Chapter 6 The curriculum and teaching

Chapter outline

This chapter presents findings relating to teaching practice and curriculum in mathematics and science in Year 5 (Y5, ages 9–10) and Year 9 (Y9, ages 13–14), reported by teachers, headteachers and National Research Coordinators (or their designated national contact). The chapter first describes how much time is spent teaching mathematics and science, whether teachers emphasise science investigations, and the availability of computers. The degree of correspondence between what pupils learn and the topics assessed in TIMSS is then examined, by presenting data on the inclusion of TIMSS mathematics and science topics in participating countries' intended curricula, in addition to teachers' reports about topics covered in lessons. Findings for Y5 are followed by findings for Y9. Within each sub-section, findings for mathematics are generally presented first, followed by findings for science.

Key findings

- England's national curriculum for mathematics and science up to Y9 includes most of the content assessed by the TIMSS mathematics and science assessments. Compared with pupils in the highest performing countries, Y9 pupils would typically have encountered more of this content in science, but less of it in mathematics. In particular, fewer Y9 pupils in England were taught the Algebra topics, compared with those in the highest performing countries.
- The key stage 2 curriculum includes most of the TIMSS mathematics content, and Y5 pupils would have encountered more of this content than their peers in some of the highest performing countries.
- The key stage 2 curriculum includes less of the TIMSS science content, but more than in many other countries, including some of the highest performers.
- Compared with other TIMSS participants, teaching time for mathematics in England was relatively high in Y5, but relatively low in Y9.
- Teaching time for science was relatively low in England for both Y5 and Y9.
- Y9 pupils were more likely to have computers available in science lessons than in mathematics lessons. This was not so in Y5, where availability was similar for both subjects.

Interpreting the data: scaled data from teachers and headteachers

Most of the data presented in this chapter is reported by teachers and headteachers. Reported percentages refer to pupils and can usually (unless otherwise indicated) be interpreted as the percentage of pupils whose teacher or headteacher reported a particular practice or gave a particular response to a questionnaire item.

When interpreting the data from pupils, headteachers and teachers it is important to take account of the relative sample sizes. Participants are expected to sample a minimum of 150 schools in each year group and a minimum of 4,000 students for each target year group (these figures represent the numbers drawn in the sample; the achieved sample numbers may be less). The achieved ranges for participating schools internationally were 96 to 459 for Y5, and 95 to 501 for Y9.[66] These wide ranges reflected the fact that some participants had fewer than 150 schools available and some participants chose to over–sample schools. Just over half of participants sampled between 150 and 200 schools for each age group.

For TIMSS 2011 in England, the number of participating schools was 125 at Y5 and 118 at Y9. Numbers of participants within these schools were:

- 3,397 Y5 and 3,482 Y9 pupils.
- 125 and 118 headteachers respectively answered the Y5 and Y9 School Questionnaire.
- 194 Y5 class teachers completed a Teacher Questionnaire for mathematics and 199 for science.
- 213 Y9 teachers completed the Mathematics Teacher Questionnaire.
- 757 Y9 teachers completed the Science Teacher Questionnaire (the number of science teachers was greater as the Y9 pupils were sampled by mathematics class).

See Appendix A for more information about numbers of participants and sampling method.

66 These figures refer to countries and exclude benchmarking participants.

Year 5

6.1 Teaching time

Teaching time,[67] for all age groups and subjects, was reported by headteachers[68] and teachers and calculated using the following formula, to enable direct comparison of teaching time to be made between different countries:

Total Instructional Hours per Year = **Principal Reports of School Days per Week** X **Principal Reports of Instructional Hours per Day**

Hours per Year for Mathematics Instructions = **Teacher Reports of Weekly Mathematics Instructional Hours** / **Principal Reports of School Days per Week** X **Principal Reports of School Days per Day**

Source: Exhibit 8.6 International mathematics and science reports

At Y5, England's average achievement score for Y5 mathematics was 542, significantly[69] above the centre point of the mathematics achievement scale. Table 6.1 shows that, in England, the average amount of time for teaching mathematics to Y5 pupils was relatively high at 188 hours per year, 19 per cent of a total 970 teaching hours per year.

