons between England and continental Western European countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Austria; Belgium *(Flemish)*; Belgium *(French)*; France; Netherlands; Switzerland	Austria; Belgium *(Flemish)*; Belgium *(French)*; France; Netherlands; Sweden; Switzerland
Not significantly different	Denmark; Germany; Sweden	Denmark; Germany; Norway
Significantly lower	Iceland; Greece; Norway; Portugal; Spain	Iceland; Greece; Portugal; Spain

Source: Figures 1.1 and 1.2 (Beaton et al., 1996b)

Comparisons with the Scandinavian countries revealed few significant differences between their mean scores and those of students in England, and, despite the fact that the German students were eight months older on average, their mean scores were not significantly different from those of students in England (Table 2.2.1). This finding, which holds for both year groups, is contrary to some reports which have appeared in the press. Whilst the TIMSS sample from Germany was more representative than those featured in many other reports, it should be pointed out that it excluded one of the 15 provinces (Baden Wurttemberg) and thus represented only 88 per cent of the school population. Baden Wurttemberg is a prosperous area and its exclusion may have lowered the mean scores of German students slightly.

Comparisons with previous international studies

In most cases, these findings of TIMSS are similar to those of previous large-scale international studies:

- Students in Belgium (FIMS), The Netherlands (FIMS, SIMS) and Switzerland (IAEP2) have all been shown to out-perform England in mathematics.
- However, the fact that previous studies (FIMS and IAEP2) found a much smaller difference between the performance of students in England and France suggests that the relative position of students in France, in terms of mathematics performance, may have improved compared with those in England.
- The TIMSS findings with regard to Sweden, the only Scandinavian country to have taken part in previous international studies, are similar to those of previous studies; in FIMS, SIMS and IAEP2, very few differences were found between the mathematics performance of students in England and Sweden.
- Since this is the first study in which the reunified Germany has taken part, the results are not comparable with those of the former Federal Republic of Germany in previous studies (FIMS).

2.2.2 Overall mean mathematics scores: comparisons between England and other English-speaking countries

The mean scores of students in England were not significantly different from those of students in New Zealand, United States or Scotland for either age group. Students in three English-speaking countries (Australia, Canada and Ireland) achieved significantly higher mean mathematics scores than those in England for both age groups. However, differences between the mean mathematics scores of students in these countries and those in England were not large, ranging from 18–24 scale points.

Table 2.2.2 Overall mean mathematics scores: *comparisons between England and other English-speaking countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Australia; Canada; Ireland	Australia; Canada; Ireland
Not significantly different	New Zealand; Scotland; United States	New Zealand; Scotland; United States
Significantly lower	*None*	*None*

Source: Figures 1.1 and 1.2 (Beaton et al., 1996b)

Comparisons with previous international studies

Compared with students in England, the relative mathematics performance of students in some other English speaking countries appears to have improved since previous international studies were carried out.

- Previous studies found very little difference between the performance of students in England and those in Australia (FIMS), Ireland (IAEP1 and IAEP2) or Canada (IAEP2) whereas students in these countries out-performed those in England in TIMSS.
- The performance of students in the United States, which was similar to that of students in England in TIMSS, was significantly lower than that of students in England in the two IAEP studies.
- However, the TIMSS results with regard to New Zealand and Scotland are similar to those of earlier studies, which also found very little difference between the performance of students in these countries and those in England.

2.2.3 Overall mean mathematics scores: comparisons between England and Eastern European countries

As Table 2.2.3 shows, students in six of the nine Eastern European countries taking part in TIMSS achieved mean scores which were significantly higher than those of students in England. The largest difference was between students in the Czech Republic and England (47 scale points in Year 8 and 58 scale points in Year 9). Differences between the mean score of students in England and the five other countries ranged from 22 to 41 scale points.

Table 2.2.3 Overall mean mathematics scores: *comparisons between England and Eastern European countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Bulgaria; Czech Republic; Hungary; Russian Federation; Slovak Republic; Slovenia	Bulgaria; Czech Republic; Hungary; Russian Federation; Slovak Republic; Slovenia
Not significantly different	Latvia	Latvia
Significantly lower	Lithuania; Romania	Lithuania; Romania

Source: Figures 1.1 and 1.2 (Beaton et al., 1996b)

Comparisons with previous international studies

Only two of the nine Eastern European countries have taken part in previous international comparative studies.

- Students in Hungary (SIMS and IAEP2) and the Soviet Union (IAEP2) achieved significantly higher mean scores than those in England in previous studies. The results of TIMSS with regard to these two countries are, therefore, similar to those of previous studies.

2.2.4 Overall mean mathematics scores: comparisons between England and Asian Pacific Rim countries

It can be seen from Table 2.2.4 that students in four of the Asian Pacific Rim countries taking part in TIMSS (Hong Kong, Japan, Korea and Singapore) had significantly higher mean mathematics scores than those in England for both year groups. The mean scores of the highest-achieving country, Singapore, were 125 scale points above those of students in England for Year 8 and 137 scale points for Year 9. These differences were more than four times the size of the difference between the international mean scores of Year 8 and Year 9 students (29 scale points). The differences between the mean scores of students in England and those in Hong Kong, Japan and Korea exceeded 80 scale points.

Table 2.2.4 Overall mean mathematics scores: *comparisons between England and the Asian Pacific Rim countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Hong Kong; Japan; Korea; Singapore	Hong Kong; Japan; Korea; Singapore
Not significantly different	Thailand	Thailand
Significantly lower	*None*	*None*

Source: Figures 1.1 and 1.2 (Beaton et al., 1996b)

Comparisons with previous international studies

- The findings with regard to Japan and Korea are neither new nor unexpected. Both these countries have outperformed England in previous large-scale studies carried out under the auspices of the IEA or the IAEP since the 1960s.
- Hong Kong, however, appears to have improved its performance compared with England since the 1980s (SIMS).
- Singapore has not taken part in previous large-scale comparisons of mathematics performance.

2.3 Comparisons of 13-year-olds

In the remainder of this chapter, comparisons are made between England and the ten other countries identified in Chapter 1.

One of the aims of TIMSS was to compare the performance of 13-year-olds in the countries taking part, irrespective of grade (year group). In some countries, such as England, the two grades (year groups) tested included practically all of their 13-year-olds, whereas in other countries substantial percentages of 13-year-olds were outside these grades, mostly in the grade below. Countries with less than 75 per cent of 13-year-olds in the tested grades were excluded from this analysis. However, for countries where the grades tested contained at least 75 per cent of 13-year-olds, TIMSS estimated the median performance of 13-year-olds. The median is the point in the mathematics scale which divides the higher-performing 50 per cent of the students from the lower-performing 50 per cent. Like the mean, the median provides a useful summary statistic on which to compare performance across countries. It is used instead of the mean in this table because it can reliably be estimated even when scores from some members of the population are not available,[4] that is, those 13-year-olds outside the tested grades (Beaton *et al.*, 1996b).

Table 2.3 Median mathematics achievement in ten countries: *the scores of 13-year-olds compared with the scores of students in international seventh grade (Year 8 in England)*

	13-year-olds		International seventh grade (Year 8 in England)		
COUNTRY	Median score	*Rank*	Median score	*Rank*	*Mean age (years)*
Singapore	608	*1*	604	*1*	*13.3*
Japan	572	*2*	568	*2*	*13.4*
Switzerland	519	*3*	502	*3*	*13.1*
Hungary	504	*4*	496	*4*	*13.4*
France	498	*5*	491	*5*	*13.3*
Canada	498	*5*	488	*6*	*13.1*
Sweden	497	*7*	475	*7*	*12.9*
Scotland	486	*8*	459	*10*	*12.7*
England	**482**	***9***	**469**	***8***	***13.1***
United States	472	*10*	465	*9*	*13.2*

The median score for 13-year-olds was not computed for Germany since fewer than 75 per cent of 13-year-olds were included in the grades tested in Germany. The mean age of international seventh grade students in Germany was 13.8 years.
Source: Tables 1.2, 1.8 and E.2 (Beaton et al., 1996b)

[4] *'Because TIMSS sampled students in the two adjacent grades with the most 13-year-olds within a country, it was possible to estimate the median for the 13-year-old students when the two tested grades included at least an estimated 75 per cent of the 13-year-olds in that country. To compute the median, TIMSS assumed that those 13-year-old students below the tested grades would score below the median and those in the grades above the tested grades would score above the median. The percentages assumed to be above and below the median were added to the tails of the distribution, before calculating the median using the modified distribution' (Beaton et al., 1996a, 1996b).*

Table 2.3 shows how the rank order of median scores of 13-year-olds in ten of the 11 selected countries compared with the median score for the international seventh grade (Year 8 in England).

It can be seen from Table 2.3 that the rank order of countries in terms of the median scores of 13-year-olds is very similar to the rank order in terms of the median scores of the international seventh grade (Year 8 in England). There appears to be very little difference in the position of England compared with the other selected countries, whether the ranking is made in terms of the median score of 13-year-olds or of the international eighth grade (Year 8 in England). As the international report (Beaton *et al.*, 1996b) concludes, 'the relative performance of countries in mathematics achievement on the basis of median performance of 13-year-olds is quite similar to that based on the mean eighth-grade and/or seventh-grade performance'.

2.4 Test-curriculum Matching Analysis

The Test-curriculum Matching Analysis was designed and conducted to investigate the appropriateness of the TIMSS mathematics test for seventh and eighth grade students (Years 8 and 9 in England) in the participating countries, and to show how student performance in individual countries varied when based only on test items that were judged to be relevant to their own curriculum.[5] A brief description of how the Test-curriculum Matching Analysis was carried out in England is given in Chapter 1; full details are given in Appendix III (Section III.6), which is included in a separate publication which collects together all the technical appendices to the TIMSS study in England (Keys, Harris and Fernandes, 1996). In the Test-curriculum Matching Analysis, comparisons are made in terms of mean percentages of correct items, since the international costs and delays of scaling would have been prohibitive (Beaton *et al.*, 1996b).

Table 2.4.1 shows, for the 11 selected countries, the scores of students in the international seventh grade (Year 8 in England) on the sub-set of items selected by curriculum experts in England as addressing the National Curriculum compared with their scores on the entire mathematics test (in terms of mean percentage correct). Table 2.4.2 provides similar information for the international eighth grade (Year 9 in England). The complete matrices, showing how students in every country achieved on their own and other countries' selected subsets of items is given in Appendix III which is contained in a companion volume to this report (Keys, Harris and Fernandes, 1996).

[5] *'Because there may also be curriculum areas covered in some countries that are not covered by the TIMSS tests, the Test-curriculum Matching Analysis does not provide complete information about how well the TIMSS tests cover the curricula of the participating countries. The purpose of the Test-curriculum Matching Analysis was to investigate whether or not the content covered by the actual test items was in the intended curricula of participating countries.' (Beaton et al., 1996b)*

Table 2.4.1 **Mathematics Test-curriculum Matching Analysis results for international seventh grade (Year 8 in England): *the scores of students in 11 selected countries on the sub-set of items selected by curriculum experts in England as addressing the National Curriculum compared with their scores on the entire mathematics test***

COUNTRY	Mean percent correct: for all 162 items %	Rank	Mean percent correct: for 93 items selected by England %	Rank	Difference in mean percent correct %
Singapore	73	*1*	76	*1*	+3
Japan	67	*2*	72	*2*	+5
Hungary	54	*3*	60	*4*	+6
Switzerland	53	*4*	62	*3*	+9
Canada	52	*5*	60	*4*	+8
France	51	*6*	58	*6*	+7
Germany	49	*7*	57	*7*	+8
United States	48	*8*	55	*10*	+7
England	**47**	***9***	**57**	*7*	**+10**
Sweden	47	*9*	57	*7*	+10
Scotland	44	*11*	55	*10*	+11
International mean	**49**		**56**		**+7**

Some of the 151 items in the TIMSS mathematics tests consisted of two or more parts. The total number of score points available for analysis therefore was 162.
Differences may be subject to rounding errors.
Source: Table B.2 (Beaton et al., 1996b)

The Year 8 students in England achieved a higher score (in terms of mean percentage correct) on the sub-set of 93 items selected by curriculum experts in England (as best addressing the National Curriculum for Year 8) than on the entire TIMSS test of 162 items, but so did students in the other nine countries. The pattern was the same for international eighth grade (Year 9 in England), although the differences were much smaller for all countries. Similar patterns were also found when comparisons were made in terms of percentages correct on the sub-sets of items identified by other countries as relevant to their own national curricula (see Appendix III). These results suggest that the TIMSS mathematics test provided a reasonable basis for comparing achievement in the participating countries. This result is not unexpected, since making the TIMSS tests as fair as possible was a major consideration in test development (Beaton *et al.*, 1996b).

Table 2.4.2 **Mathematics Test-curriculum Matching Analysis results for international eighth grade (Year 9 in England): *the scores of students in 11 selected countries on the sub-set of items selected by curriculum experts in England as addressing the National Curriculum compared with their scores on the entire mathematics test***

COUNTRY	Mean percent correct: for all 162 items %	Rank	Mean percent correct: for 130 items selected by England %	Rank	Difference in mean percent correct %
Singapore	79	*1*	81	*1*	+2
Japan	73	*2*	75	*2*	+2
Switzerland	62	*3*	66	3	+4
Hungary	62	*3*	63	*4*	+1
France	61	*5*	63	*4*	+2
Canada	59	*6*	62	*6*	+3
Sweden	56	*7*	59	*7*	+3
Germany	54	*8*	57	*8*	+3
England	**53**	***9***	**57**	***8***	**+4**
United States	53	*9*	56	*10*	+3
Scotland	52	*11*	55	*11*	+3
International mean	**55**		**58**		**+3**

Some of the 151 items in the TIMSS mathematics tests consisted of two or more parts. The total number of score points available for analysis therefore was 162. Differences may be subject to rounding errors.

Source: Table B.1 (Beaton et al., 1996b)

The number of items selected by each of the 11 countries as being relevant to their own curriculum for each grade/year group are shown overleaf. As yet there is no information available about the specific items selected and rejected by different countries.

It can be seen that, for the international seventh grade (Year 8 in England), there was considerable variation between countries in the proportion of items deemed relevant to the intended curriculum. These results provide some evidence of a positive association between curriculum coverage and achievement: curriculum experts in three of the countries whose students achieved relatively low mean scores on the mathematics test (England, Scotland and Sweden) indicated that Year 8 (or equivalent) students would only have covered about 50 to 60 per cent of the items by the time of testing.

However, the relationship is not consistent for all countries: experts in one of the higher-scoring countries (Switzerland) selected a similar proportion of items as relevant to their curriculum, and students in Singapore, whose students achieved the highest score, were deemed to have covered the content for only about three-quarters of the items. Although the pattern was quite similar for the international eighth grade (Year 9 in England), the variation between countries in terms of the number of items covered was much smaller than for Year 8 and the match between the content of the test and the intended curriculum was reasonably close for most countries. The relationship between the intended curriculum and achievement will be investigated further in subsequent reports on TIMSS.

	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
United States	162	162
Hungary	158	162
Japan	145	153
Germany	132	155
France	128	140
Singapore	126	144
Sweden	100	127
England	**93**	**130**
Switzerland	91	133
Canada	87	147
Scotland	76	125
International test	162	162

Source: Tables B.1 and B.2 (Beaton et al., 1996b)

2.5 Comparisons between 11 countries: differences in overall mean mathematics score between international seventh and eighth grades (Years 8 and 9 in England)

One of the questions which TIMSS sought to answer was: how do students in different countries vary in the amount of progress they make over time? The most reliable way to answer this question would have been to test the same group of students in each country on two separate occasions several years apart. For a number of reasons, such as time constraints, cost and placing additional demands on schools, this was not possible in TIMSS. However, each country taking part in TIMSS at Population 2 tested students in two adjacent age groups, equivalent to Years 8 and 9 in England in each of the schools taking part in the study. For each country, the difference between the mean scores of Year 8 and Year 9 students can be considered to be a proxy measure for the progress achieved between Year 8 and Year 9 (one school year) by students in that country: the progress score.

Table 2.5 shows the difference in mean scores for Year 8 and Year 9 students in each of the selected countries. In each country the mean score for Year 9 was higher than the mean score for Year 8. The magnitude of the difference ranged from 24 to 46 scale points with a median of 35 scale points. The difference in mean score in England (30 scale points) was close to the difference between the international mean scores for the upper and lower age groups. Only two of the selected countries, the United States and Germany, had differences which were smaller than that of England. Selected countries with differences in mean scores of 40 or more scale points were France, Sweden, Switzerland and Singapore.

It is difficult to find a consistent pattern in these results. Three of the four lowest-scoring countries in terms of their students' mean scores in Year 8 (England, United States and Germany) also had relatively low progress scores, whereas the fourth, Sweden, had a relatively high progress score. Similarly, France, whose Year 8 students' mean score was only just significantly higher than that of students in England (Figure 1.2 (Mathematics)), had a progress score of 46 scale points (16 scale points larger than that of students in England). On the other hand, Singapore, the highest scoring country at Year 8 also had a high progress score (42 scale points), whereas that of Japan, another high-scoring country in Year 8, was only just above the international progress score.

These results suggest that different sets of factors may have affected the size of Year 8/9 increases in different countries. Possible factors include:

- the students' prior knowledge and understanding (e.g. curricula and teaching approaches experienced in previous years)

- curricula experienced in Year 9 (e.g. the range of topics covered, new topics introduced and the match between what is taught and the content of the TIMSS tests)
- the nature and quality of mathematics teaching at Year 9
- the amount of time students spent doing mathematics in school and at home.

The relationship between students' scores on the mathematics tests and some of these factors will be explored in Part 2 of this report which will be published in spring 1997.

Table 2.5 Comparisons between 11 countries: *difference in overall mean mathematics score of international seventh and eighth grades (Years 8 and 9 in England)*

COUNTRY	Mean score of international seventh grade (Year 8 in England)	Mean score of international eighth grade (Year 9 in England)	Difference between mean scores of Years 8 and 9
France	492	538	46
Singapore	601	643	42
Sweden	477	519	41
Switzerland	506	545	40
Scotland	463	498	36
Hungary	502	537	35
Japan	571	605	34
Canada	494	527	33
England	**476**	**506**	**30**
Germany	484	509	25
United States	476	500	24
International	**484**	**513**	**29**

Differences may be subject to rounding errors.
Source: Table 1.3 (Beaton et al., 1996b)

2.6 International marker levels

One of the questions which TIMSS was designed to answer was: how do the proportions of very high-scoring students and very low-scoring students vary from country to country? In order to answer this question, international marker levels, corresponding to the percentiles computed from the combined data of all participating countries, were calculated as follows.

	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
• Top 10 per cent marker level (90th percentile)	619	656
• Top 25 per cent marker level (75th percentile)	551	587
• Top half marker level (50th percentile or median)	476	509
• Bottom 25 per cent marker level (25th percentile)	410	436

Source: Tables 1.4 and 1.5 (Beaton et al., 1996b) and additional analysis provided by the International Study Centre

Table 2.6 uses the information provided in the international report to show the percentages of international eighth grade students (Year 9 in England) in each of the selected countries in the top ten per cent and top half of the international distribution. The pattern was broadly similar for the international seventh grade (Year 8) students.