England's average achievement score for Y5 science was 529, also significantly above the centre point of the achievement scale. For Y5 science, the average amount of teaching time was 76 hours per year, 8 per cent of a total 970 teaching hours per year, and lower than the international average of 85 hours (see Table 6.1).

The amount of teaching time was variable internationally for both subjects, including among the high performing countries. Teaching time for mathematics was lower than in England in the majority of the high performing countries, but in Singapore and Northern Ireland it was higher than in England (208 hours and 232 hours respectively).

However, in the majority of high performing countries in science, teaching time for science was higher than in England. The exceptions to this were the Russian Federation and Czech Republic, where it was 49 and 60 hours respectively (compared with 76 hours in England). In the Netherlands and Denmark, where average science attainment was not significantly different from England's, teaching time for science was also lower than in England at 42 and 62 hours respectively.

Like the majority of countries, teaching time was higher for mathematics than science at both age groups in England.[70]

67 Teaching time is referred to as 'instructional time' in the international data and report.

68 Headteachers are referred to as principals in the international data and report.

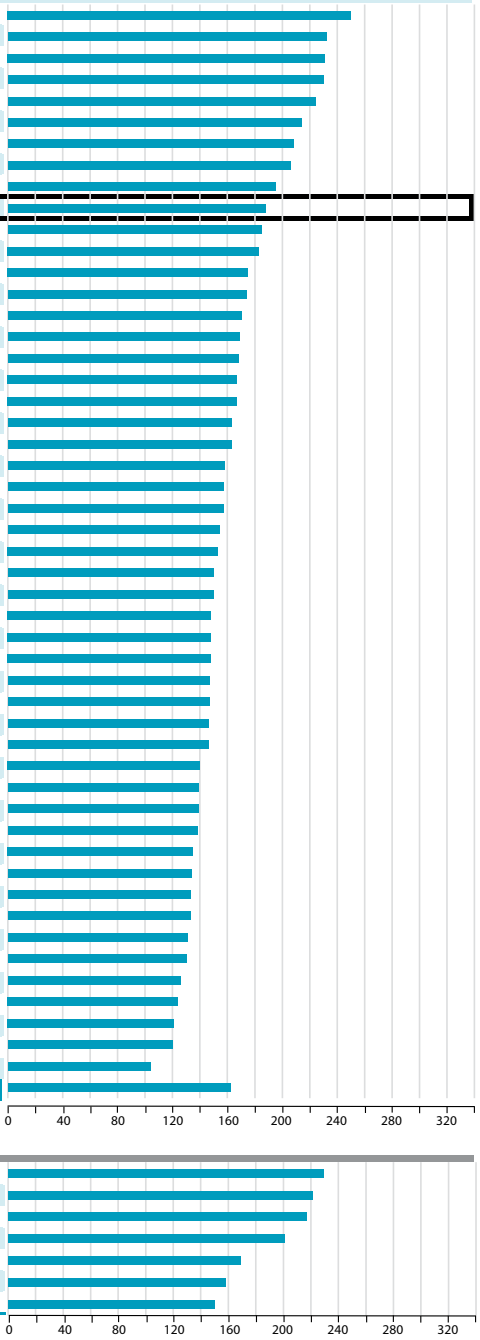
69 Throughout this report, the term 'significant' refers to statistical significance.

70 Trend comparisons with 2007 cannot be made in this instance as the measure used for teaching time in 2007 was different.

Table 6.1 Teaching time at ages 9–10

Mathematics

Country	Total Instructional Hours per Year	Hours per Year for Mathematics Instruction
Portugal	r 940 (13.1)	r 250 (4.3)
Northern Ireland	r 970 (11.0)	s 232 (6.1)
Chile	r 1228 (22.6)	s 231 (6.7)
Australia	1008 (6.9)	s 230 (5.8)
Belgium (Flemish)	r 1010 (16.8)	r 224 (4.1)
Italy	1085 (12.6)	214 (3.9)
Singapore	1012 (0.0)	208 (3.2)
United States	1078 (7.3)	r 206 (4.6)
Netherlands	s 1074 (9.9)	s 195 (7.0)
England	r 970 (8.3)	s 188 (3.3)
Qatar	1068 (9.1)	185 (6.3)
Malta	r 891 (0.2)	r 183 (0.1)
Tunisia	r 963 (22.9)	r 175 (2.9)
Morocco	r 1040 (23.6)	s 174 (3.5)
Oman	s 999 (17.4)	s 170 (3.1)
Slovenia	684 (0.0)	169 (2.6)
New Zealand	925 (3.9)	168 (2.4)
Thailand	r 1201 (20.9)	167 (5.2)
Spain	r 884 (9.7)	r 167 (2.3)
Germany	r 863 (11.2)	r 163 (3.1)
Czech Republic	782 (8.2)	163 (3.0)
Hong Kong SAR	r 1059 (11.2)	r 158 (3.0)
Norway	817 (10.7)	157 (4.1)
Poland	r 764 (13.5)	r 157 (3.0)
United Arab Emirates	r 1025 (8.5)	s 154 (2.4)
Serbia	778 (18.5)	153 (2.1)
Ireland, Rep. of	854 (0.0)	150 (2.8)
Japan	891 (3.7)	150 (1.6)
Georgia	r 748 (18.7)	r 148 (3.9)
Hungary	760 (12.2)	148 (3.3)
Romania	796 (17.9)	148 (3.9)
Saudi Arabia	r 977 (19.4)	r 147 (6.6)
Slovak Republic	780 (8.8)	147 (1.4)
Austria	808 (6.9)	146 (2.1)
Iran, Islamic Rep. of	727 (11.2)	146 (3.9)
Kazakhstan	779 (10.6)	140 (2.7)
Finland	779 (9.8)	139 (2.5)
Armenia	r 851 (17.1)	r 139 (1.7)
Sweden	r 849 (11.3)	s 138 (3.8)
Yemen	r 831 (14.1)	r 135 (6.4)
Croatia	776 (19.4)	134 (2.3)
Chinese Taipei	r 989 (13.4)	133 (3.9)
Lithuania	649 (9.0)	133 (2.6)
Bahrain	964 (10.8)	r 131 (4.4)
Azerbaijan	804 (27.7)	130 (3.3)
Turkey	900 (19.3)	126 (2.5)
Denmark	r 863 (9.4)	s 124 (2.0)
Korea, Rep. of	789 (11.4)	121 (3.0)
Kuwait	r 928 (23.1)	r 120 (4.9)
Russian Federation	r 660 (8.0)	104 (1.0)
International Avg.	897 (2.0)	162 (0.5)
Benchmarking Participants		
Quebec, Canada	916 (5.1)	229 (5.0)
North Carolina, US	r 1113 (22.9)	r 221 (13.5)
Florida, US	r 1073 (19.7)	s 217 (8.8)
Ontario, Canada	969 (7.4)	r 201 (4.1)
Alberta, Canada	1006 (8.8)	s 169 (3.2)
Dubai, UAE	r 993 (0.7)	s 158 (2.3)
Abu Dhabi, UAE	r 1033 (18.1)	s 150 (4.3)



( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

An "r" indicates data are available for at least 70% but less than 85% of the students. An "s" indicates data are available for at least 50% but less than 70% of the students.