Table 2.6 Comparisons between 11 countries: *percentages of students reaching international marker levels (top ten per cent and top half) of mathematics achievement in international eighth grade (Year 9 in England)*

COUNTRY	Top half %	*Rank*	Top ten per cent %	*Rank*
Singapore	94	*1*	45	*1*
Japan	83	*2*	32	*2*
Switzerland	65	*3*	11	*3*
France	63	*4*	7	*5*
Hungary	60	*5*	11	*3*
Canada	58	*6*	7	*5*
Sweden	53	*7*	5	*9*
Germany	49	*8*	6	*8*
England	**48**	***9***	**7**	***5***
United States	45	*10*	5	*10*
Scotland	44	*11*	5	*10*

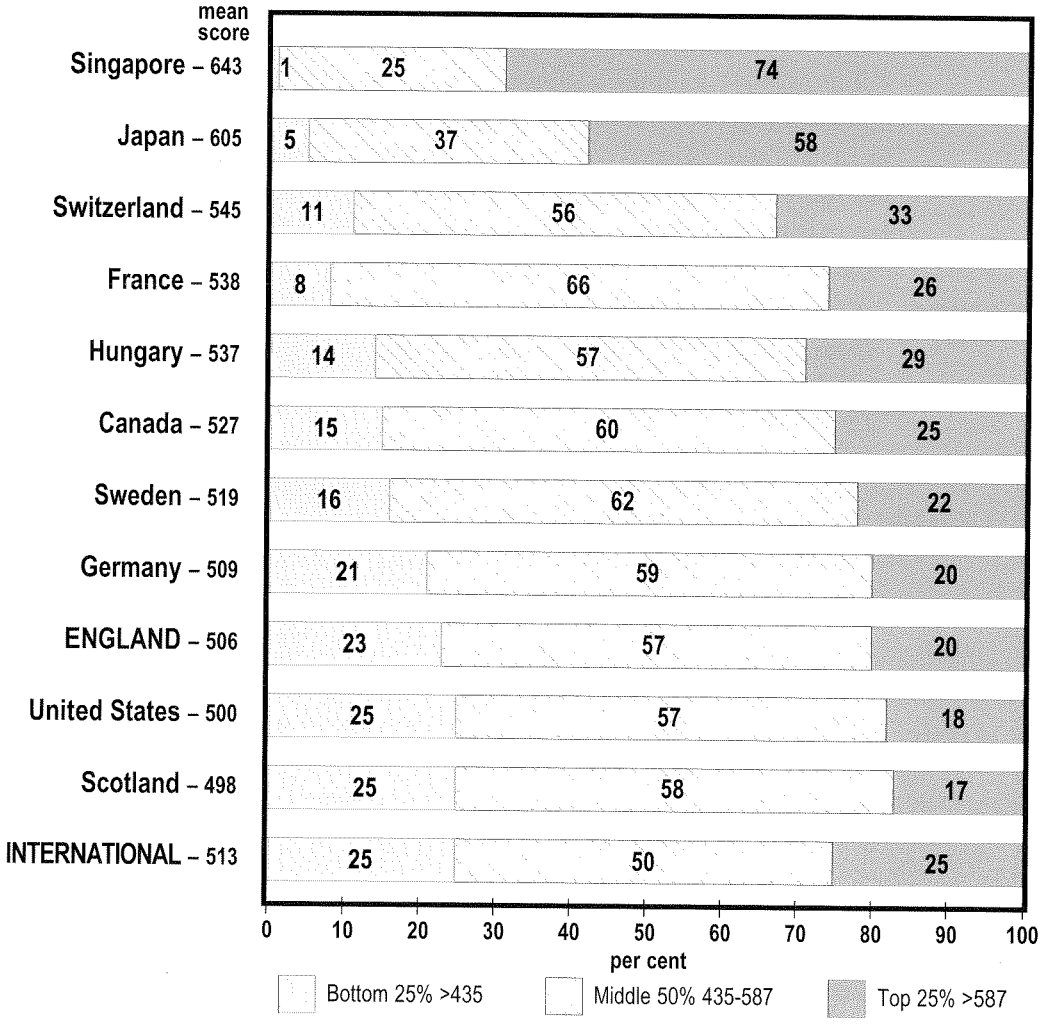
Differences may be subject to rounding errors.
Source: Table 1.4 (Beaton et al., 1996b)

Table 2.6 shows that Canada and France had higher proportions of students than England in the top half of the international distribution (58 and 63 per cent compared with 48 per cent in England) but similar proportions in the international top ten per cent (seven per cent), i.e. students in these countries performed better overall than those in England but the performance

of the most able students in England was similar to that of students in these countries. However, the proportion of high-scoring students in England was considerably smaller than in Singapore and Japan.

Figure 2.6 shows the percentages of students in the international eighth grade (Year 9 in England) in each of the ten selected countries in the top 25 per cent and bottom 25 per cent of the international distribution. The pattern was broadly similar for the international seventh grade (Year 8 in England).

Figure 2.6 Percentages in the bottom 25%, middle 50% and top 25% of the international distribution for mathematics (international eighth grade : Year 9 in England): *comparisons between 11 countries*



Source: Table 1.4 (Beaton et al., 1996b) and additional analyses provided by the International Study Centre

Figure 2.6 shows that, whereas the proportions of students in the international top 25 per cent were quite similar in England and Sweden, the proportion of students in the bottom 25 per cent was higher in England than in Sweden (23 per cent compared with 16 per cent). Possible reasons for this difference will be explored in Part 2 of this report, which will be published in spring 1997.

2.7 Comparisons between 11 countries: gender differences in overall mean mathematics score

In general, the differences between the mean scores of boys and girls were not statistically significant in most countries in either year group. However, at Year 8, statistically significant differences in favour of boys were found in England and two other countries, Switzerland and Japan (Table 2.7). The difference between the mean scores of boys and girls in England at Year 9 was not statistically significant. The only one of the selected countries with a statistically significant difference at Year 9 was Japan, where the boys out-performed the girls by ten scale points.

Table 2.7 Comparisons between 11 countries: *gender differences in overall mean mathematics scores for international seventh grade (Year 8 in England)*

COUNTRY	Boys' Mean	Girls' Mean	Difference in favour of boys
Singapore	601	601	0
Hungary	503	501	1
Canada	495	493	2
Germany	486	484	2
Scotland	465	462	3
United States	478	473	5
Sweden	480	475	5
France	497	489	8
Japan	576	565	11*
Switzerland	513	498	14*
England	**484**	**467**	**17***

* *Gender difference statistically significant at the five per cent level*[1].

Differences may be subject to rounding errors.

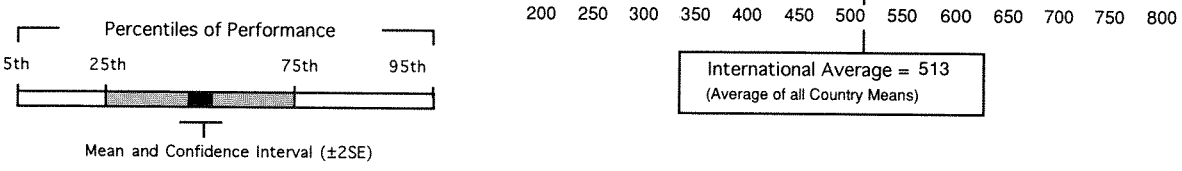
Source: Table 1.7 (Beaton et al., 1996b)

[1] There is always a possibility that the given difference between two samples could have arisen by chance. The level of statistical significance gives an indication of how likely this is. 0.05 is generally taken as the cut-off between differences that are thought to be real and those which could have arisen by chance, i.e. a difference of this size is only likely to have arisen by chance five times out of a hundred.

Table 1.1 (Mathematics)

Distributions of mathematics achievement–international eighth grade* (Year 9 in England)

Country	Mean	Years of Formal Schooling	Average Age	Mathematics Achievement Scale Score
Singapore	643 (4.9)	8	14.5	
Korea	607 (2.4)	8	14.2	
Japan	605 (1.9)	8	14.4	
Hong Kong	588 (6.5)	8	14.2	
† Belgium (Fl)	565 (5.7)	8	14.1	
Czech Republic	564 (4.9)	8	14.4	
Slovak Republic	547 (3.3)	8	14.3	
¹ Switzerland	545 (2.8)	7 or 8	14.2	
France	538 (2.9)	8	14.3	
Hungary	537 (3.2)	8	14.3	
Russian Federation	535 (5.3)	7 or 8	14.0	
Ireland	527 (5.1)	8	14.4	
Canada	527 (2.4)	8	14.1	
Sweden	519 (3.0)	7	13.9	
New Zealand	508 (4.5)	8.5 - 9.5	14.0	
†² England	506 (2.6)	9	14.0	
Norway	503 (2.2)	7	13.9	
† United States	500 (4.6)	8	14.2	
¹ Latvia (LSS)	493 (3.1)	8	14.3	
Spain	487 (2.0)	8	14.3	
Iceland	487 (4.5)	8	13.6	
¹ Lithuania	477 (3.5)	8	14.3	
Cyprus	474 (1.9)	8	13.7	
Portugal	454 (2.5)	8	14.5	
Iran, Islamic Rep.	428 (2.2)	8	14.6	
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):				
Australia	530 (4.0)	8 or 9	14.2	
Austria	539 (3.0)	8	14.3	
Belgium (Fr)	526 (3.4)	8	14.3	
Bulgaria	540 (6.3)	8	14.0	
Netherlands	541 (6.7)	8	14.3	
Scotland	498 (5.5)	9	13.7	
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	385 (3.4)	8	15.7	
†¹ Germany	509 (4.5)	8	14.8	
Romania	482 (4.0)	8	14.6	
Slovenia	541 (3.1)	8	14.8	
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	502 (2.8)	7	13.9	
Greece	484 (3.1)	8	13.6	
Thailand	522 (5.7)	8	14.3	
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
¹ Israel	522 (6.2)	8	14.1	
Kuwait	392 (2.5)	9	15.3	
South Africa	354 (4.4)	8	15.4	



*Eighth grade in most countries.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

¹National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

²National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Source: Beaton et al., 1996b

Figure 1.1 (Mathematics)

Multiple comparisons of mathematics achievement–international eighth grade* (Year 9 in England)

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.†

Country	Singapore	Korea	Japan	Hong Kong	Belgium (Fl)	Czech Republic	Slovak Republic	Switzerland	Netherlands	Slovenia	Bulgaria	Austria	France	Hungary	Russian Fed.	Australia	Ireland	Canada	Belgium (Fr)	Thailand	Israel	Sweden	Germany	New Zealand	England	Norway	Denmark	United States	Scotland	Latvia (LSS)	Spain	Iceland	Greece	Romania	Lithuania	Cyprus	Portugal	Iran, Islamic Rep.	Kuwait	Colombia	South Africa
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	▼		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	▼	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	▼	▼	▼	●		●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼	▼	▼	●	●		●	▲	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	●	▼	●		●	●	●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	●	●	▲	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Israel	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●	●		●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●	●	●	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	●	●	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	●	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	▲	▲	▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲
Kuwait	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Eighth grade in most countries.

†Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

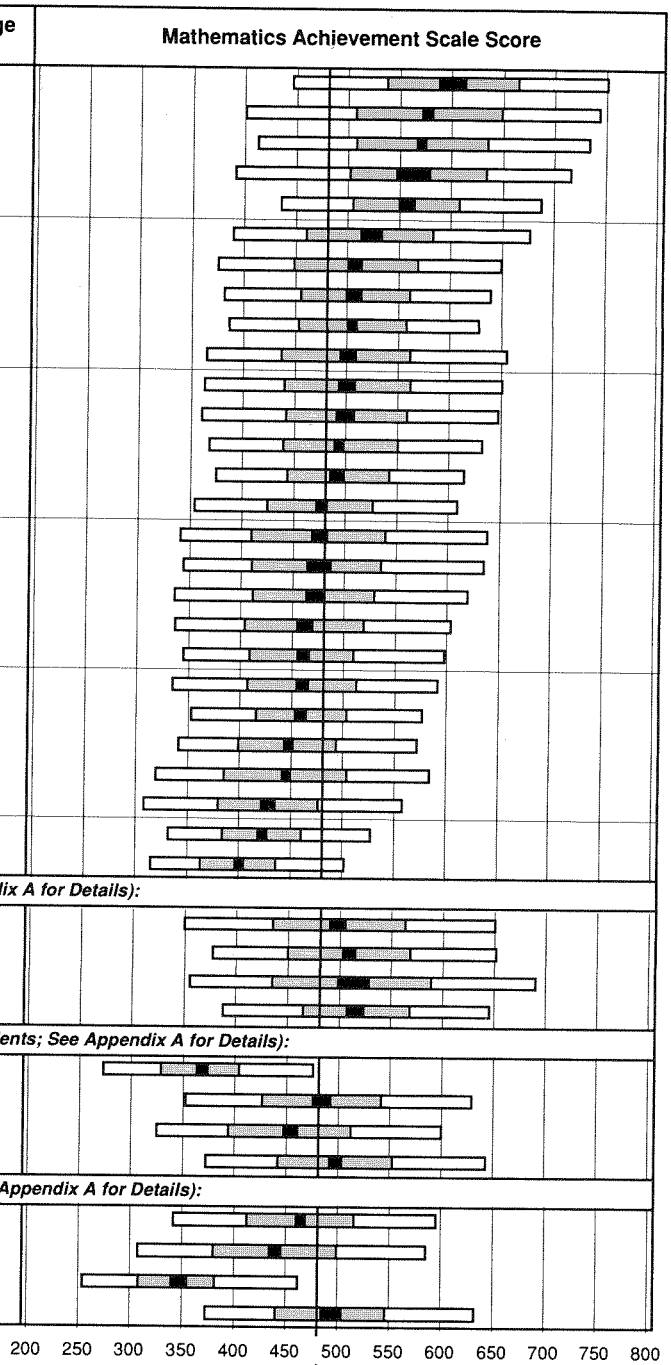
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

Source: Beaton et al., 1996b

Table 1.2 (Mathematics)

Distributions of mathematics achievement–international seventh grade* (Year 8 in England)

Country	Mean	Years of Formal Schooling	Average Age
Singapore	601 (6.3)	7	13.3
Korea	577 (2.5)	7	13.2
Japan	571 (1.9)	7	13.4
Hong Kong	564 (7.8)	7	13.2
† Belgium (Fl)	558 (3.5)	7	13.0
Czech Republic	523 (4.9)	7	13.4
Slovak Republic	508 (3.4)	7	13.3
† Belgium (Fr)	507 (3.5)	7	13.2
¹ Switzerland	506 (2.3)	6 or 7	13.1
Hungary	502 (3.7)	7	13.4
Russian Federation	501 (4.0)	6 or 7	13.0
Ireland	500 (4.1)	7	13.4
Canada	494 (2.2)	7	13.1
France	492 (3.1)	7	13.3
Sweden	477 (2.5)	6	12.9
†² England	476 (3.7)	8	13.1
† United States	476 (5.5)	7	13.2
New Zealand	472 (3.8)	7.5 - 8.5	13.0
† Scotland	463 (3.7)	8	12.7
¹ Latvia (LSS)	462 (2.8)	7	13.3
Norway	461 (2.8)	6	12.9
Iceland	459 (2.6)	7	12.6
Spain	448 (2.2)	7	13.2
Cyprus	446 (1.9)	7	12.8
¹ Lithuania	428 (3.2)	7	13.4
Portugal	423 (2.2)	7	13.4
Iran, Islamic Rep.	401 (2.0)	7	13.6
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	498 (3.8)	7 or 8	13.2
Austria	509 (3.0)	7	13.3
Bulgaria	514 (7.5)	7	13.1
Netherlands	516 (4.1)	7	13.2
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	369 (2.7)	7	14.5
†¹ Germany	484 (4.1)	7	13.8
Romania	454 (3.4)	7	13.7
Slovenia	498 (3.0)	7	13.8
Countries With Unapproved Sampling Procedures At The Classroom Level (See Appendix A for Details):			
Denmark	465 (2.1)	6	12.9
Greece	440 (2.8)	7	12.6
† South Africa	348 (3.8)	7	13.9
Thailand	495 (4.8)	7	13.5



*Seventh grade in most countries.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

¹National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

²National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Source: Beaton et al, 1996b

Figure 1.2 (Mathematics)

Multiple comparisons of mathematics achievement–international seventh grade* (Year 8 in England)

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.†

Country	Singapore	Korea	Japan	Hong Kong	Belgium (Fl)	Czech Republic	Netherlands	Bulgaria	Austria	Slovak Republic	Belgium (Fr)	Switzerland	Hungary	Russian Fed.	Ireland	Slovenia	Australia	Thailand	Canada	France	Germany	Sweden	England	United States	New Zealand	Denmark	Scotland	Latvia (LSS)	Norway	Iceland	Romania	Spain	Cyprus	Greece	Lithuania	Portugal	Iran, Islamic Rep.	Colombia	South Africa
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	▼		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	▼	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	▼	▼	▼	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼	▼	▼	▼	▼		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	▼	▼	▼	▼	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	▼	▼	▼	▼	▼	●	●		●	●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	▼	●	●	●	●	●	●		●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	▼	●	●	●	●	●	●	●		●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	▲	▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Seventh grade in most countries.

†Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

Source: Beaton et al., 1996b

CHAPTER 3

The students' performance on the mathematics topics

Summary of main points

Compared with the international means for each of the six mathematics reporting categories, students in England showed:

- **higher scores both in Year 8 and in Year 9 for one content area: *Data representation, analysis and probability***
- **lower scores in both Year 8 and Year 9 for five content areas: *Fractions and number sense*; *Geometry*; *Algebra*; *Measurement*; and *Proportionality*.**

With regard to gender differences in achievement:

- **there were no significant differences in the mean scores of boys and girls in England in either Year 8 or Year 9 in any of the six content areas.**

3.1 Preface

The mathematics items used in TIMSS covered the content areas defined by the curriculum frameworks which were developed to ensure that the content of the tests were as relevant as possible to the curricula of the countries taking part in the study (Robitaille, 1993). The items have been organised into six reporting categories, each of which reflects different broad aspects of the mathematics curriculum. These categories are shown below, together with the number of items for each category and the nearest corresponding attainment targets from the 1995 National Curriculum Order for mathematics.[1]

Reporting category	No. of items	Attainment target
Fractions and number sense	51	Ma 2: Number and Algebra
Geometry	23	Ma 3: Shape, Space and Measures
Algebra	27	Ma 2: Number and Algebra
Data representation, analysis and probability	21	Ma 4: Handling Data
Measurement	18	Ma 3: Shape, Space and Measures
Proportionality	11	Ma 2: Number and Algebra
	Total 151	

It can be seen that none of the mathematics items were closely linked with Ma1: Using and Applying Mathematics. The type of extended investigation that would be more representative of this part of the National Curriculum for mathematics did not form part of the written tests, although the investigative or problem-solving approach was required to some extent in the practical tasks that comprised the Performance Assessment component of TIMSS (see Appendix III, section III.5 for details of the administration of this element, and Appendix IV, section IV.7 for details of the development of the tasks). A separate report (to be published in 1997) will present the results for the Performance Assessment component of TIMSS.