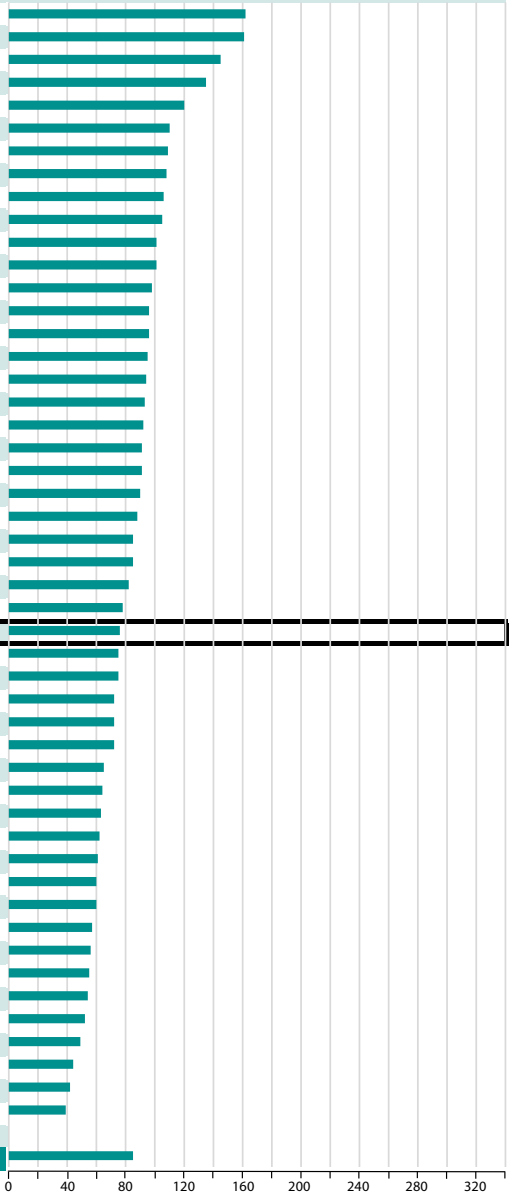
Source: Exhibit 8.6, international mathematics report

Table 6.1 Teaching time at ages 9–10 (continued)

Science

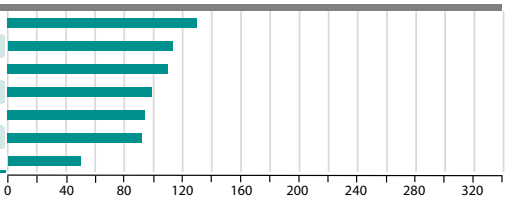
Reported by Principals and Teachers

Country	Total Instructional Hours per Year	Hours per Year for Science Instruction
Portugal	r 940 (13.1)	r 162 (4.1)
Chile	r 1228 (22.6)	s 161 (6.4)
Spain	r 884 (9.7)	r 145 (2.6)
Qatar	1068 (9.1)	135 (6.8)
Oman	s 999 (17.4)	s 120 (2.4)
Georgia	r 748 (18.7)	r 110 (2.7)
Thailand	r 1201 (20.9)	109 (4.9)
United Arab Emirates	r 1025 (8.5)	s 108 (3.0)
Iran, Islamic Rep. of	727 (11.2)	106 (3.2)
United States	1078 (7.3)	r 105 (3.1)
Slovenia	684 (0.0)	101 (1.2)
Slovak Republic	780 (8.8)	101 (4.3)
Finland	779 (9.8)	98 (1.9)
Singapore	1012 (0.0)	96 (2.1)
Austria	808 (6.9)	96 (2.3)
Croatia	776 (19.4)	95 (2.4)
Turkey	900 (19.3)	94 (1.8)
Tunisia	r 963 (22.9)	r 93 (5.4)
Korea, Rep. of	789 (11.4)	92 (2.5)
Yemen	r 831 (14.1)	r 91 (5.6)
Japan	891 (3.7)	91 (0.8)
Chinese Taipei	r 989 (13.4)	90 (2.3)
Hong Kong SAR	r 1059 (11.2)	r 88 (4.2)
Kuwait	r 928 (23.1)	s 85 (5.8)
Bahrain	964 (10.8)	r 85 (2.7)
Saudi Arabia	r 977 (19.4)	r 82 (4.2)
Italy	1085 (12.6)	r 78 (1.8)
England	r 970 (8.3)	s 76 (3.2)
Sweden	r 849 (11.3)	s 75 (3.0)
Germany	r 863 (11.2)	s 75 (3.5)
Hungary	760 (12.2)	72 (2.2)
Serbia	778 (18.5)	72 (5.0)
Northern Ireland	r 970 (11.1)	s 72 (3.9)
Australia	1008 (6.9)	s 65 (2.3)
Poland	r 764 (13.5)	r 64 (3.1)
Ireland, Rep. of	854 (0.0)	63 (6.6)
Denmark	r 863 (9.4)	s 62 (1.9)
Azerbaijan	804 (27.7)	61 (1.4)
Lithuania	649 (9.0)	60 (1.5)
Czech Republic	782 (8.2)	60 (2.2)
Kazakhstan	779 (10.6)	57 (1.3)
Romania	796 (17.9)	56 (6.2)
Norway	817 (10.7)	55 (2.2)
Armenia	r 851 (17.1)	s 54 (0.6)
New Zealand	925 (3.9)	s 52 (3.0)
Russian Federation	r 660 (8.0)	49 (0.7)
Morocco	r 1040 (23.6)	s 44 (5.5)
Netherlands	s 1074 (9.9)	s 42 (2.4)
Malta	r 891 (0.2)	r 39 (0.1)
Belgium (Flemish)	r 1010 (16.8)	- -
International Avg.	897 (2.0)	85 (0.5)