This chapter presents information about the mean scores of students in England for each of the mathematics reporting categories and draws comparisons with the performance of students in the ten other countries listed in Chapter 1. Separate comparisons are made for each of the following for each reporting category:

[1] *At the time of testing (February–March 1995), the 1991 statutory Orders for mathematics were still in effect. The attainment targets at that time were as follows:*

Ma1: Using and applying mathematics

Ma2: Number

Ma3: Algebra

Ma4: Shape and space

Ma5: Handling data.

- comparisons of students' mean percentage of correct answers
- differences in mean scores between Year 8 and Year 9 (a proxy measure for progress in achievement)
- gender differences in mean scores for both Year 8 and Year 9: these are presented for all six mathematics content areas in one section of this chapter.

Illustrative examples of items are included at the end of each of the sections relating to reporting categories. For each item, the percentages of students making correct responses are given for England and the countries with the median and highest scores (see Beaton *et al.*, 1996b), together with the international percentage correct. Details of the international coding guidelines for free response items are included where appropriate. Additional information, for example relating to incorrect answers that were common, is provided for each illustrative item. Each of the examples was one of those selected by the national panels of subject experts for England as being representative of the National Curriculum for mathematics for both ages tested (Years 8 and 9 in England) unless otherwise stated. Some items were included in only one version of the test, whereas others were included in two or more booklets (see Chapter 1, section 1.3.1 and Appendix IV, section IV.3). Consequently, the total number of students on which the percentages of correct answers have been calculated varies.

Within this chapter, comparisons are made using the mean percentages of correct responses[2] attained by students in the 11 selected countries; differences are expressed in terms of percentage points. This is in contrast to Chapter 2, where scores on a scale were quoted, and differences were expressed in scale points. Differences of ± five percentage points or more in the mean percentage of correct responses have been taken as evidence of real differences in performance.

[2] *Students who omitted to answer specific items were included in the percentage of students offering incorrect responses. Full details are provided in the international report (Beaton et al., 1996b).*

3.2 Fractions and number sense

The mean percentages of correct answers achieved by the two age groups tested are shown for England and selected other countries in Table 3.2, together with the international means and the differences between the two age groups. The countries are ranked in order of their mean scores for the international seventh grade (Year 8 in England), although there is very little difference between the rank orders for the two age groups.

Table 3.2 Mean percentages of correct answers for *Fractions and number sense* in 11 countries (51 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	79	84	5
Japan	71	75	4
Switzerland	60	67	7
Hungary	59	65	6
Canada	58	64	6
Germany	55	58	3
United States	54	59	5
France	53	64	11
Sweden	51	62	11
England	**48**	**54**	**6**
Scotland	47	53	6
International mean	**53**	**58**	**5**

Differences may be subject to rounding errors.

Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

3.2.1 Comparisons of total topic scores: *Fractions and number sense*

The mean scores of students in England for *Fractions and number sense* were below the international mean for both age groups. Furthermore, the mean scores of students in England and Scotland were the lowest of the selected countries for both year groups. Within the countries where students' scores were higher than those of students in England, the national mean scores ranged from three to 31 percentage points higher for the international seventh grade (Year 8 in England) and from four to 30 percentage points higher for the international eighth grade (Year 9 in England).

These results are generally similar to those of previous large-scale international studies which have highlighted the relatively poor performance

of students in England on number and related topics. For example, the following countries from the ten selected for comparisons have out-performed England in previous studies in number: Japan (FIMS, SIMS), Switzerland (IAEP2), Hungary (SIMS, IAEP2), Canada (IAEP2), France (SIMS and IAEP2, but not FIMS) and Germany (FIMS). However, the mean scores of the United States in number and related topics in previous studies have not been significantly different from those of England. The performance of students in England was also similar to that of their counterparts in Scotland in previous studies in number (FIMS, SIMS and IAEP2).

Students in England performed at a similar level in IAEP2, with a mean percentage which was slightly below the international mean for that content area. However, the set of countries taking part in TIMSS was different from the set taking part in IAEP2.

3.2.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Fractions and number sense*

As stated in Chapter 2, one of the questions which TIMSS sought to answer was: how do students in different countries vary in the amount of progress they make over time? The overall differences in mean scores between the lower and upper grades (a proxy measure for progress in achievement) were discussed in the previous chapter, but further comparisons may be made between students' performance in different countries within each content area.

In each of the 11 countries, students in the international eighth grade achieved higher scores than those in the international seventh grade (Years 9 and 8 respectively). The increase in mean scores in this content area ranged from three to 11 percentage points (see Table 3.2).

3.2.3 Examples of items for *Fractions and number sense*

Example items[3] O9, P13 and U1 are shown below, together with national and international percentages correct.

Item O9

O9. Luke exercises by running 5 km each day. The course he runs is $\frac{1}{4}$ km long. How many times through the course does he run each day?

Answer: 20

O9	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	49.4	52.5
International	42.2	49.5
Median country	43.6	51.5
Highest-scoring country	71.9	84.0

A range of incorrect responses was offered by students in England. The incorrect answer most frequently suggested was '4' (6.2 per cent of Year 8 and 8.4 per cent of Year 9).

* * * * * * * * * * * *

[3] *Some of the items used in TIMSS may not be quoted because of restrictions imposed by the IEA (who hold the copyright). The examples of items shown throughout this report have all been selected from the ones the IEA has released. Copies of all the released items together with item statistics will be available in a separate publication (forthcoming).*

Item P13

P13. A person's heart is beating 72 times a minute. At this rate, about how many times does it beat in one hour?

A. 420 000

B. 42 000

C. 4 200

D. 420

P13	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	42.4	47.9
International	61.4	66.2
Median country	62.4	68.6
Highest-scoring country	85.6	88.0

Option (B) was a popular wrong answer, with approximately one-third of students in England selecting this response (34.8 per cent of Year 8 and 31.5 per cent of Year 9).

* * * * * * * * * * * *

Item U1

U1. Teresa wants to record 5 songs on tape. The length of time each song plays for is shown in the table.

Song	Amount of Time
1	2 minutes 41 seconds
2	3 minutes 10 seconds
3	2 minutes 51 seconds
4	3 minutes
5	3 minutes 32 seconds

ESTIMATE to the nearest minute the total time taken for all five songs to play and explain how this estimate was made.

Estimate: 16 minutes

Explain: Round each time to the nearest minute then add the times together.

Acceptable estimates were 15 or 16 minutes.

U1a (estimate)	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	48.6	56.6
International	30.8	35.1
Median country	33.6	36.6
Highest-scoring country	74.3	77.6

A small number of students in England (fewer than five per cent of each year group) responded to the first part of the question *not* by giving an estimate, but by accurately *totalling* the five amounts of time to give 15 minutes 14 seconds. Since this was not what pupils had been asked to do, the international guidelines stated that this answer must be deemed an incorrect response.

Acceptable explanations for Item U1 included:

- showing calculations, with rounding each time to whole minutes/30 seconds/ 15 seconds before adding
- no calculations shown, but statements referring to rounding
- totalling the times then rounding correctly from 15 minutes 14 seconds.

U1b (explanation)	**Percentage correct for international seventh grade (Year 8 in England) %**	**Percentage correct for international eighth grade (Year 9 in England) %**
England	41.5	46.2
International	28.2	31.3
Median country	24.6	29.2
Highest-scoring country	64.0	71.2

In comparison with the number of students who gave an acceptable estimate, slightly fewer students gave acceptable explanations as to *how* they had reached their estimate,than had given aceptable estimates. The most popular strategy mentioned by students from each year group (22.0 per cent of Year 8 students and 24.0 per cent of Year 9) was that of rounding times to the nearest minute, or rounding numbers up or down; this type of response was not accompanied by any calculations.

* * * * * * * * * * * *

3.3 Geometry

The mean percentages of correct responses achieved by the two year groups tested are shown for England and selected other countries in Table 3.3, together with the international means and the differences between the two year groups. Countries are ranked in terms of their mean score for the younger age group.

Table 3.3 Mean percentages of correct answers for *Geometry* in 11 countries (23 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Japan	70	80	10
Singapore	69	76	7
France	58	66	8
Hungary	52	60	8
Canada	50	58	8
England	**49**	**54**	**5**
Switzerland	46	60	14
Scotland	46	52	6
Germany	46	51	5
United States	44	48	4
Sweden	43	48	5
International mean	**49**	**56**	**7**

Differences may be subject to rounding errors.
Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

3.3.1 Comparisons of total topic scores: *Geometry*

Students in England had mean scores for *Geometry* which were in line with or very slightly below the international mean. This is in contrast to the results in IAEP2, where the mean percentage of correct responses for 13-year-old students in England was above the international mean on *Geometry*.

Students in three of the selected countries (Japan, Singapore and France) had mean scores for *Geometry* which were more than five percentage points higher than those of students in England in both year groups. Students in Switzerland and Hungary had mean scores more than five percentage points higher than the mean scores of students in England in the international eighth grade only. These differences are similar to those found in previous studies: students in Japan (FIMS and SIMS), Hungary

(SIMS) and Switzerland (IAEP2) have all achieved appreciably higher mean scores than those in England. However, in previous studies, students in France (FIMS and IAEP2) achieved mean scores which were not appreciably different from those of students in England.

There was very little difference between the mean scores of students in England, Scotland, Germany and Canada. This is similar to the findings of previous studies: Scotland (FIMS and IAEP2), Germany (FIMS) and Canada (IAEP2).

England's mean scores for both age groups were more than five percentage points above those of the United States and Sweden. The result with regard to the United States is similar to the findings of all the previous large-scale studies (FIMS, SIMS, IAEP1 and IAEP2). However, students in Sweden have scored at approximately the same level as those in England in previous studies (FIMS and SIMS).

3.3.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Geometry*

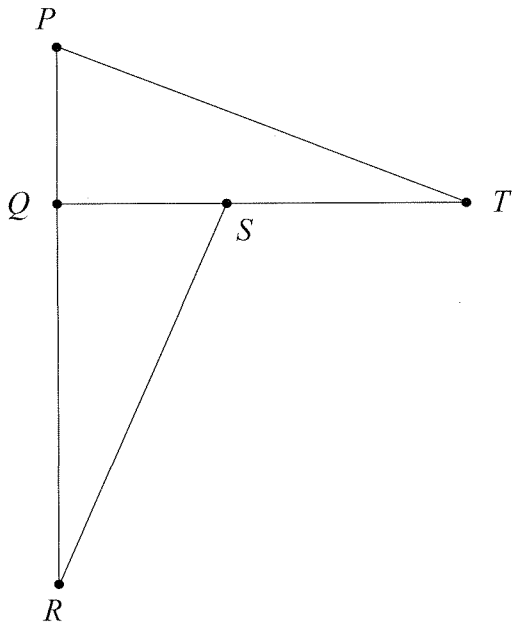
All of the selected countries identified in Chapter 1 showed an increase in mean scores between students in the international seventh and eighth grades (Years 8 and 9 in England). The difference in mean scores ranged from four to 14 percentage points (see Table 3.3).

3.3.3 Examples of items for *Geometry*

Example items O8, J16 and R10 are shown below, together with national and international percentages correct.

Item O8

O8. Triangle *PQT* can be rotated (turned) onto triangle *SQR*.



What point is the centre of rotation?

A. *P*

B. *Q*

C. *R*

D. *S*

E. *T*

O8	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	57.5	62.2
International	61.3	69.9
Median country	62.3	73.0
Highest-scoring country	86.8	92.8

Option (D) was a popular wrong answer, with approximately one-quarter of students in England selecting this response (27.5 per cent of Year 8 and 25.0 per cent of Year 9).

* * * * * * * * * * * *

Item J16

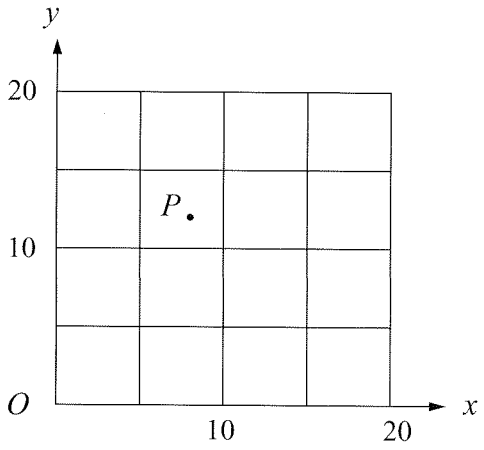
J16. Which of the following are most likely to be the coordinates of point P ?

A. (8, 12)

B. (8, 8)

C. (12, 8)

D. (12, 12)



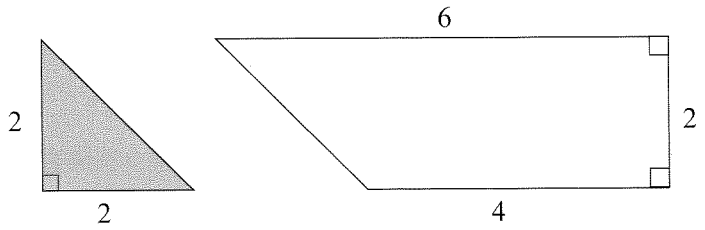
J16	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	66.5	78.6
International	46.5	54.3
Median country	48.0	56.4
Highest-scoring country	80.3	91.0

The most popular wrong answer selected by students in England was (C), chosen by 19.1 per cent of Year 8 and 11.2 per cent of Year 9 students.

* * * * * * * * * * * *

Item R10

R10.



How many triangles of the shape and size of the shaded triangle can the trapezium above be divided into?

A. Three

B. Four

C. Five

D. Six

R10	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	47.1	55.2
International	46.8	52.1
Median country	48.8	54.5
Highest-scoring country	80.0	83.9

Similar percentages of students in both grades in England selected options (A) and (B): 22.8 per cent of students in Year 8 and 21.9 per cent in Year 9 chose option (A), and 18.2 per cent of Year 8 and 18.7 per cent of Year 9 chose option (B).

* * * * * * * * * * * *

3.4 Algebra

The mean percentages of correct responses attained by the two year groups tested are shown for England and selected other countries in Table 3.4, together with the international means and the differences between the two year groups.

Table 3.4 Mean percentages of correct answers for *Algebra* in 11 countries (27 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	68	76	8
Japan	64	72	8
Hungary	52	63	11
United States	44	51	7
Canada	43	54	11
Switzerland	41	53	12
England	**41**	**49**	**8**
France	39	54	15
Germany	39	48	9
Scotland	36	46	10
Sweden	35	44	9
International mean	**44**	**52**	**8**

Differences may be subject to rounding errors.

Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

3.4.1 Comparisons of total topic scores: *Algebra*

The mean scores for *Algebra* for students in England were slightly below the international mean.

Students in three of the selected countries (Singapore, Japan and Hungary) had mean *Algebra* scores more than five percentage points above those of England for both year groups. Previous studies have found similar differences between England and Japan (FIMS and SIMS) and Hungary (SIMS and IAEP2). Singapore has not taken part in any previous large-scale comparisons of mathematics.

Students in Canada and France had mean *Algebra* scores which were five percentage points above those of England for the older age group only. These countries have tended to perform at a similar level (Canada, SIMS; France, IAEP2) or better (Canada, IAEP2) than England in previous studies.

There was very little difference between the mean scores of England, the United States and Germany. The finding with regard to the United States contrasts with previous studies, which have tended to show that students in England performed better than those in the United States (FIMS, IAEP1 and IAEP2).

The difference between the mean scores of students in England and Scotland was not large for either year group; this is consistent with the results of previous studies (FIMS and IAEP2). The mean scores of students in Sweden (both year groups) were five percentage points or more below those of students in England, which is similar to the findings of previous studies (FIMS and SIMS).

3.4.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Algebra*

Differences in mean scores ranged from seven to 15 percentage points, with students in four countries showing increases in performance in excess of ten percentage points (see Table 3.4). The increase in performance for the students in England was eight percentage points: this was slightly higher than the overall increase in performance across all reporting categories from Year 8 to Year 9 (six percentage points) (see Beaton *et al.*, 1996b).

3.4.3 Examples of items for *Algebra*

Example items P10 and S1 are shown below, together with national and international percentages correct.

Item P10

P10. If m represents a positive number, which of these is equivalent to $m + m + m + m$?

A. $m + 4$

B. $4m$

C. m^4

D. $4(m + 1)$

P10	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	46.5	41.6
International	47.3	57.7
Median country	44.9	58.4
Highest-scoring country	77.4	81.6

The most popular wrong answers for students in both years in England were (A) and (C). Option (A) was chosen by 18.1 per cent of Year 8 students and 17.1 per cent of Year 9 students, and option (C) was chosen by 28.1 per cent of Year 8 and 33.9 per cent of Year 9.

* * * * * * * * * * * *

Item S1

S1. Here is a sequence of three similar triangles. All of the small triangles are congruent.

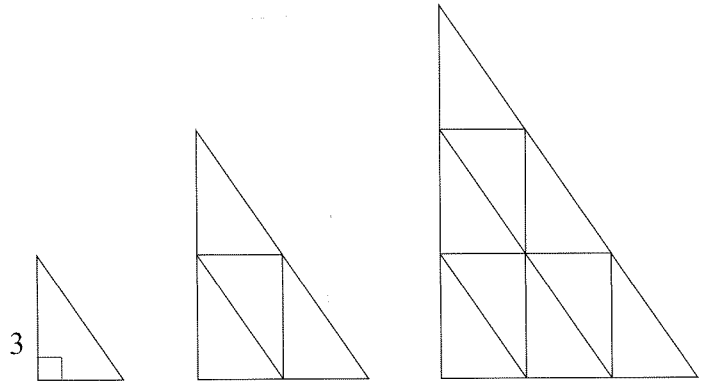


Figure 1 Figure 2 Figure 3

a. Complete the chart by finding how many small triangles make up each figure.

Figure	Number of small triangles
1	1
2	4
3	9

b. The sequence of similar triangles is extended to the 8th Figure. How many small triangles would be needed for Figure 8?

64

S1a	**Percentage correct for international seventh grade (Year 8 in England) %**	**Percentage correct for international eighth grade (Year 9 in England) %**
England	84.1	85.9
International	71.9	75.2
Median country	74.7	78.5
Highest-scoring country	90.6	94.1

The most common wrong answer offered by students in England for part (a) was '5 and 10' (2.8 per cent of Year 8 and 4.5 per cent of Year 9 students).

S1b	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	19.6	42.3
International	17.7	25.8
Median country	17.3	24.3
Highest-scoring country	43.5	52.2

A large range of incorrect responses was offered for part (b) with no single answer suggested by a large number of students; 12.8 per cent of Year 8 and 9.5 per cent of Year 9 students did not attempt to answer.

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3.5 Data representation, analysis and probability

The mean percentages of correct responses attained by the two year groups tested are shown for England and selected other countries in Table 3.5, together with the international means.

Table 3.5 Mean percentages of correct answers for *Data representation, analysis and probability* in 11 countries (21 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Japan	73	78	5
Singapore	72	79	7
Switzerland	65	72	7
Sweden	64	70	6
France	63	71	8
Canada	63	69	6
England	**62**	**66**	**4**
Germany	61	64	3
Hungary	60	66	6
United States	60	65	5
Scotland	58	65	7
International mean	**57**	**62**	**5**

Differences may be subject to rounding errors.

Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

3.5.1 Comparisons of total topic scores: *Data representation, analysis and probability*

This was the only category for which the mean scores of students in England were above (in both year groups) the international means; their mean scores were also above the international mean in IAEP2 for the equivalent content area.

Students in two of the selected countries (Singapore and Japan) achieved mean scores which were more than five percentage points higher than those of students in England for both year groups, and students in two other countries (Switzerland and France) achieved a similar difference for the older age group only. There was very little difference between the mean scores of students in England and the remaining countries for either year group.

3.5.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Data representation, analysis and probability*

The performance of students in all the selected countries showed an increase in mean scores from the international seventh grade to the international eighth grade; the increase ranged from three to eight percentage points (see Table 3.5).

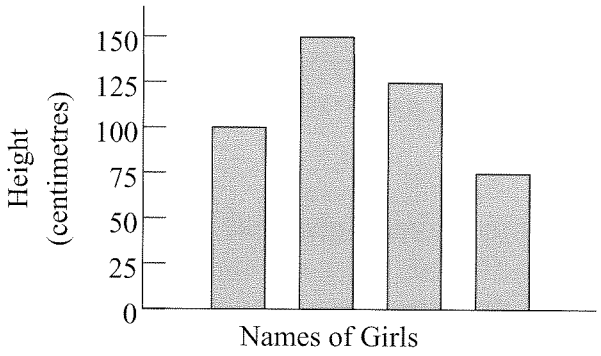
The increase in mean scores in *Data representation, analysis and probability* in England was four percentage points, which was slightly lower than the overall six percentage point-increase in performance across all reporting categories shown by students from Year 8 to Year 9 (see Beaton *et al.*, 1996b). However, it is worth noting that students in both Year 8 and Year 9 achieved mean scores in this content area which were higher than the international mean (by five percentage points and four percentage points for Years 8 and 9 respectively).

3.5.3 Examples of items for *Data representation, analysis and probability*

Example items Q4, P17 and N18 are shown below, together with national and international percentages correct.

Item Q4

Q4. The graph shows the heights of four girls.



The names are missing from the graph. Debbie is the tallest. Amy is the shortest. Dawn is taller than Sarah. How tall is Sarah?

A. 75 cm

B. 100 cm

C. 125 cm

D. 150 cm

Q4	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	90.2	88.3
International	80.8	83.0
Median country	84.8	87.3
Highest-scoring country	94.4	93.5

The most popular wrong answer for students in both years in England was (C), chosen by 6.7 per cent of Year 8 and 5.4 per cent of Year 9.

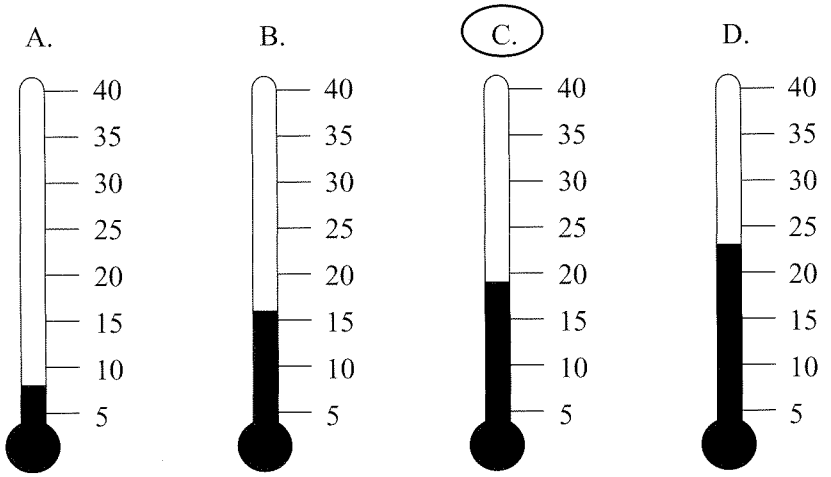
* * * * * * * * * * * *

Item P17

P17. This table shows temperatures at various times during the week.

TEMPERATURES					
	6 a.m.	9 a.m.	Noon	3 p.m.	8 p.m.
Monday	15°	17°	20°	21°	19°
Tuesday	15°	15°	15°	10°	9°
Wednesday	8°	10°	14°	13°	15°
Thursday	8°	11°	14°	17°	20°

Which thermometer shows the temperature at 8 p.m. on Monday?



P17	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	81.5	72.8
International	79.2	82.2
Median country	81.4	84.3
Highest-scoring country	96.1	97.1

Option (B) was chosen by more students in Year 9 than in Year 8 in England: 23.1 per cent of Year 9 and 14.6 per cent of Year 8.

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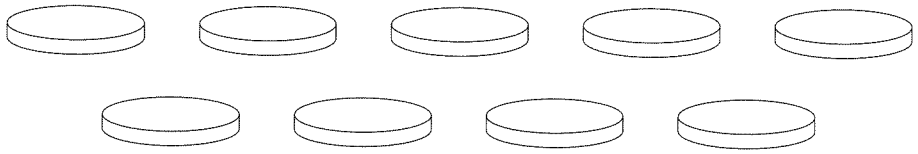
Item N18

N18. The nine counters shown are placed in a jar and mixed.



Mandy draws one counter from the jar. What is the probability that Mandy draws a counter with an even number?

A. $\frac{1}{9}$

B. $\frac{2}{9}$

C. $\frac{4}{9}$

D. $\frac{1}{2}$

N18	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	61.6	75.3
International	47.5	54.9
Median country	50.6	58.9
Highest-scoring country	85.1	90.3

Incorrect responses were fairly evenly distributed between options (A), (B) and (D) for both grades in England. Option (A) was chosen by 13.0 per cent of students in Year 8 and 10.5 per cent of students in Year 9; option (B) was chosen by 9.5 per cent of Year 8 and 6.5 per cent of Year 9; and option (D) was chosen by 14.9 per cent of Year 8 and 7.3 per cent of Year 9.

* * * * * * * * * * * *

3.6 Measurement

The mean percentages of correct responses achieved by the two year groups tested are shown for England and selected other countries in Table 3.6, together with the international means.

Table 3.6 Mean percentages of correct answers for *Measurement* in 11 countries (18 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	70	77	7
Japan	62	67	5
Switzerland	53	61	8
France	49	57	8
Hungary	49	56	7
Sweden	47	56	9
Germany	46	51	5
Canada	44	51	7
England	**43**	**50**	**7**
Scotland	40	48	8
United States	36	40	4
International mean	**45**	**51**	**6**

Differences may be subject to rounding errors.

Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

3.6.1 Comparisons of total topic scores: *Measurement*

The mean percentages of correct answers for English students for this category were close to the international means for both year groups. In IAEP2, the mean scores of students in England were slightly above the international means for the equivalent content area.

The results for Switzerland (IAEP2), Hungary (SIMS and IAEP2) and Japan (SIMS) are similar to those of previous studies (i.e. above those of their counterparts in England).

In previous studies, students in Sweden (SIMS) and France (IAEP2) scored at a similar level to students in England in *Measurement*, whereas in TIMSS the mean scores of students in those countries were higher than those of students in England.

There was very little difference in the mean scores of students in England and Scotland in both year groups: this is consistent with the findings of previous studies (SIMS and IAEP2).

3.6.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Measurement*

The difference in mean scores between the two year groups tested ranged from four to nine percentage points, and the difference between the international mean scores for the lower and upper grades was six percentage points (see Table 3.6).

In each of the selected countries, the increase in performance was close to (or below) that country's mean increase in performance across all reporting categories (see Beaton *et al.*, 1996b). This suggests that, amongst the 11 selected countries, *Measurement* was not an area of the mathematics curriculum selected for particular emphasis in the upper grade.

The mean scores of the Year 9 students in England as compared with the scores of the Year 8 students were seven percentage points higher; this was slightly higher than the overall increase in mean scores across all reporting categories from Year 8 to Year 9 (six percentage points) (see Beaton *et al.*, 1996b).

3.6.3 Examples of items for *Measurement*

Example items O6 and V4 are shown below, together with national and international percentages correct.

Item 06

O6. A cake is put in the oven at 7:20. If the cake takes three quarters of an hour to bake, at what time should it be taken out of the oven?

Answer: 8.05 or five past eight

O6	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	81.9	80.5
International	63.6	68.9
Median country	71.7	78.1
Highest-scoring country	87.8	91.1

There was no single incorrect response given by a large number of students in either of the grades tested in England.

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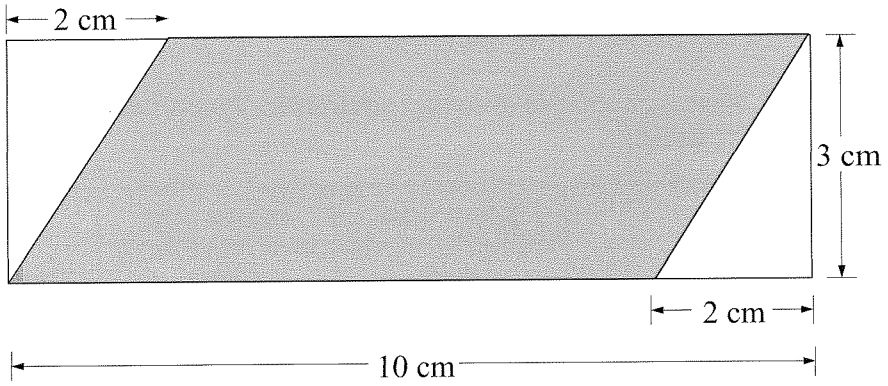
Item V4

V4. The figure shows a shaded parallelogram inside a rectangle.



What is the area of the parallelogram?

Answer: 24 (cm^2)

V4	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	31.7	42.6
International	33.9	39.8
Median country	31.7	40.5
Highest-scoring country	73.3	80.9

It should be noted that the international guidelines did not discriminate between answers with/without units (i.e. cm^2). A large range of incorrect responses was suggested by students in both grades in England; the one that was most frequently offered by students in Year 8 and Year 9 was '18' (6.0 per cent and 7.4 per cent respectively).

* * * * * * * * * * * *

3.7 Proportionality

The mean percentages of correct responses achieved by the two year groups tested are shown for England and selected other countries in Table 3.7, together with the international means and the differences in mean scores between the two year groups.

Table 3.7 Mean percentages of correct answers for *Proportionality* in 11 countries (11 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	71	75	4
Japan	55	61	6
Switzerland	44	52	8
Canada	42	48	6
France	41	49	8
Hungary	38	47	9
United States	38	42	4
England	**38**	**41**	**3**
Germany	37	42	5
Sweden	36	44	8
Scotland	34	40	6
International mean	**40**	**45**	**5**

Differences may be subject to rounding errors.
Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

3.7.1 Comparisons of total topic scores: *Proportionality*

It should be noted that, in the opinion of the mathematics experts who considered each item for the purposes of the Test-curriculum Matching Analysis (see Chapter 2, section 2.4), only one of the 11 items on *Proportionality* could be regarded as being representative of the National Curriculum for students in England in Year 8, whereas seven were considered to cover content that was part of the curriculum for students in Year 9.

The mean percentages of correct answers for English students for this category were below the international mean for both year groups. In IAEP2, and earlier studies, items on *Proportionality* were not grouped as a content area in their own right, so no comparisons can be drawn. It is noticeable that there is very little difference between the mean scores of Year 8 students in England and the international mean, despite the fact that only one item was considered by the Test-curriculum Matching Analysis

panel to be representative of the National Curriculum for mathematics for this age group. Reasons for this are unclear, but it is possible that for some of the items students were able to apply skills gained in other areas.

3.7.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Proportionality*

The difference in mean scores between the students in the two grades tested ranged from three to nine percentage points (see Table 3.7). In each of the selected countries, the increase in mean scores was close to (or below) that country's mean increase in mean scores across all reporting categories (see Beaton *et al.*, 1996b). This suggests that, within the 11 selected countries, *Proportionality* was not one of the content areas selected for considerable emphasis in the upper grade.

3.7.3 Example item for *Proportionality*

Example M6 is shown below, together with national and international percentages correct. *(This item was not considered by the Test-curriculum Matching Analysis panel — see Chapter 1, section 1.2.4 and Chapter 2, section 2.2.4 — to be representative of the National Curriculum for Year 8 students, although it was considered appropriate for Year 9 students.)*

Item M6

M6. A class has 28 students. The ratio of girls to boys is 4 : 3. How many girls are in the class?

Answer: 16

M6	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	40.4	41.9
International	30.2	37.3
Median country	26.8	36.9
Highest-scoring country	89.3	91.5

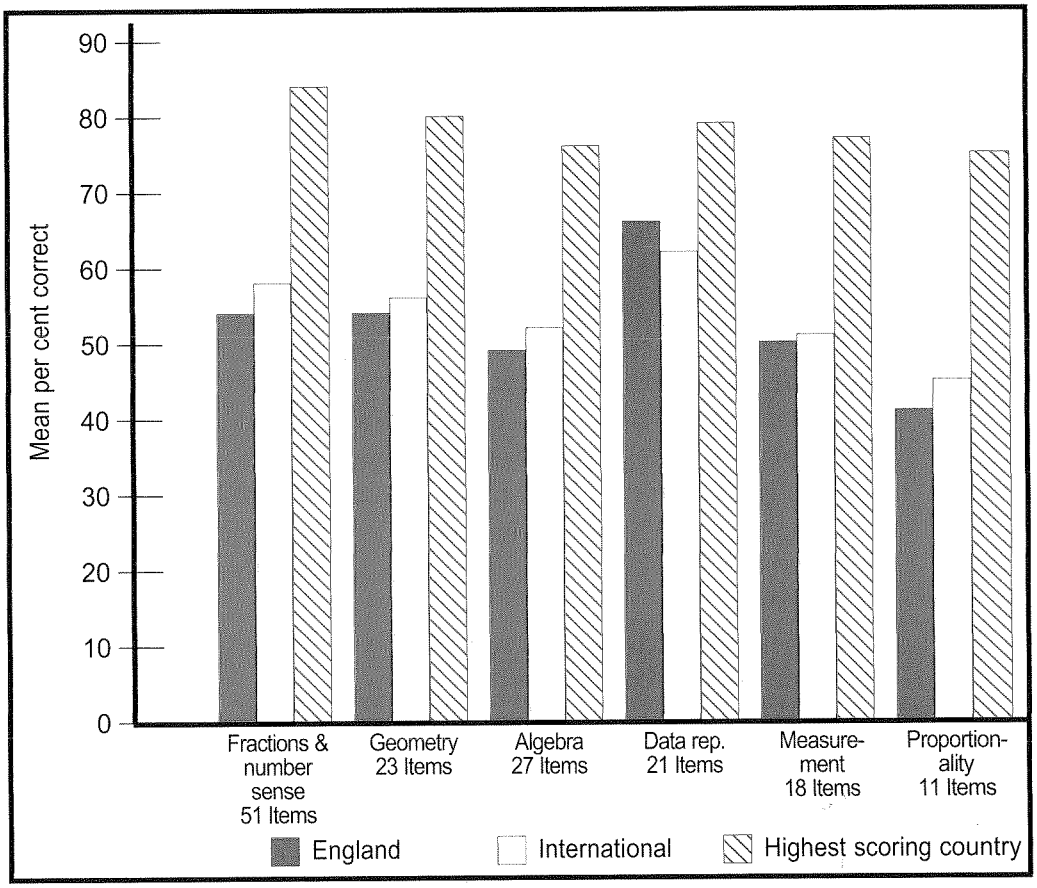
The two most popular incorrect answers suggested by students in England were '12' and '15' offered by 7.9 per cent and 10.1 per cent of students respectively in Year 8, and 10.4 per cent and 7.2 per cent respectively in Year 9.

* * * * * * * * * * * *

3.8 Overview of results for each mathematics reporting category

The mean percentages of correct responses achieved by students in Year 9 in England for each of the six mathematics reporting categories are shown in Figure 3.8 below, together with the international means for the equivalent year groups and the mean scores of the highest-scoring country for each category.

Figure 3.8 Overview of mean percentages for mathematics reporting categories: *international eighth grade (Year 9 in England)*



Source: Tables 2.1 and 2.2 (Beaton et al., 1996b)

The results for students in Year 8 in England were broadly similar to those for Year 9.

3.9 Gender differences

The preceding sections have presented the mean scores of students in Years 8 and 9 in England in each of the mathematics content areas and drawn comparisons with the mean scores of students in ten other selected countries. This section identifies where there were statistically significant gender differences in performance in those mathematics content areas.

In the international seventh grade (Year 8 in England) there were two reporting categories where there was a statistically significant gender difference (only one country in each case):

- **Algebra**: a difference of three percentage points in favour of girls in Canada
- **Proportionality**: a difference of four percentage points in favour of boys in Japan.

In all 11 countries, there were no significant gender differences in mean scores in any of the six mathematics reporting categories for the upper grade (Year 9 in England).

It is worth noting that although there were no significant gender differences in achievement in England in either Year 8 or Year 9 for any of the six mathematics reporting categories, the cumulative effect of slight (but not statistically significant) differences in favour of the boys on each of the reporting categories for Year 8 resulted in an overall gender difference for mathematics for the lower grade which *was* statistically significant. There were slight (but not statistically significant) differences in favour of the boys on four of the reporting categories for Year 9, but there was no gender difference in overall mathematics scores.

In some respects, the TIMSS results given differ from the results found in the National Curriculum key stage 3 statutory assessments. This may be connected with the way in which questions are presented: there is evidence that the performance of girls is lower than that of boys on multiple-choice items (Ramos and Lambating, 1996). In TIMSS, about 80 per cent of questions were presented using multiple-choice format, so this may have been a contributory factor to gender differences.

The mean percentages achieved by male and female students in England for each of the mathematics reporting categories are shown below. None of the differences was statistically significant in either Year 8 or Year 9.

Overview of gender differences in mean percentages of correct answers for mathematics reporting categories for students in England

Reporting category	Fractions & number (51 items) %	Geometry (23 items) %	Algebra (27 items) %	Data rep., analysis & probability (21 items) %	Measure-ment (18 items) %	Proportion-ality (11 items) %
Boys Year 8	49	51	42	63	46	41
Girls Year 8	46	47	40	61	40	35
Boys Year 9	54	54	47	67	51	42
Girls Year 9	53	54	51	65	48	40

Source: Tables 2.4 and 2.5 (Beaton et al., 1996b)

CHAPTER 4

The students' overall performance on the science tests

Summary of main points

- **The mean overall science scores of Year 9 students in England were:**
  - **significantly *lower* than those of students in only four countries taking part in TIMSS**
  - **not significantly different from those in about a quarter of the countries**
  - **significantly *higher* than those of students in nearly two-thirds of the countries.**

  The pattern was similar for Year 8.
- **Compared with students in other countries, the relative performance of England in science was much better than in mathematics.**
- **The relative position of England in science appears to have improved since previous comparative studies were carried out.**
- **About one in six of the students in England were in the international top ten per cent in both year groups. Similar proportions were found in Japan.**
- **Boys' overall mean science scores were significantly higher than those of girls in England and in about three-quarters of the countries taking part in TIMSS.**

4.1 Preface

This chapter describes and compares the mean scores on the TIMSS science tests of students in England with students of the same age in other countries. As with the mathematics results, separate mean scores are provided for two year groups (international seventh and eighth grades: the equivalent of Years 8 and 9 in England) and for 13-year-olds (i.e. students aged 13.0–13.11 years at the time of testing).