Benchmarking Participants

Alberta, Canada		1006 (8.8)	s	130 (4.1)
Florida, US	r	1073 (19.7)	s	113 (9.6)
Abu Dhabi, UAE	r	1033 (18.1)	s	110 (6.8)
Dubai, UAE	r	993 (0.7)	s	99 (1.6)
North Carolina, US	r	1113 (22.9)	r	94 (6.0)
Ontario, Canada		969 (7.4)	r	92 (3.2)
Quebec, Canada		916 (5.1)		50 (1.7)



( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
A dash (-) indicates comparable data not available.
An "r" indicates data are available for at least 70% but less than 85% of the students. An "s" indicates data are available for at least 50% but less than 70% of the students.

Source: Exhibit 8.6, international science report

6.2 Teachers' emphasis on science investigations

Interpreting the data: indices and scales

In order to summarise data from a questionnaire, responses to several related items are sometimes combined to form an index or scale. The respondents to the questionnaire items are grouped according to their responses and the way in which responses have been categorised is shown for each index or scale. The data in an index or scale is often considered to be more valid and reliable than the responses to individual items.

The emphasis teachers place on science investigations is measured by teachers' responses to six statements about teaching science (these statements can be seen below Table 6.2). The international analysis uses responses to these statements to create the *Emphasize Science Investigation* scale.[71] Pupils were categorised into two bands: those whose teachers emphasise science investigations in *About Half the Lessons or More* and those whose teachers emphasise science investigations in *Less Than Half the Lessons* (details of how pupils were assigned to each band is provided above Table 6.2). In England the average scale score was 10.0; within the *Less Than Half the Lessons* category overall.

Forty–one per cent of Y5 pupils in England were taught by teachers who emphasised science investigations in *About Half the Lessons or More*. Percentages of pupils in England whose teachers did each individual activity on the *Emphasize Science Investigation* scale (see the box below Table 6.2) in half of the lessons or more were higher than in TIMSS 2007 for all six activities.[72]

There was no clear pattern among high performing countries in terms of the frequency of teachers' emphasis on science investigations. For some high performing participants such as Korea, Chinese Taipei, Japan, Singapore and Alberta, a higher proportion of pupils than in England were taught by teachers who emphasised science investigations in *About Half the Lessons or More*. However, in other countries where performance was significantly better than England's at Y5 science, for example Finland, Russian Federation and Czech Republic, a lower proportion of pupils than in England was taught by teachers who emphasised science investigations in *About Half the Lessons or More*. In England, it is likely that there is no significant difference[73] between pupils' average achievement according to the frequency with which their teachers emphasised science investigations.

71 The table is labelled as in the international report; hence American spelling may be used in such labels.

72 Analysis was conducted using the weighted international data and comparing this to the percentages reported by teachers in TIMSS 2007, which were presented as individual activities rather than as a scale. The 2007 data was presented as *Percentage of Students whose teachers reported students doing the activity about half of the lessons or more* for each individual activity. In order to compare the 2011 data to this, the percentages in the response categories *about half the lessons or more* and *every or almost every lesson* were combined to make percentages for each activity that were directly comparable. In 2007 teachers were also asked about an additional activity, *Work Together in Small Groups on Experiments or Investigations*, whereas this was not included in the 2011 *Emphasize Science Investigation* scale: percentages were only compared for the six activities reported by teachers in both surveys.