Comparisons with other countries are made in terms of:

- students' overall mean scores on the TIMSS science test
- students' mean scores on the sub-set of items identified by curriculum experts in England as being covered by the mathematics curriculum for each year group (the Test-curriculum Matching Analysis)
- ranges of scores in different countries (percentages of students reaching the following international marker levels: top ten per cent, top 25 per cent, top half, and bottom 25 per cent of the international distribution)
- differences in mean scores of students in international seventh and eighth grades (the equivalent of Years 8 and 9 in England)
- differences in mean scores of boys and girls.

Where appropriate, the results of TIMSS are compared with the results of the following previous large-scale international studies.

Date of testing	Study	References to reports
1970-71	First International Science Study (FISS)	Comber and Keeves (1973)
1984	Second International Science Study (SISS)	Postlethwaite and Wiley (1992) IEA (1988) Keys (1987)
1988	The first study carried out by the International Association for the Evaluation of Educational Progress (IAEP1)	Lapointe *et al.* (1989) Keys and Foxman (1989)
1991	The second study carried out by the International Association for the Evaluation of Educational Progress (IAEP2)	Lapointe *et al.* (1992b) Foxman (1992)

In the following discussions, previous studies will be referred to by their abbreviations (e.g. FISS, SISS, IAEP1, and IAEP2). In comparing the results of previous studies with those of TIMSS, it should be remembered that:

- some of the countries taking part in TIMSS have not participated in any previous international comparative studies
- different sets of countries participated in different studies
- only two countries (England,[1] United States) have taken part in all four previous large-scale studies
- the lower secondary age groups tested varied between studies: for example, FISS and SISS tested 14-year-olds, whereas the two IAEP studies tested 13-year-olds (as in TIMSS)
- because of curriculum changes, different tests were used in each study and there are only small numbers of common items between any two studies.

4.2 Overall mean scores on the science tests

In this report, the overall mean science scores of students in England have been compared with those of students of similar ages in four distinct groups of other countries: continental Western European countries (Table 4.2.1); English speaking countries (Table 4.2.2); Eastern European countries (Table 4.2.3); and Asian Pacific Rim countries (Table 4.2.4). The information displayed in these tables derives from Tables 1.1 (Science) and 1.2 (Science) and Figures 1.1 (Science) and 1.2 (Science) from the international report of TIMSS (Beaton *et al.*, 1996a); these tables and figures have been reproduced at the end of this chapter. Overall mean science scores are expressed in terms of a scale with a mean of 500, and a standard deviation[2] of about 100, based on the performance of students in both grades (year groups).

The international tables and figures include all the countries participating in TIMSS. In the international tables, countries which did not meet the international sampling requirements are shown 'below the line', i.e. the mean scores of their students are not included in the rank orders of results. The reasons why each country did not meet the sampling requirements are explained in the footnotes to the international tables. In the international figures, however, these countries are listed in italics but included in the rank ordering of results.

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[1] *In TIMSS, FISS and SISS, samples were selected from schools in England. In IAEP1, samples were selected from schools in England, Wales and Scotland. In IAEP2, samples were selected from schools in England and Wales.*

[2] *This means that about two-thirds of students in both age groups combined achieved scores between 400–600 and about 95 per cent achieved scores between 300–700.*

It can be seen from the international tables and figures that the relative performance of students in England, compared with students in most of the other countries taking part in TIMSS, was much higher in science than in mathematics. The mean scores of students in England were significantly *higher* than those in nearly two thirds of the other countries taking part in TIMSS (Figures 1.1 (Science) and 1.2 (Science)), whereas in mathematics the mean scores of students in England were significantly *lower* than those of students in about half of the countries (Figures 1.1 (Mathematics) and 1.2 (Mathematics)). The mean scores of students in England were 33 and 36 scale points above the international means for Years 8 and 9, respectively; these differences were almost as large as the difference between the international means for Years 8 and 9 (37 scale points). In only four countries (Singapore, Czech Republic, Japan and Korea) did students achieve mean scores that were significantly higher than those in England for both year groups. Detailed comparisons for science are given below.

4.2.1 Overall mean science scores: comparisons between England and continental Western European countries

Table 4.2.1 shows how the science performance of students in England compares with that of students in the 14 continental Western European countries taking part in TIMSS.

Table 4.2.1 Overall mean science scores: *comparisons between England and continental Western European countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Belgium *(Flemish)*	*None*
Not significantly different	Austria; Germany; Netherlands	Austria, Belgium *(Flemish)*; Netherlands
Significantly lower	Belgium *(French)*; Denmark; France; Greece; Iceland; Portugal; Norway; Spain; Sweden; Switzerland	Belgium *(French)*; Denmark; France; Germany; Greece; Iceland; Portugal; Norway; Spain; Sweden; Switzerland

Source: Figures 1.1 and 1.2 (Beaton et al., 1996a)

Students in England achieved significantly higher mean science scores than students in ten of the 14 Western European countries taking part in TIMSS at Year 8 and 11 at Year 9. Statistically significant differences in favour of English students ranged from 17 scale points (Sweden (Year 9 equivalent)) to 84 scale points (Portugal (Year 8 equivalent)).

Comparisons with previous international studies

The results of TIMSS suggest that, compared with several other Western European countries, the relative position of England in science has improved since previous studies took place.

- In TIMSS, the mean scores of students in England were significantly higher than those of students in Switzerland, whereas in the early 1990s (IAEP2) the position was reversed.
- Students in England achieved higher mean scores than those in Sweden in TIMSS, whereas in the 1970s and 1980s (FISS and SISS) the mean scores of students in England and Sweden were similar.
- The mean score of students in England in TIMSS were similar to those of students in The Netherlands, whereas in the 1980s (SISS) students in The Netherlands achieved a higher mean score.

4.2.2 Overall mean science scores: comparisons between England and other English-speaking countries

Table 4.2.2 shows how the science performance of students in England compares with that of students in the six other English-speaking countries taking part in TIMSS.

Table 4.2.2 Overall mean science scores: *comparisons between England and other English-speaking countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	*None*	*None*
Not significantly different	Australia; United States	Australia; Ireland
Significantly lower	Canada; Ireland; New Zealand; Scotland	Canada; New Zealand; Scotland; United States

Source: Figures 1.1 and 1.2 (Beaton et al., 1996a)

No other English speaking country scored significantly higher than England. In both year groups, the mean scores of students in England were significantly higher than those of students in four countries.

Comparisons with previous international studies

Comparisons suggest that the relative position of England, in terms of students' science performance, has improved compared with some of the other English-speaking countries since the previous studies were carried out.

- In TIMSS, English students achieved significantly higher mean science scores than those in Canada, whereas in previous studies carried out in the 1980s students in Canada achieved higher mean scores (SISS) or scored at the same level as England (IAEP2).
- Students in England achieved higher mean science scores in TIMSS than those in Scotland and New Zealand, whereas previous studies (Scotland, FISS and IAEP2; New Zealand, FISS) have shown no such differences.

4.2.3 Overall mean science scores: comparisons between England and Eastern European countries

Table 4.2.3 shows how the overall mean science scores of students in England compared with those of students in the nine Eastern European countries taking part in TIMSS.

Table 4.2.3 Overall mean science scores: *comparisons between England and Eastern European countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Czech Republic; Slovenia	Czech Republic
Not significantly different	Bulgaria; Hungary; Slovak Republic	Bulgaria; Hungary; Russian Federation; Slovak Republic; Slovenia
Significantly lower	Latvia; Lithuania; Romania; Russian Federation	Latvia; Lithuania; Romania

Source: Figures 1.1 and 1.2 (Beaton et al., 1996a)

Students in England in Year 9 achieved mean scores that were the same or better than those of students in equivalent grades in eight of the nine Eastern European countries and those in Year 8 equalled or surpassed students in seven countries.

Comparisons with previous international studies

Only three of these countries have taken part in previous studies. In 1991 (IAEP2) there were no appreciable differences between the mean scores of these countries and England. In the 1970s and 1980s (FISS, SISS), however, the mean science scores of students in Hungary were appreciably higher than those of students in England.

4.2.4 Overall mean science scores: comparisons between England and Asian Pacific Rim countries

Table 4.2.4 shows how the overall mean science scores of students in England compared with those of students in the five Asian Pacific Rim countries taking part in TIMSS.

Table 4.2.4 Overall mean science scores: *comparisons between England and Asian Pacific Rim countries*

Compared with England	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Significantly higher	Japan; Korea; Singapore	Japan; Korea; Singapore
Not significantly different	Hong Kong	*None*
Significantly lower	Thailand	Hong Kong; Thailand

Source: Figures 1.1 and 1.2 (Beaton et al., 1996a)

Three of the Asian Pacific Rim Countries taking part in TIMSS (Singapore, Korea, Japan) had significantly higher mean scores than England for both year groups. Singapore stands out as the highest scoring country. The differences in mean science scores between these countries and England were much smaller than those for mathematics described in Chapter 2.

Comparisons with previous international studies

Lower secondary school students in England have tended to achieve lower mean scores on previous international tests of science than most of their counterparts in Asian Pacific Rim countries.

- It is therefore interesting to note that, whereas students in Hong Kong out-performed those in England in mathematics, this was not the case for science; the Year 9 students in England achieved significantly higher mean science scores than those in Hong Kong and there was no difference between the mean scores of students in the two countries at Year 8.
- The mean scores of students in England were appreciably lower than those of students in Japan in the 1970s and 1980s (FISS and SISS) and Korea in the 1980s and 1990s (SISS, IAEP1 and IAEP2) as well as in TIMSS.
- Students in Singapore achieved substantially higher mean scores than those in England in TIMSS, whereas the mean score of students in England was similar to that of Singapore in the 1980s (SISS).

4.3 Comparisons of 13-year-olds

In the remainder of this chapter comparisons are made between England and the ten other countries identified in Chapter 1.

Table 4.3 shows how the rank order of median scores of 13-year-olds in ten of the 11 selected countries compared with the median score for the international seventh grade (Year 8 in England). The median science scores for 13-year-olds were estimated in the same way as the median mathematics scores. A full explanation of how the medians were estimated is given in Chapter 2, section 2.3.

Table 4.3 Median science achievement in ten countries: *the scores of 13-year-olds compared with the scores of students in international seventh grade (Year 8 in England)*

	13-year-olds		International seventh grade (Year 8 in England)		
COUNTRY	Median score	*Rank*	Median score	*Rank*	*Mean age (years)*
Singapore	555	*1*	548	*1*	*13.3*
Japan	535	*2*	530	*2*	*13.4*
Hungary	521	*4*	519	*3*	*13.4*
England	**529**	***3***	**511**	***4***	*13.1*
United States	510	*7*	507	*5*	*13.2*
Canada	511	*5*	496	*6*	*13.1*
Sweden	511	*5*	485	*7*	*12.9*
Switzerland	495	*9*	484	*8*	*13.1*
Scotland	504	*8*	465	*9*	*12.7*
France	455	*10*	453	*10*	*13.3*

The median score for 13-year-olds was not computed for Germany since fewer than 75 per cent of 13-year-olds were included in the grades tested in Germany.

Source: Tables 1.2, 1.8 and E.2 (Beaton et al., 1996a)

The rank order of the ten countries (including that of England) in terms of the median performance of 13-year-olds is very similar to the rank order in terms of the median scores of the international seventh grade (Year 8 in England).

4.4 Test-curriculum Matching Analysis

The Test-curriculum Matching Analysis was designed and conducted to investigate the appropriateness of the TIMSS science test for seventh and eighth grade students (Years 8 and 9 in England) in the participating countries, and to show how student performance in individual countries varied when based only on test items that were judged to be relevant to their own curriculum.[3] It was carried out in the same way as the Test-curriculum Matching Analysis for mathematics described in Chapter 2, section 2.4.

Table 4.4 shows the scores of students in the international eighth grade (Year 9 in England) in the 11 selected countries on the sub-set of items selected by curriculum experts in England as addressing the National Curriculum compared with their scores on the entire science test (in terms of mean percentage correct).

Table 4.4 Science Test-curriculum Matching Analysis results for international eighth grade (Year 9 in England): *the scores of students in 11 selected countries on the sub-set of items selected by curriculum experts in England as addressing the National Curriculum compared with their scores on the entire science test*

COUNTRY	Mean percent correct: for all 146 items %	Rank	Mean percent correct: for 124 items selected by England %	Rank	Difference in mean percent correct %
Singapore	70	1	71	1	+1
Japan	65	2	66	2	+1
Hungary	61	3	60	4	-1
England	**61**	**3**	**62**	**3**	**+1**
Canada	59	5	59	5	0
Sweden	59	5	58	6	-1
Germany	58	7	58	6	0
United States	58	7	59	8	+1
Switzerland	56	9	56	9	0
Scotland	55	10	56	10	+1
France	54	11	54	11	0
International mean	**55**		**56**		**+1**

Differences may be subject to rounding errors.

Source: Table B.1 (Beaton et al., 1996a)

[3] *Because there may also be curriculum areas covered in some countries that are not covered by the TIMSS tests, the Test-curriculum Matching Analysis does not provide complete information about how well the TIMSS tests cover the curricula of the participating countries. The purpose of the Test-curriculum Matching Analysis was to investigate whether or not the content covered by the actual test items was in the intended curricula of participating countries.*

These results (and those for Year 8, which were similar) suggest that the TIMSS science test provided a reasonable basis for comparing achievement in the participating countries. This result is not unexpected, since making the TIMSS tests as fair as possible was a major consideration in test development (Beaton *et al.*, 1996a).

The number of items selected by each of the 11 countries as being relevant to their own intended curriculum for each grade/year group are shown below. As yet there is no information available about the specific items selected and rejected by different countries.

	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
United States	146	146
England	**104**	**124**
Hungary	98	129
Sweden	96	125
Germany	88	129
Singapore	83	109
Canada	78	121
Scotland	49	97
Japan	45	86
Switzerland	36	105
France	26	73
International test	**146**	**146**

Source: Tables B.1 and B.2 (Beaton et al., 1996a)

These figures suggest that the variation between countries in terms of what is taught in science is greater than the variation for mathematics for both grades/year groups (Chapter 2, section 2.4). However, the relationship between the number of science items relevant to a country's curriculum and performance of students in that country on the TIMSS tests is not a straightforward one. Curriculum experts in three of the lowest-scoring countries, France, Scotland and Switzerland, indicated that large proportions of the science items were not covered in their national curricula for the international seventh grade (Year 8 in England), suggesting that there could be a positive association between curriculum coverage and science achievement. However, curriculum experts in two of the highest scoring countries, Japan and Singapore, also indicated that a substantial proportion of the science items were not covered in their intended curricula for the international seventh grade; this would seem to cast doubt on the association between curriculum coverage in school and science achievement. The complex relationships between curriculum coverage and achievement will be explored in subsequent reports on TIMSS.

4.5 Comparisons between 11 countries: differences in overall mean science score between international seventh and eighth grades (Years 8 and 9 in England)

As in the mathematics analyses reported in Chapter 2, the difference between the mean science scores of Year 8 and Year 9 students in each country was used as a proxy measure for the progress achieved by students between Year 8 and Year 9 (the progress score).

Table 4.5 shows the differences in mean science scores for Year 8 and Year 9 students in each of the 11 countries. In each country the mean score for Year 9 was higher than the mean score for Year 8. The magnitude of the difference ranged from 26–63 scale points with a median of 40 scale points for these 11 countries. The increase in mean score in England (40 scale points) equalled the median increase for the 11 selected countries.

Table 4.5 Comparisons between 11 countries: *difference in overall mean science scores of international seventh and eighth grade students (Years 8 and 9 in England).*

COUNTRY	Mean score of international seventh grade (Year 8 in England)	Mean score of international eighth grade (Year 9 in England)	Difference between mean scores of Years 8 and 9
Singapore	545	607	63
Scotland	468	517	49
Sweden	488	535	47
France	451	498	46
Japan	531	571	40
England	**512**	**552**	**40**
Switzerland	484	522	38
Hungary	518	554	36
Germany	499	531	32
Canada	499	531	32
United States	508	534	26
International	**479**	**516**	**37**

Differences may be subject to rounding errors.
Source: Table 1.3 (Beaton et al., 1996a)

As with the mathematics analyses, it is difficult to find a consistent pattern in these results. Singapore, the highest-achieving country in terms of its students' mean science scores in Year 8 had the largest progress score. On the other hand, France, with much lower-achieving students at Year 8, also

has a relatively high progress score; and the United States, whose students scored well above the international mean at Year 8, had a relatively low progress score. Analyses of the science curricula in these countries may well reveal some of the reasons for the size of their progress scores.

4.6 International marker levels

One of the questions which TIMSS was designed to answer was: how do the proportions of very high-scoring students and very low-scoring students vary from country to country? In order to answer this question, international marker levels, corresponding to the percentiles computed from the combined data of all participating countries, were calculated as follows.

	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
• Top 10 per cent marker levels (90th percentile)	615	655
• Top 25 per cent marker levels (75th percentile)	553	592
• Top half marker levels (50th percentile or median)	483	522
• Bottom 25 per cent marker levels (25th percentile)	415	452

Source: Tables 1.4 and 1.5 (Beaton et al., 1996a) and additional analysis provided by the International Study Centre.

Table 4.6 uses the information provided in the international report to show the percentages of international eighth grade students (Year 9 in England) in each of the selected countries in the top ten per cent and top half of the international science distribution. The pattern was broadly similar for the international seventh grade (Year 8 in England).

Table 4.6 suggests that the performance of the most able students in England in the international eighth grade (Year 9 in England) is similar to that of Japan. Only one of the ten selected countries, Singapore, had a noticeably higher proportion of students in the international top ten per cent. The proportion of students in England included in the international top ten per cent was higher than in the other eight countries. When comparisons are made in terms of the proportion of students in the top half of the international distribution, Japan (71 per cent) and Hungary (63 per cent), as well as Singapore (82 per cent) out-perform England (60 per cent). The pattern was quite similar in the international seventh grade (Year 8 in England).

Table 4.6 **Comparisons between 11 countries:** ***percentages of students reaching international marker levels (top ten per cent and top half) of science achievement in international eighth grade (Year 9 in England)***

COUNTRY	Top half %	*Rank*	Top ten per cent %	*Rank*
Singapore	82	*1*	31	*1*
Japan	71	*2*	18	*2*
England	**60**	***4***	**17**	***3***
Hungary	63	*3*	14	*4*
United States	55	*6*	13	*5*
Germany	54	*7*	11	*6*
Canada	54	*7*	9	*7*
Sweden	56	*5*	9	*7*
Scotland	48	*10*	9	*7*
Switzerland	51	*9*	7	*10*
France	37	*11*	1	*11*

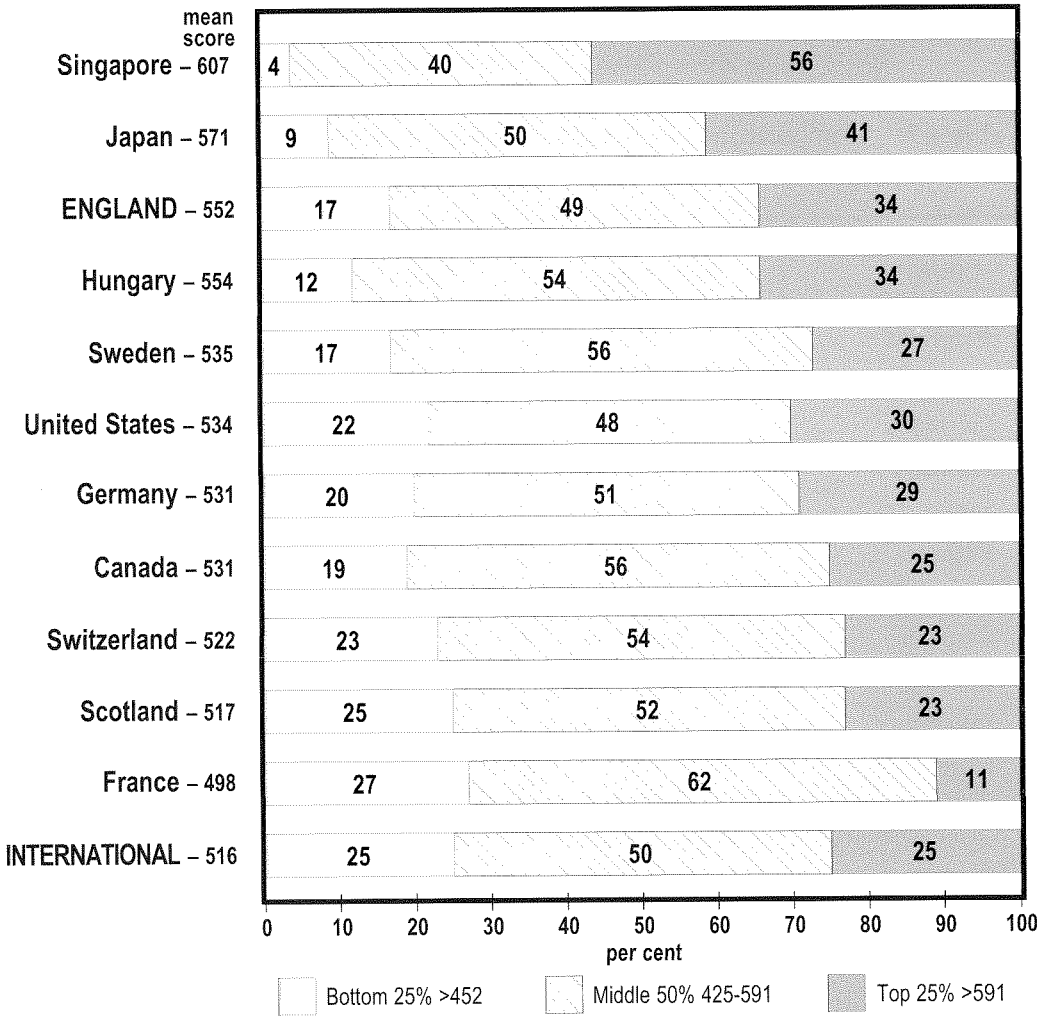
Differences may be subject to rounding errors.
Source: Table 1.4 (Beaton et al., 1996a)

Figure 4.6 shows the percentages of students in the international eighth grade (Year 9 in England) in each of the 11 selected countries in the top 25 per cent and bottom 25 per cent of the international distribution. The results for Year 8 were very similar.

Figure 4.6 shows that the relative proportions of Year 9 students in England achieving very high scores are high compared with most of the 11 selected countries. Just over a third of the students in England were in the top 25 per cent of the international distribution for the international eighth grade (Year 9 in England). This proportion was only exceeded in two of the selected countries (Singapore and Japan).

Comparisons between England and Hungary reveal that, whilst both countries had about a third of their students in the top 25 per cent, a higher proportion of students in England were in the bottom 25 per cent of the international distribution (17 per cent compared with 12 per cent in Hungary). This issue will be explored in Part 2 of this report which will be published in spring 1997.

Figure 4.6 **Percentages in the bottom 25%, middle 50% and top 25% of the international distribution for science (international eighth grade : Year 9 in England): *comparisons between 11 countries***



Source: Table 1.4 (Beaton et al., 1996a) and additional analyses provided by the International Study Centre

4.7 Comparisons between 11 countries: gender differences in overall mean science score

Table 4.7 shows the gender differences in science performance at Year 9 for the selected countries. The results for Year 8 were very similar.

Table 4.7 Comparisons between 11 countries: *gender differences in overall mean science score for international eighth grade (Year 9 in England)*

COUNTRY	Boys' Mean	Girls' Mean	Difference in favour of boys
England	**562**	**542**	**20***
Scotland	527	507	20*
Germany	542	524	18*
Hungary	563	545	18*
Japan	579	562	17*
France	506	490	16*
Switzerland	529	514	15*
Sweden	543	528	15*
Canada	537	525	12*
Singapore	612	603	9
United States	539	530	9

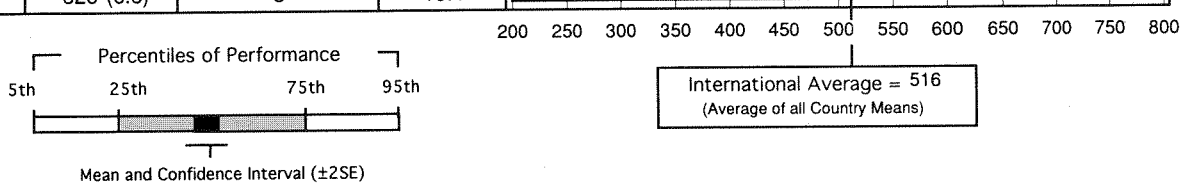
**Gender difference statistically significant at the five per cent level.*
Differences may be subject to rounding errors.
Source: Table 1.6 (Beaton et al., 1996a)

In all 11 countries, the boys' mean scores were higher than those of the girls for both year groups. The differences in England and Scotland were amongst the highest (20 scale points). In most of the countries, the differences in favour of boys were statistically significant; exceptions were United States and Singapore. This contrasts with the results for mathematics, where very few of the gender differences were statistically significant. The international report (Beaton *et al.*, 1996a) presents a similar picture: statistically significant differences in favour of boys in about three-quarters of the countries taking part.

Table 1.1 (Science)

Distributions of achievement in the sciences–international eighth grade* (Year 9 in England)

Country	Mean	Years of Formal Schooling	Average Age	Science Achievement Scale Score
Singapore	607 (5.5)	8	14.5	
Czech Republic	574 (4.3)	8	14.4	
Japan	571 (1.6)	8	14.4	
Korea	565 (1.9)	8	14.2	
Hungary	554 (2.8)	8	14.3	
†2 England	552 (3.3)	9	14.0	
† Belgium (Fl)	550 (4.2)	8	14.1	
Slovak Republic	544 (3.2)	8	14.3	
Russian Federation	538 (4.0)	7 or 8	14.0	
Ireland	538 (4.5)	8	14.4	
Sweden	535 (3.0)	7	13.9	
† United States	534 (4.7)	8	14.2	
Canada	531 (2.6)	8	14.1	
Norway	527 (1.9)	7	13.9	
New Zealand	525 (4.4)	8.5 - 9.5	14.0	
Hong Kong	522 (4.7)	8	14.2	
1 Switzerland	522 (2.5)	7 or 8	14.2	
Spain	517 (1.7)	8	14.3	
France	498 (2.5)	8	14.3	
Iceland	494 (4.0)	8	13.6	
1 Latvia (LSS)	485 (2.7)	8	14.3	
Portugal	480 (2.3)	8	14.5	
1 Lithuania	476 (3.4)	8	14.3	
Iran, Islamic Rep.	470 (2.4)	8	14.6	
Cyprus	463 (1.9)	8	13.7	
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):				
Australia	545 (3.9)	8 or 9	14.2	
Austria	558 (3.7)	8	14.3	
Belgium (Fr)	471 (2.8)	8	14.3	
Bulgaria	565 (5.3)	8	14.0	
Netherlands	560 (5.0)	8	14.3	
Scotland	517 (5.1)	9	13.7	
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	411 (4.1)	8	15.7	
†1 Germany	531 (4.8)	8	14.8	
Romania	486 (4.7)	8	14.6	
Slovenia	560 (2.5)	8	14.8	
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	478 (3.1)	7	13.9	
Greece	497 (2.2)	8	13.6	
Thailand	525 (3.7)	8	14.3	
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	524 (5.7)	8	14.1	
Kuwait	430 (3.7)	9	15.3	
South Africa	326 (6.6)	8	15.4	



*Eighth grade in most countries.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Source: Beaton et al., 1996a

Figure 1.1 (Science)

Multiple comparisons of achievement in the sciences–international eighth grade* (Year 9 in England)

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.†

Country	Singapore	Czech Republic	Japan	Korea	Bulgaria	Netherlands	Slovenia	Austria	Hungary	England	Belgium (Fl)	Australia	Slovak Republic	Russian Fed.	Ireland	Sweden	United States	Germany	Canada	Norway	New Zealand	Thailand	Israel	Hong Kong	Switzerland	Scotland	Spain	France	Greece	Iceland	Romania	Latvia (LSS)	Portugal	Denmark	Lithuania	Belgium (Fr)	Iran, Islamic Rep.	Cyprus	Kuwait	Colombia	South Africa
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	▼	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	▼	●	●		●	●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	▼	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	●	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	●	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	●	●	▼	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Israel	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●	●	●	●	●	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		▲	▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	▼		●	●	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	▼	●		▲	▲	▲
Kuwait	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Eighth grade in most countries.

†Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

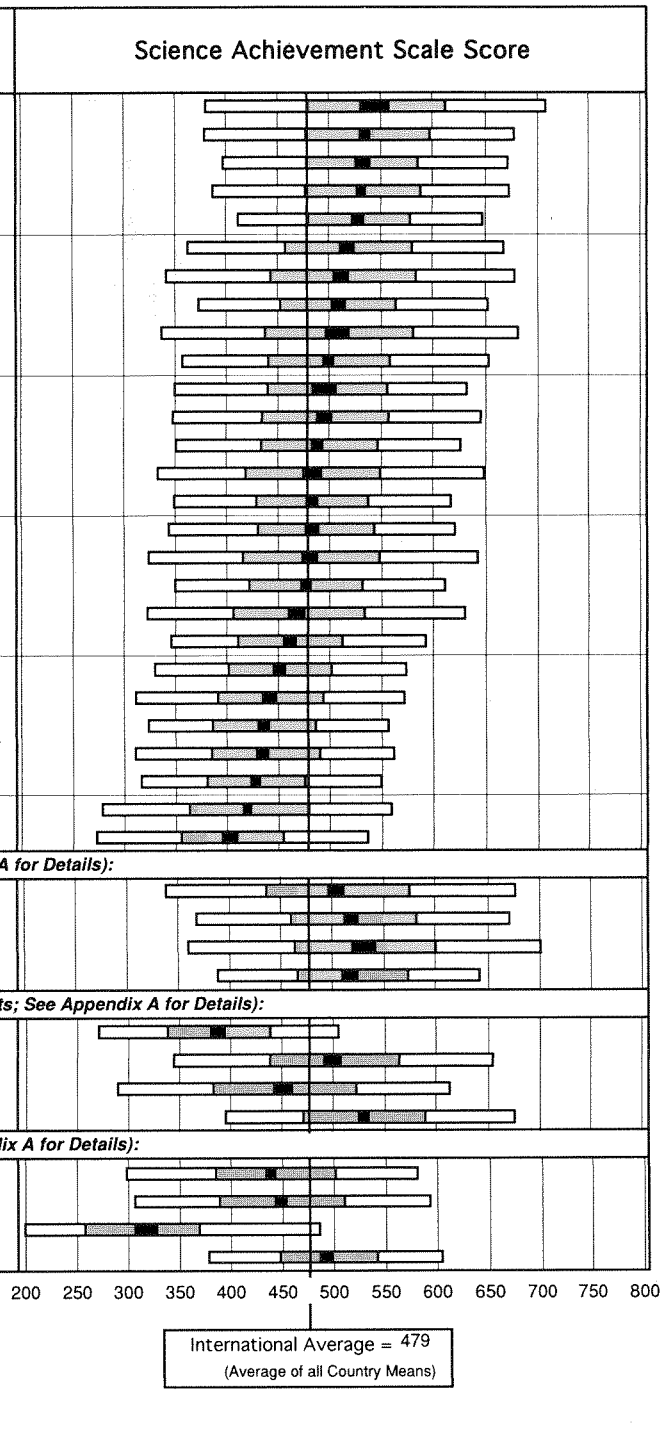
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

Source: Beaton et al., 1996a

Table 1.2 (Science)

Distributions of achievement in the sciences–international seventh grade* (Year 8 in England)

Country	Mean	Years of Formal Schooling	Average Age
Singapore	545 (6.6)	7	13.3
Korea	535 (2.1)	7	13.2
Czech Republic	533 (3.3)	7	13.4
Japan	531 (1.9)	7	13.4
† Belgium (Fl)	529 (2.6)	7	13.0
Hungary	518 (3.2)	7	13.4
†[2] England	512 (3.5)	8	13.1
Slovak Republic	510 (3.0)	7	13.3
† United States	508 (5.5)	7	13.2
Canada	499 (2.3)	7	13.1
Hong Kong	495 (5.5)	7	13.2
Ireland	495 (3.5)	7	13.4
Sweden	488 (2.6)	6	12.9
Russian Federation	484 (4.2)	6 or 7	13.0
[1] Switzerland	484 (2.5)	6 or 7	13.1
Norway	483 (2.9)	6	12.9
New Zealand	481 (3.4)	7.5 - 8.5	13.0
Spain	477 (2.1)	7	13.2
† Scotland	468 (3.8)	8	12.7
Iceland	462 (2.8)	7	12.6
France	451 (2.6)	7	13.3
† Belgium (Fr)	442 (3.0)	7	13.2
Iran, Islamic Rep.	436 (2.6)	7	13.6
[1] Latvia (LSS)	435 (2.7)	7	13.3
Portugal	428 (2.1)	7	13.4
Cyprus	420 (1.8)	7	12.8
[1] Lithuania	403 (3.4)	7	13.4
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	504 (3.6)	7 or 8	13.2
Austria	519 (3.1)	7	13.3
Bulgaria	531 (5.4)	7	13.1
Netherlands	517 (3.6)	7	13.2
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	387 (3.2)	7	14.5
†[1] Germany	499 (4.1)	7	13.8
Romania	452 (4.4)	7	13.7
Slovenia	530 (2.4)	7	13.8
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	439 (2.1)	6	12.9
Greece	449 (2.6)	7	12.6
† South Africa	317 (5.3)	7	13.9
Thailand	493 (3.0)	7	13.5



*Seventh grade in most countries.

[1]Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Source: Beaton et al., 1996a

Figure 1.2 (Science)

Multiple comparisons of achievement in the sciences–international seventh grade* (Year 8 in England)

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.†

Country	Singapore	Korea	Czech Republic	Japan	*Bulgaria*	*Slovenia*	Belgium (Fl)	*Austria*	Hungary	*Netherlands*	England	Slovak Republic	United States	*Australia*	*Germany*	Canada	Hong Kong	Ireland	*Thailand*	Sweden	Russian Fed.	Switzerland	Norway	New Zealand	Spain	Scotland	Iceland	*Romania*	France	*Greece*	Belgium (Fr)	*Denmark*	Iran, Islamic Rep.	Latvia (LSS)	Portugal	Cyprus	Lithuania	*Colombia*	*South Africa*
Singapore		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	●	●		●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	●	●	●	●		●	●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	●	▼	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	▼	●	▼	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	●	▼	▼	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	●	▼	▼	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	●	●	●	●	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	▼		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲	▲	▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		▲	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Seventh grade in most countries.

†Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

Source: Beaton et al., 1996a

CHAPTER 5

The students' performance on the science topics

Summary of main points

Compared with the international means for each of the five reporting categories for science, students in England showed:

- **higher scores both in Year 8 and in Year 9 in all five content areas: *Earth science*; *Life science*; *Physics*; *Chemistry*; and *Science and environment***
- **the progress in students' mean scores from Year 8 to Year 9 was higher than the difference between the international means for the equivalent grades in two content areas: *Life science*; and *Science and environment.***

Overall, the data suggest that there has been an improvement in England's relative position compared with other countries in terms of students' performance since the IAEP2 study in the early 1990s.

With regard to gender differences in achievement:

- **the boys' mean scores in England were higher in both Year 8 and Year 9 than those of the girls in all five reporting categories: *Earth science*; *Life science*; *Physics*; *Chemistry*; and *Science and environment*, but the difference was only statistically significant in *Chemistry* for Year 8 only.**

5.1 Preface

The science items used in TIMSS covered the content areas defined by the curriculum frameworks which were developed to ensure that the content of the tests was as relevant as possible to the curricula of the countries taking part in the study (see Appendix IV, section IV.2). The items have been organised into five reporting categories, each of which reflects different broad aspects of the science curriculum. These categories are shown below, together with the number of items for each category and the nearest corresponding attainment targets from the 1995 National Curriculum Order for science.[1]

Reporting category	No. of items	Attainment target(s)
Earth science	22	Sc3: Materials and their Properties
		Sc4: Physical Processes
Life science	40	Sc2: Life Processes and Living Things
Physics	40	Sc4: Physical Processes
Chemistry	19	Sc3: Materials and their Properties
Science and environment	14	Sc4: Physical Processes
		Sc1: Experimental and Investigative Science
	Total 135	

The majority of items focused on areas of science knowledge that are linked to Sc2–4, although some items within the *Science and environment* category addressed skills and concepts related to Sc1, such as identifying variables and carrying out fair tests. There was more emphasis on skills relating to experimental and investigative science in the practical tasks that comprised the Performance Assessment component of TIMSS (see Appendix III, section III.5 for details of the administration of this element, and Appendix IV, section IV.7 for details of the development of the tasks). A separate report (to be published in 1997) will present the results for the Performance Assessment component of TIMSS.

This chapter presents information about the mean scores of students in England for each of the science reporting categories and draws comparisons with the performance of students in the ten other countries listed in Chapter 1. Separate comparisons are made for each of the following for each reporting category:

[1] *At the time of testing (February–March 1995), the 1991 statutory Orders for science were still in effect. The attainment targets at that time were as follows:*

Sc1: Scientific investigation

Sc2: Life and living processes

Sc3: Materials and their properties

Sc4: Physical processes.

- comparisons of students' mean percentage of correct answers: comparisons are made with the ten selected countries and also with the international means
- differences in mean scores between Year 8 and Year 9 (a proxy measure for progress in achievement)
- gender differences in mean scores for both Year 8 and Year 9: these are presented for all five science content areas in one section of this chapter.