73 This difference has not been tested formally for statistical significance; this conclusion is drawn from the size of the standard errors relating to the average achievement scores of the two groups of pupils: see Table 6.2.

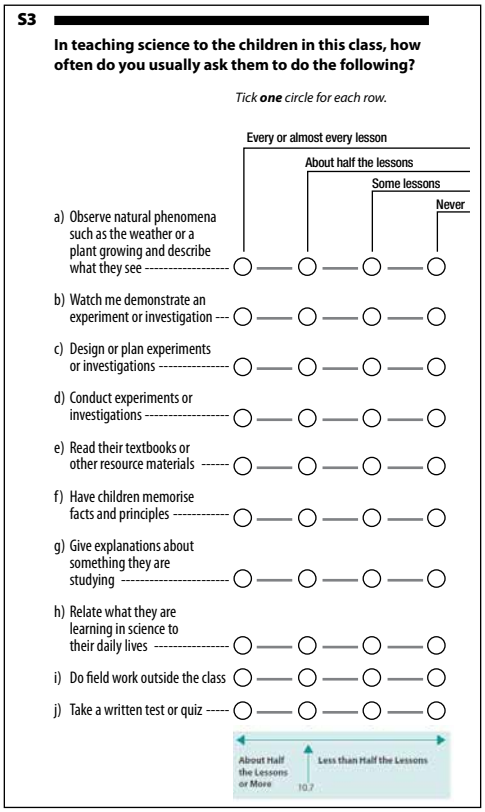
Table 6.2 Teachers' emphasis on science investigations in Y5

Students were scored according to their teachers' responses to how often they used each of six instructional activities on the *Emphasize Science Investigation* scale. Students with teachers who emphasized science investigation in **About Half the Lessons or More** had a score on the scale of at least 10.7, which corresponds to their teachers using all six activities in "about half the lessons," on average. All other students had teachers who emphasized science investigation in **Less than Half the Lessons**.

Country	About Half the Lessons or More		Less than Half the Lessons		Average Scale Score
	Per cent of Students	Average Achievement	Per cent of Students	Average Achievement	
England r	41 (4.7)	535 (7.5)	59 (4.7)	524 (4.4)	10.0 (0.15)
International Avg.	40 (0.5)	488 (0.9)	60 (0.5)	484 (0.9)	

Centre point of scale set at 10.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

An "r" indicates data are available for at least 70% but less than 85% of the students.



Items e, f, i and j did not contribute to this scale.

Source: Exhibit 8.27, international science report

6.3 Use of computers in Y5 lessons

Mathematics

In England, 71 per cent of Y5 pupils were taught by teachers who reported that computers were available for mathematics lessons (see Table 6.3), one of the highest proportions across all countries, and considerably higher than the international average (42 per cent). Among the countries whose average score for mathematics was significantly higher than England's, computer availability varied substantially: 76 per cent in Northern Ireland, 65 per cent in Singapore; but 31 per cent and 39 per cent in Korea and Hong Kong respectively. The most common uses of computers in mathematics lessons in England were *to practice skills and procedures* and *to explore*

mathematical principles and concepts (60 and 55 per cent respectively had teachers who asked them to use computers for these purposes at least monthly).

Science

In England, 74 per cent of Y5 pupils were taught by teachers who reported that computers were available for use in science lessons (see Table 6.3). The percentage of pupils who had computers available for science lessons was higher in England than in most of the high performing Pacific Rim countries (in Japan the percentage was the same: 74 per cent). Computer availability was very varied across countries. As for mathematics, computer availability for science lessons was particularly low in Korea (35 per cent), the highest performing country in science at this age group. Computer availability was particularly high in Denmark and Northern Ireland. Where pupils did have access *to* computers for their science lessons, they were mainly used *to look up ideas and information*. This was the case across the majority of participants.