Illustrative examples of items are included at the end of each of the sections relating to reporting categories. For each item, the percentages of students making correct responses are given for England and the countries with the median and highest scores (see Beaton *et al.*, 1996a), together with the international percentage correct. Details of the international coding guidelines for free response items are included where appropriate. Additional information, for example relating to incorrect answers that were common, is provided for each illustrative item. Each of the examples was one of those selected by the national panels of subject experts for England as being representative of the National Curriculum for science for both ages tested (Years 8 and 9 in England). Some items were included in only one version of the test, whereas others were included in two or more booklets (see Appendix IV, section IV.3). Consequently, the total number of students on which the percentages of correct answers have been calculated varies.

Within this chapter, comparisons are made using the mean percentages of correct responses[2] attained by students in the 11 selected countries; differences are expressed in terms of percentage points. This is in contrast to Chapter 4, where scores on a scale were quoted, and differences were expressed in scale points. Differences of $\pm$ five percentage points or more in the mean percentage of correct responses have been taken as evidence of real differences in performance.

[2] *Students who omitted to answer specific items were included in the percentage of students offering incorrect responses. Full details are provided in the international report (Beaton et al., 1996a).*

5.2 Earth science

The mean percentages of correct answers achieved by students in the international seventh and eighth grades (in England, Years 8 and 9 respectively) for this category are shown for England and selected other countries in Table 5.2, together with the international means. The differences between the mean scores of students in the two grades are also shown.

Table 5.2 Mean percentages of correct answers for *Earth science* in 11 countries (22 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	60	65	5
Japan	56	61	5
England	**56**	**59**	**3**
Hungary	54	60	6
United States	54	58	4
Sweden	53	62	9
Canada	53	58	5
Switzerland	52	58	6
Germany	52	57	5
Scotland	46	52	6
France	45	55	10
International mean	**50**	**55**	**5**

Source: Tables 2.1 and 2.2 (Beaton et al., 1996a)

5.2.1 Comparisons of total topic scores: *Earth science*

Only students in Singapore (upper grade only) achieved a score which was more than five percentage points above that of students in England.

5.2.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Earth science*

In each of the 11 countries, students in the international eighth grade achieved higher scores than students in the international seventh grade. The size of the increase in performance ranged from three percentage points (England) to ten percentage points (France) (see Table 5.2).

5.2.3 Examples of items for *Earth science*

Example items J1 and W2 are shown below, together with the national and international percentages correct.

Item J1

J1. Which BEST describes the surface of the Earth over billions of years?

A. A flat surface is gradually pushed up into higher and higher mountains until the Earth is covered with mountains.

B. High mountains gradually wear down until most of the Earth is at sea level.

(C.) High mountains gradually wear down as new mountains are continuously being formed, over and over again.

D. High mountains and flat plains stay side by side for billions of years with little change.

J1	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	36.8	38.1
International	35.1	40.0
Median country	35.8	40.9
Highest-scoring country	65.3	75.5

The incorrect options which were most popular with students in England were (D) and, to a lesser extent, (B). Option (D) was selected by 31.4 per cent of Year 8 students and 37.1 per cent of Year 9, and option (B) was selected by 22.4 per cent of Year 8 and 17.3 per cent of Year 9.

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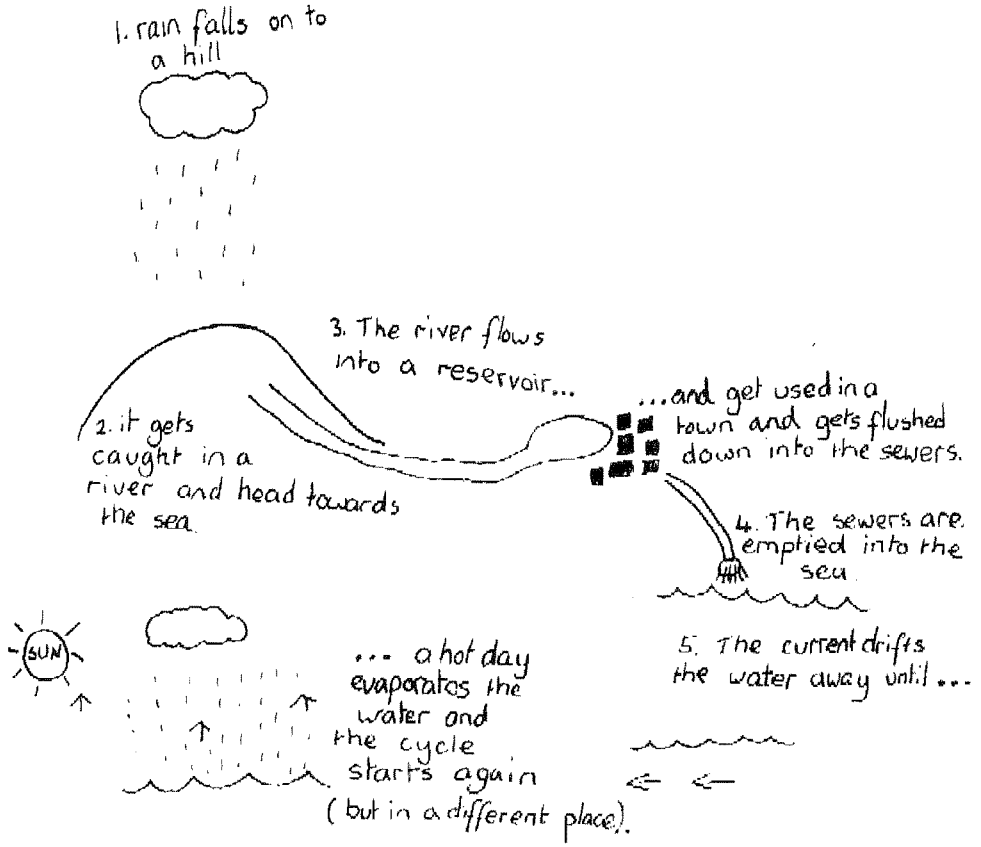
Item W2

W2. Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.



The criteria for a fully correct response required students to identify the following stages:

i. evaporation of water from a source
ii. transportation of water as vapour/clouds to another place
iii. precipitation in other places.

The international guidelines stipulated that responses which mentioned any two of the above were partially correct.

W2 fully correct	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	44.3	53.0
International	27.2	31.8
Median country	24.8	30.7
Highest-scoring country	56.3	59.7

*W2 fully or partially correct**	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	65.8	70.5
International	44.7	50.8
Median country	43.1	50.7
Highest-scoring country	68.4	76.7

* *For this question, students responses were marked as either fully correct, partially correct or incorrect. The international data tables showed the percentages of students who gave fully correct answers and the percentages who gave partially correct OR fully correct responses, together with the percentages providing incorrect answers.*

In England 17.7 per cent of Year 8 and 12.9 per cent of Year 9 students gave answers which referred only to precipitation. The international guidelines stated that this gave insufficient information to be treated as even partially correct. In both years about one in ten students did not attempt the question (9.9 per cent of Year 8 and 11.6 per cent of Year 9).

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5.3 Life science

The mean percentages of correct answers achieved by the lower and upper grades tested (in England, Years 8 and 9 respectively) for this category are shown for England and selected other countries in Table 5.3. The differences between the mean scores of students in the two grades are also shown.

Table 5.3 Mean percentages of correct answers for *Life science* in 11 countries (40 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Japan	64	71	7
Singapore	62	72	10
Hungary	61	65	4
United States	59	63	4
Germany	58	63	5
England	**57**	**64**	**7**
Canada	57	62	5
Sweden	56	63	7
Switzerland	53	59	6
France	50	56	6
Scotland	49	57	8
International mean	**53**	**59**	**6**

Source: Tables 2.1 and 2.2 (Beaton et al., 1996a)

5.3.1 Comparisons of total topic scores: *Life science*

The mean scores of students in England were above the international mean. Only students in Singapore and Japan achieved mean scores which were more than five percentage points above those of England.

5.3.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Life science*

England was one of five countries out of the 11 selected for comparisons in which the increase in performance from the seventh to the eighth grade was greater than the difference between the international means for the two grades (see Table 5.3).

5.3.3 Examples of items for *Life science*

Example items K16, N6 and X1 are shown below, together with the national and international percentages correct.

Item K16

K16. Which is made with the help of bacteria?

A. Yogurt

B. Cream

C. Soap

D. Cooking oil

K16	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	35.6	47.7
International	33.1	40.2
Median country	27.5	39.1
Highest-scoring country	83.1	89.4

Options (C) and (D) were chosen by similar numbers of students in England in both grades: option (C) was selected by 23.2 per cent of Year 8 students and 20.1 per cent of Year 9, and option (D) by 27.0 per cent of Year 8 and 21.5 per cent of Year 9.

* * * * * * * * * * * *

Item N6

N6. Which is the most basic unit of living things?

A. Cells

B. Bones

C. Tissues

D. Organs

N6	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	50.5	59.3
International	58.4	65.5
Median country	59.1	65.7
Highest-scoring country	89.8	88.6

Two options were chosen by considerable numbers of students in England: (B) and (D). Option (B) was selected by 26.7 per cent of Year 8 students and 20.6 per cent of Year 9, and option (D) was chosen by 17.8 per cent of Year 8 students and 15.3 per cent of Year 9.

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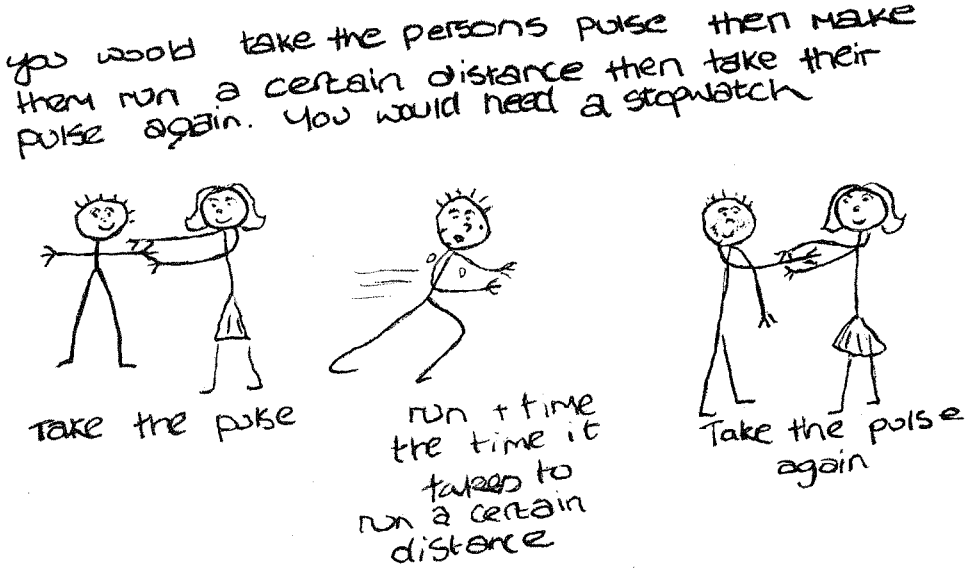
Item X1

X1. Suppose you want to investigate how the human heart rate changes with changes in activity. What materials would you use and what procedures would you follow?



The criteria for a fully correct response required students to describe a procedure in which:

i. the resting pulse rate is measured using a timer or watch
ii. the subject does some physical activity/exercise
iii. the pulse is measured during or after the exercise.

The international guidelines stipulated that responses which offered incomplete descriptions of suitable equipment and/or procedures were partially correct.

X1 fully correct	**Percentage correct for international seventh grade (Year 8 in England) %**	**Percentage correct for international eighth grade (Year 9 in England) %**
England	16.7	25.6
International	8.2	14.1
Median country	7.9	12.8
Highest-scoring country	22.8	31.9

*X1 fully or partially correct**	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	44.4	54.2
International	26.1	37.0
Median country	23.3	35.4
Highest-scoring country	63.4	71.1

* *For this question, students responses were marked as either fully correct, partially correct or incorrect. The international data tables showed the percentages of students who gave fully correct answers and the percentages who gave partially correct OR fully correct responses, together with the percentages providing incorrect answers.*

Of the students in England who gave partially correct responses (27.7 per cent of Year 8 and 28.6 per cent of Year 9), the majority in both grades provided an adequate description of a procedure but omitted to mention a timer or watch to measure the pulse rate. A considerable number of students in both years did not attempt the question (21.0 per cent of Year 8 and 14.3 per cent of Year 9).

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5.4 Physics

Table 5.4 shows the mean percentage correct answers achieved by each of the two year groups tested in England and selected other countries, together with the international means. The differences between the mean scores of students in the two year groups are also shown.

Table 5.4 Mean percentages of correct answers for *Physics* in 11 countries (40 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	63	69	6
Japan	63	67	4
England	**58**	**62**	**4**
Hungary	54	60	6
Canada	54	59	5
Germany	53	57	4
Switzerland	52	58	6
Sweden	51	57	6
Scotland	51	57	6
United States	51	56	5
France	48	54	6
International mean	**50**	**55**	**5**

Source: Tables 2.1 and 2.2 (Beaton et al., 1996a)

5.4.1 Comparisons of total topic scores: *Physics*

The mean scores of students in England were well above the international means for this topic. Only students in Singapore and Japan (both year groups) had mean scores which were five percentage points or more higher than students in England.

5.4.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Physics*

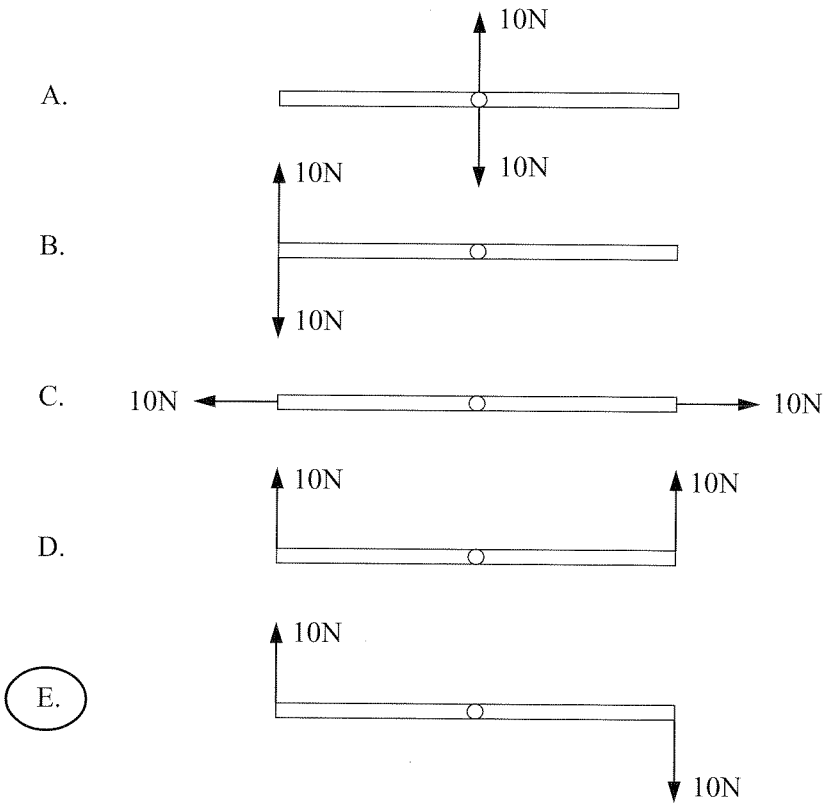
Students in all of the 11 selected countries showed an increase in performance in the international eighth grade as compared with the performance of students in the international seventh grade (Years 9 and 8 respectively in England). However, there was a far smaller range in the size of the difference in performance in *Physics* between the two grades tested than for any of the other science reporting categories. The increase in mean scores from the lower to the upper grade in the 11 selected countries ranged from four to six percentage points (see Table 5.4).

5.4.3 Examples of items for *Physics*

Example items L1, M14 and P5 are shown below, together with the national and international percentages correct.

Item L1

L1. A uniform rod is pivoted at its centre. It is acted on by two forces in the same plane. Each force has the same size, equal to 10 N (newtons). In which case is there a turning effect?



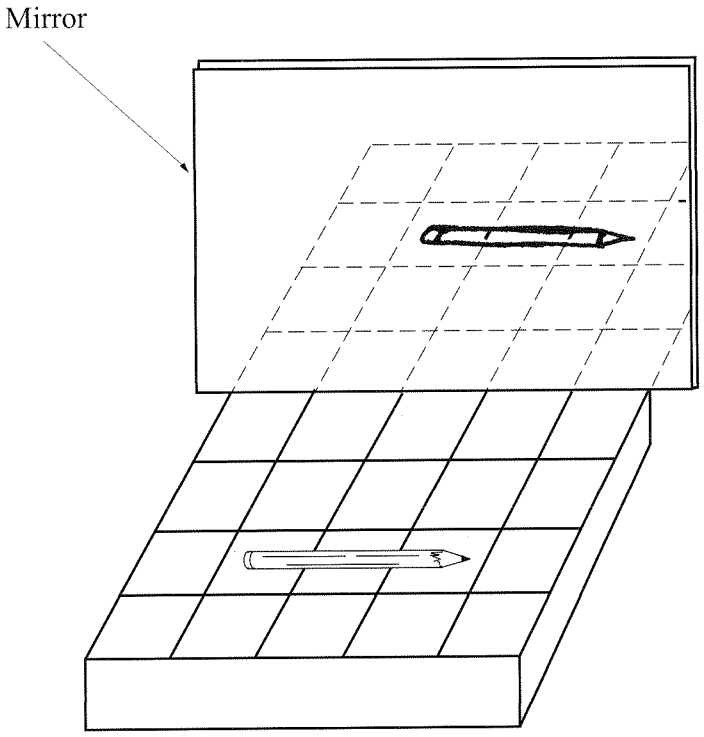
L1	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	51.7	59.1
International	43.5	48.6
Median country	44.1	50.0
Highest-scoring country	70.3	77.9

Two incorrect options were popular with students in Year 8 in England: (A) and (C), chosen by 15.1 per cent and 16.6 per cent of students respectively. In Year 9, options (A), (B) and (C) were selected by similar numbers of students: 10.9 per cent, 11.7 per cent and 10.0 per cent respectively.

* * * * * * * * * * * *

Item M14

M14. The picture shows a pencil that is lying on a shelf in front of a mirror. Draw a picture of the pencil as you would see it in the mirror. Use the patterns of lines on the shelf to help you.



M14	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	80.1	84.1
International	66.4	68.9
Median country	68.7	73.1
Highest-scoring country	83.4	85.2

Most incorrect drawings by students in Year 9 in England positioned the pencil at some point in the correct row of squares, whereas one row nearer to the mirror was equally popular with Year 8 students.

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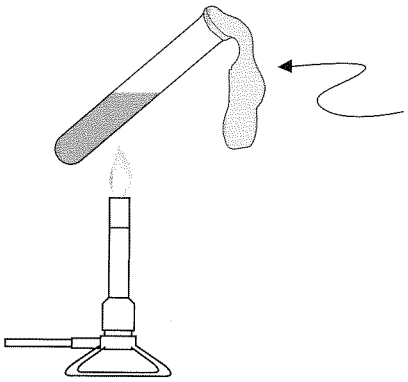
Item P5

P5. The water in a tube is heated, as shown in the diagram. As the water is heated, the balloon increases in size. Explain why.