Table 6.3 Computer activities in Y5 lessons

Mathematics

Reported by Teachers

Country	Computers Available for Mathematics Lessons			Per cent of Students Whose Teachers Have Them Use Computers At Least Monthly		
	Per cent of Students	Average Achievement				
	Yes	Yes	No	To Explore Mathematics Principles and Concepts	To Look Up Ideas and Information	To Practice Skills and Procedures
England	71 (4.2)	545 (3.9)	542 (8.0)	55 (4.4)	41 (4.4)	60 (4.3)
International Avg.	42 (0.5)	491 (1.1)	490 (0.7)	27 (0.4)	26 (0.5)	34 (0.5)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Science

Reported by Teachers

Country	Computers Available for Science Lessons			Per cent of Students Whose Teachers Have Them Use Computers At Least Monthly			
	Per cent of Students	Average Achievement					
	Yes	Yes	No	To Look Up Ideas and Information	To Do Scientific Procedures or Experiments	To Study Natural Phenomena Through Simulations	To Practice Skills and Procedures
England	74 (4.3)	531 (3.8)	519 (9.3)	68 (5.0)	40 (4.8)	51 (5.1)	43 (4.8)
International Avg.	47 (0.5)	488 (1.0)	486 (0.8)	41 (0.5)	24 (0.4)	25 (0.4)	31 (0.5)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Source: Exhibit 8.29, international mathematics and science reports

6.4 The Year 5 curriculum

6.4.1 The intended curriculum

The TIMSS 2011 mathematics and science Assessment Frameworks were not designed to match exactly the curriculum of any one participating country. In order to assess the degree of correspondence between national curricula and the topics covered in TIMSS 2011, National Research Coordinators (NRCs), or their designated contact, were asked to indicate whether each of the TIMSS 2011 mathematics and science topics (listed below Table 6.4 for mathematics, and below Table 6.5 for science) was included in their countries' intended curriculum for pupils aged 9–10 (Y5), and, if so, whether the topics were intended to be taught *to all or almost all pupils* or *only the more able pupils* by the end of Y5.[74] The outcomes for England are summarised in Table 6.4 and Table 6.5.

Mathematics

Table 6.4 shows that, in England, 17 of the 18 TIMSS mathematics topics were intended to be taught to all Y5 pupils. One number topic was intended to be taught only to more able students; this was *Adding and subtracting with fractions* (see the box below Table 6.4 for a full list of the TIMSS 2011 mathematics topics). The number of TIMSS mathematics topics covered in the curriculum was similar to countries performing significantly better than England, such as Japan, Singapore, Korea and Northern Ireland, as well as to countries performing at a similar level, such as Belgium (Flemish) and the United States. In countries where topics were not in the curriculum, these were mainly within the content areas of Number and Geometrical Shapes and Measures. Across all countries, it was rare for topics to be taught only to more able pupils in this age group.

Table 6.4 Number of TIMSS mathematics topics intended to be taught by the end of Y5

Reported by National Research Coordinators

Country	All Mathematics (18 Topics)			Number (8 Topics)			Geometric Shapes and Measures (7 Topics)			Data Display (3 Topics)		
	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4
England	17	1	0	7	1	0	7	0	0	3	0	0
International Avg.	13	1	4	6	0	2	5	0	2	2	0	1

Because of rounding some results may appear inconsistent.

74 NRCs were asked: "According to the national mathematics/science curriculum, what proportion of grade 4 students should have been taught each of the following topics or skills by the end of grade 4?" For countries with no national curriculum, NRCs were advised to "summarize for your state or provincial curricula".

TIMSS 2011 Mathematics Topics

A.Number

1) Concept of whole numbers, including place value and ordering
2) Adding, subtracting, multiplying, and/or dividing with whole numbers
3) Concepts of fractions
4) Adding and subtracting with fractions
5) Cocepts of decimals, including place value and ordering
6) Adding and subtracting with decimals
7) Number sentences
8) Number patterns

B.Geometric Shapes and Measures

1) Lines measuring, estimating length of; parallel and perpendicular lines
2) Comparing and drawing angles
3) Using informal coordinate systems to locate points in plane
4) Elementary properties of common geometric shapes
5) Reflections and rotations
6) Relationships between two-dimensional and three-dimen shapes
7) Finding and estimating areas, perimeters, and volumes

C.Data Display

1) Reading data from tables, pictographs, bar graphs, or pie charts
2) Drawing conclusions from data displays
3) Display data using tables, pictographs, and bar graphs.