The water evaporates and the vapour fills the balloon.

Acceptable responses to this question included an explicit mention of the expansion being due to the increase in pressure of air/gas/water vapour, or a reference to the evaporation of the water. The international guidelines stipulated that general statements which were not appropriate in the given situation, such as 'hot air always rises', were incorrect.

P5	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	62.8	69.3
International	51.8	57.7
Median country	51.7	57.7
Highest-scoring country	72.1	76.2

In England, 10.7 per cent of students in Year 8 and 5.3 per cent of students in Year 9 indicated that 'hot air (or gas) always rises'.

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5.5 Chemistry

The mean percentages of correct answers attained by the lower and upper grade students tested for England and selected other countries are shown in Table 5.5. The differences between the mean scores of students in the two grades are also shown.

Table 5.5 Mean percentages of correct answers for *Chemistry* in 11 countries (19 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	57	69	12
Hungary	54	60	6
Japan	49	61	12
England	**48**	**55**	**7**
United States	48	53	5
Germany	47	54	7
Canada	46	52	6
Sweden	45	56	11
Scotland	41	51	10
Switzerland	41	50	9
France	38	47	9
International mean	**43**	**51**	**8**

Source: Tables 2.1 and 2.2 (Beaton et al., 1996a)

5.5.1 Comparisons of total topic scores: *Chemistry*

Students in England had mean percentage correct scores which were above the international mean for both year groups. Students in only two countries (Singapore and Hungary) achieved mean scores which were five percentage points or more higher than their counterparts in England in both grades tested.

5.5.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Chemistry*

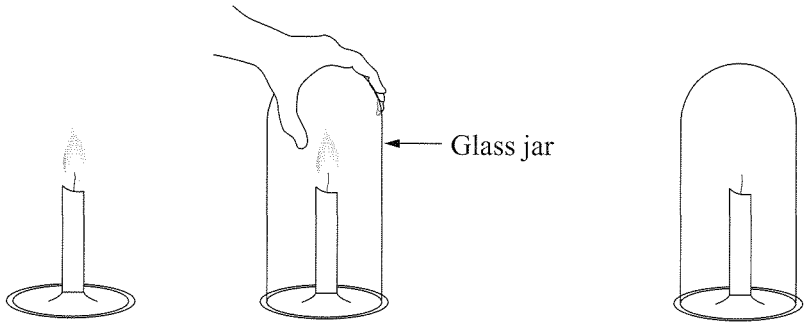
Students in most countries showed a greater increase in performance in *Chemistry* than in any of the other science reporting categories (see Beaton *et al.*, 1996a). This suggests that the majority of countries emphasised *Chemistry* in the curriculum for the upper grade tested.

5.5.3 Examples of items for *Chemistry*

Example items N7 and Q14 are shown below, together with the national and international percentages correct.

Item N7

N7. When a glass jar is placed over a lighted candle, the flame goes out.



Why does this happen?

The candle wont burn when it has used up all the oxygen.

Acceptable responses to this question referred explicitly to the need for oxygen or air, or mentioned this need using non-scientific language (e.g. 'the fire cannot breathe').

N7	**Percentage correct for international seventh grade (Year 8 in England) %**	**Percentage correct for international eighth grade (Year 9 in England) %**
England	91.9	97.1
International	85.4	88.1
Median country	90.1	92.5
Highest-scoring country	97.1	99.4

Very few students in either grade in England gave incorrect explanations; it is therefore impossible to identify any one incorrect answer as being widespread.

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Item Q14

Q14. A mixture of powdered iron and sulphur is heated. What will be formed?

A. a single element

B. two other elements

C. a solution

D. an alloy

(E.) a compound

Q14	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	37.6	49.0
International	36.1	45.8
Median country	36.8	46.9
Highest-scoring country	70.1	83.8

The most popular incorrect answer selected by students in both grades in England was (C), chosen by 28.5 per cent of students in Year 8 and 19.2 per cent in Year 9.

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5.6 Science and environment

This category included all items concerning environmental science together with items that were not directly related to any of the other reporting categories: some of them address aspects of science that form part of Sc1: Experimental and Investigative Science. Typically, these items focused on such things as identifying and controlling variables; and distinguishing between an observation and a conclusion.

Table 5.6 shows the mean percentages of correct answers achieved by students in the year groups tested in England and selected other countries. The differences between the mean scores of students in the two year groups are also shown.

Table 5.6 Mean percentages of correct answers for *Science and environment* in 11 countries (14 items)

COUNTRY	Mean score of international seventh grade (Year 8 in England) %	Mean score of international eighth grade (Year 9 in England) %	Difference between Years 8 and 9
Singapore	62	74	12
England	**56**	**65**	**9**
United States	56	61	5
Canada	56	61	5
Japan	53	60	7
Scotland	50	57	7
Hungary	48	53	5
Sweden	46	52	6
Germany	46	51	5
Switzerland	46	51	5
France	44	53	9
International mean	**47**	**53**	**6**

Source: Tables 2.1 and 2.2 (Beaton et al., 1996a)

5.6.1 Comparisons of total topic scores: *Science and environment*

This was the most outstanding single performance by students in Year 9 in England in science. The mean percentages correct achieved by students in both grades tested in England for this category were well above the international mean: their performance exceeded the international means by nine percentage points for Year 8 and 12 percentage points for Year 9. In only one of the selected countries, Singapore, did students achieve higher mean scores than their counterparts in England.

5.6.2 Differences in mean scores between international seventh grade and international eighth grade (Years 8 and 9 in England): *Science and environment*

The increase of nine percentage points shown by students in Year 9 in England as compared with the Year 8 students was a greater increase in performance than for any of the other science reporting categories, and was also greater than the difference between the means for the international seventh grade and the international eighth grade (six percentage points) (see Table 5.6).

5.6.3 Examples of items for *Science and environment*

Example items Z2 and I12 are shown below, together with the national and international percentages correct.

Item Z2

Z2. Since water is a renewable resource and so much of it falls each year, theoretically there should be enough water for everyone on Earth. Write down TWO reasons why not everyone has enough water.

Some water is polluted so you can't drink it and in hot places water evaporates very quickly.

Acceptable reasons included:

- the uneven distribution of rain, or other sources of water
- the uneven distribution of people
- water pollution
- higher consumption *or* wastage of water in some places
- the fact that evaporation of water is greater in some areas.

Z2a (first reason)	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	80.1	83.1
International	57.5	63.2
Median country	58.1	63.2
Highest-scoring country	85.9	86.6

Z2b (second reason)	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	59.1	62.1
International	36.2	42.2
Median country	35.8	42.3
Highest-scoring country	63.1	69.5

Although it was not possible to identify any single incorrect response that was more common than others suggested by students in England, it was noticeable that a substantial number of students in both Year 8 and Year 9 did not suggest a second reason for shortages of water (25.1 per cent and 21.0 per cent respectively).

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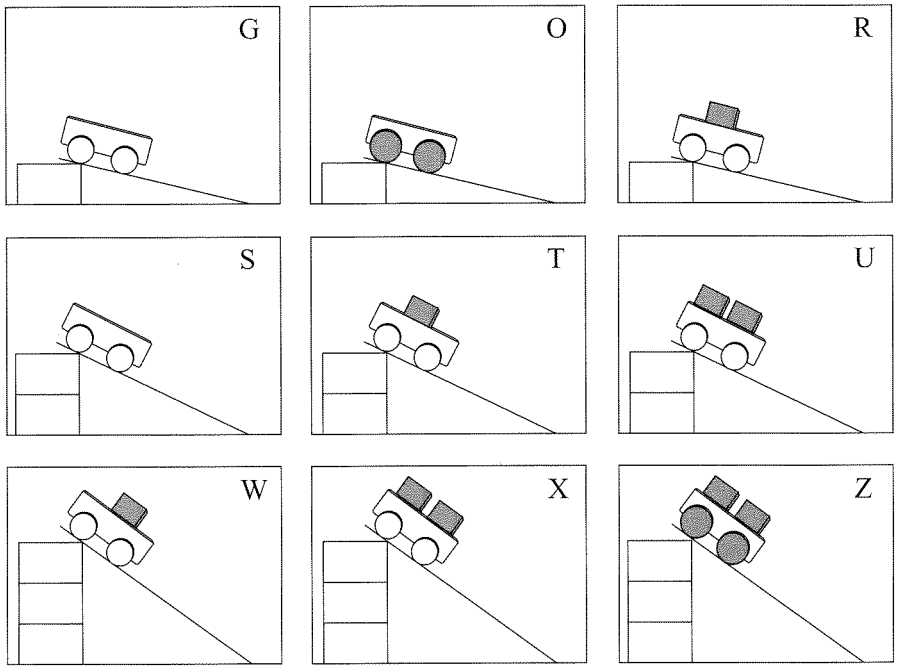
Item I12

I12. The diagrams show different trials Abdul carried out with carts having different-sized wheels. He started them from different heights and the blocks he put in them were of equal mass.



He wants to test this idea: The heavier a cart is, the greater its speed at the bottom of a ramp. Which three trials should he compare?

A. G, T, and X

B. O, T, and Z

C. R, U, and Z

(D.) S, T, and U

E. S, W, and X

I12	Percentage correct for international seventh grade (Year 8 in England) %	Percentage correct for international eighth grade (Year 9 in England) %
England	34.9	53.3
International	30.1	36.8
Median country	29.5	37.2
Highest-scoring country	65.4	71.5

A popular incorrect response for students in Year 8 in England was option (C), chosen by 24.3 per cent. In Year 9, options (A) and (C) were selected by similar numbers of students (15.9 per cent and 14.1 per cent respectively).

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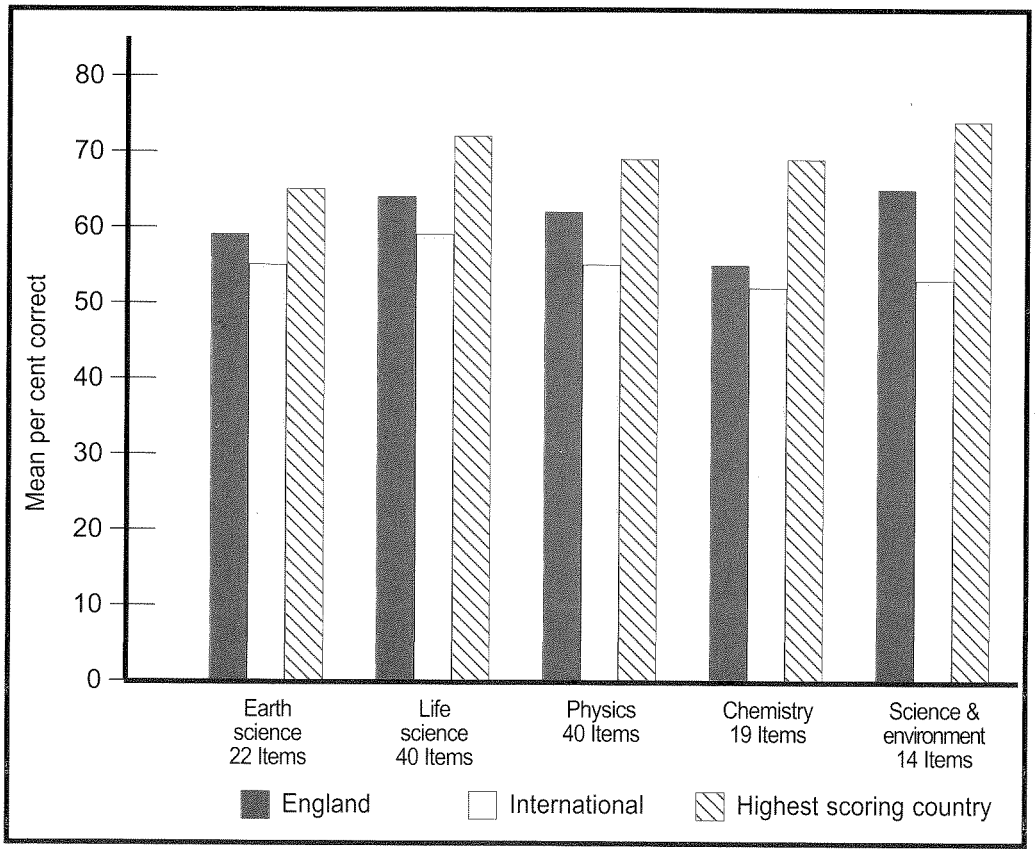
5.7 Overview of results for each science reporting category

The mean percentages of correct responses achieved by students in Year 9 in schools in England for each of the five science reporting categories are shown in Figure 5.7 below, together with the international means and the means achieved by students in the highest-scoring country for the equivalent year group.

Figure 5.7 Overview of mean percentages for science reporting categories: *international eighth grade (Year 9 in England)*



Source: Tables 2.1 and 2.2 (Beaton et al, 1996a)

The pattern of achievement was broadly similar in Year 8.

5.8 Gender differences

The preceding sections have presented the mean scores of students in Years 8 and 9 in England in each of the science content areas and drawn comparisons with the mean scores of students in ten other selected countries. This section identifies where there are statistically significant gender differences in performance in those science content areas.

There were no statistically significant gender differences in mean scores in any of the 11 selected countries in either of the two grades tested for two reporting categories:

- Life science
- Science and environment.

There were significant gender differences (all of which were in favour of boys) in the remaining three content areas within the selected countries: these are shown in Table 5.8. It is noticeable that there were different patterns of gender differences in different countries.

It should be noted that although there was only one significant gender difference in achievement in England (in favour of Year 8 boys for *Chemistry*), there were slight (but not significant) gender differences in favour of boys in the remaining reporting categories for both Year 8 and Year 9 which had the cumulative effect of producing a significant gender difference in favour of boys in both grades at the overall science level (see Chapter 4).

Table 5.8 Gender differences for science reporting categories in 11 countries

COUNTRY	EARTH SCIENCE		PHYSICS		CHEMISTRY	
	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)	International seventh grade (Year 8 in England)	International eighth grade (Year 9 in England)
Canada			*	*	*	
England					*	
France	*		*	*	*	
Germany			*		*	
Hungary	*	*	*	*		*
Japan	*	*		*	*	*
Scotland	*	*			*	*
Singapore						
Sweden			*	*	*	*
Switzerland	*		*	*	*	*
United States						

Source: Tables 2.1 and 2.2 (Beaton et al., 1996a)

**Statistically significant at the 0.05 level*

The mean percentages achieved by male and female students in England for each of the science reporting categories are shown below. Although the boys' mean scores were higher than those of the girls for each of the five science reporting categories in both Year 8 and Year 9, only one of the differences was statistically significant: the boys' higher score in *Chemistry* in Year 8.

Overview of gender differences in mean percentages of correct answers for science reporting categories for students in England

Reporting category	Earth science (22 items) %	Life science (40 items) %	Physics (40 items) %	Chemistry (19 items) %	Science & environment (14 items) %
Boys Year 8	58	58	59	51	57
Girls Year 8	53	56	55	44	56
Boys Year 9	61	65	63	57	65
Girls Year 9	58	63	60	53	64

Source: Tables 2.4 and 2.5 (Beaton et al., 1996a)

CHAPTER 6

Preview of further analyses

In this report the performance of 13-year-old students in England on the TIMSS mathematics and science tests has been compared with that of students of similar age in other countries.

The study also collected a wide range of background information from the students, teachers and schools taking part. Part 2 of this report will draw upon these background data to describe the contexts of mathematics and science education at the lower secondary level and to identify possible reasons for the key findings of this study. To this end, it will:

- compare the responses to the TIMSS questionnaires (see Chapter 1, Section 1.3.2) of students, teachers and headteachers in England with those of their counterparts in a small number of other countries
- examine the relationships between students' performance on the mathematics and science tests and the range of school, classroom and student data collected by the questionnaire.

Part 2 of this report will be published in spring 1997.

TIMSS in England included two other components, which will be described in future publications: the Second National Report on TIMSS will compare the performance of nine-year-old students in different countries on the mathematics and science tests; and a third report will describe the results of the Performance Assessment of 13-year-olds.

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APPENDIX I
National steering committee

Member	Association
Mark Neale (Chairman, 1993–1995)	Department for Education and Employment
Michael Richardson (Chairman 1995–present)	Department for Education and Employment
Robert Wood	Department for Education and Employment
John Gardner	Department for Education and Employment
Dr Seamus Hegarty	Director, National Foundation for Educational Research
Dr Wendy Keys	National Foundation for Educational Research
Sue Harris	National Foundation for Educational Research
Cres Fernandes	National Foundation for Educational Research
George Smith (1993–1996)	OFSTED
Christine Agambar (1996–present)	OFSTED
Richard Browne	School Curriculum and Assessment Authority
Miranda Simond (1993–1995)	School Curriculum and Assessment Authority
Carolyn Swain	School Curriculum and Assessment Authority
Dr John Marks	Consultant
Dr Hilary Steedman	Centre for Economic Performance, LSE
Prof. Geoffrey Howson	University of Southampton
Dr Barbara Jaworski (1993–1995)	Mathematical Association (secondary)
Roy Ashley (1995–present)	Mathematical Association (secondary)
Susan Sanders	Mathematical Association (primary)
Dr Alan Eales	Association of Teachers of Mathematics (secondary)
Marjorie Gorman	Association of Teachers of Mathematics (primary)
Judith Lee	Association for Science Education (secondary)
Mick Revell	Association for Science Education (primary)
Brian Semple	Scottish Office Education Department
Hywel Jones	Welsh Office Education Department
Mike Richards (1993–1996)	Welsh Office Education Department
Andrew George (1996–present)	Welsh Office Education Department

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 *(Flemish)*		●			
Belgium *(French)*		●			
Cyprus	●	●	●	●	●
Denmark		●		●	●
France		●			●
Germany		●			●
Greece	●	●			●
Iceland	●	●			●
[1]Italy		●			
Netherlands	●	●			●
Norway	●	●	●	●	●
Portugal	●	●	●	●	
Spain		●		●	
Sweden		●			●
Switzerland		●		●	●

Other 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.*

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THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY
First National Report
Part 1

This report presents the national results for England in the Third International Mathematics and Science Study (TIMSS), a major study involving over 40 other countries. Information on the performance of 13-year-old students is presented, together with comparisons with other countries and with previous international studies.

Comparisons are made in terms of:

- students' overall scores in mathematics and science;
- students' scores on each of the following mathematics and science reporting categories:

Mathematics	**Science**
Fractions and number sense	Earth science
Geometry	Life science
Algebra	Physics
Data representation and analysis	Chemistry
Measurement	Science and environment
Proportionality	

Examples of items in each of the reporting categories are provided, together with information on the responses made by students in England and international data relevant to the illustrative items.

This report is based on a national survey of nearly 3,700 students in 127 schools, which was part of a worldwide sample of nearly 300,000 students in approximately 6,000 schools in over 40 countries. It is essential reading for all those concerned with the teaching of mathematics and science in secondary schools: teachers, governors, LEA advisory teams, policy makers and researchers.

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