Source: Exhibit 8.10, international mathematics report

Science

Table 6.5 shows that in England, 16 of the 20 TIMSS science topics were intended to be taught to all Y5 pupils. All topics in Life Science were included (see the box below Table 6.5 for a full list of the TIMSS 2011 science topics). The topics not included are shown in Table 6.6. The topics not included from the Earth Science domain are likely to be found in other parts of the curriculum, notably Geography.

Table 6.5 Number of TIMSS science topics intended to be taught by the end of Y5

Reported by National Research Coordinators

Country	All Science (20 Topics)			Life Science (6 Topics)			Physical Science (8 Topics)			Earth Science (6 Topics)		
	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 4
England	16	0	4	6	0	0	7	0	1	3	0	3
International Avg.	14	1	5	5	0	1	5	0	2	4	0	2

Because of rounding some results may appear inconsistent.

TIMSS 2011 Science Topics

A. Life Science

1) Major body structures and their functions in humans and other organisms (plant and animals)
2) Life cycles and reproduction in plants and animals
3) Physical features, behavior, and survival of organisms living in different environments
4) Relationships in a given community (e.g., simple food chains, predator-prey relationships)
5) Changes in environments (effects of human activity, pollution and its prevention)
6) Human health (e.g., transmission/prevention of communicable diseases, signs of health/illness, diet, exercise)

B. Physical Science

1) States of matter (solids, liquids, gases) and differences in their physical properties (shape, volume), includeing changes in state of matter by heating and coolng
2) Classification of objects/materials based on physical properties (e.g., weight/mass, volume, magnetic attraction)
3) Forming and separating mixtures
4) Elementary properties of common geometric shapes
5) Common energy sources/forms and their practical uses (e.e., the Sun, electricity, water, wind)
6) Light (e.g.,sources, behavior)
7) Electrical circuits and properties of magnets
8) Forces that cause objects to move (e.g., gravity, push/pull forces)

C. Earth Science

1) Water on Earth (location, types, and movements) and air (composition, proof of its existance, uses)
2) Common features of Earth's landscape (e.g., mountains, plain, rivers, deserts) and relationship to human use (e.g., farming, irrigation, land development)
3) Weather conditions from day to day or over the seasons
4) Fossils of animals and plants (age, location, formation)
5) Earth's solar system (planets, Sun, moon)
6) Day, might, and shadows due to Earth's rotation and its relationship to the Sun

Source: Exhibit 8.10 international science report

Table 6.6 TIMSS 2011 Science topics not intended to be taught by the end of Y5

Physical Science	Earth Science
• *Common energy sources/forms and their practical uses (e.g., the Sun, electricity, water, wind)*	• *Common features of Earth's landscape (e.g., mountains, plains, rivers, deserts) and relationship to human use (e.g., farming, irrigation, land development)* • *Weather conditions from day to day or over the seasons* • *Fossils of animals and plants (age, location, formation)*

Source: information provided by National Research Coordinator

Internationally, there was variation in the number of topics included in curricula, as well as in the content domains these topics were drawn from. However, very few countries intended to teach particular topics only to more able pupils. Compared with the countries with significantly higher average achievement, England's science curriculum included a greater number of TIMSS science topics. In Korea and Singapore fewer than half of the TIMSS topics feature in their respective science curricula. Alberta and participants achieving at a similar level to England, such as Italy and North Carolina also included fewer topics than England, typically in Earth Science. Northern Ireland included all 20 topics, and the Netherlands did not prescribe any grade–specific science curriculum at this level.

6.4.2 Percentage of Y5 pupils taught the TIMSS topics

Teachers were asked to indicate, for their class, whether each of the TIMSS topics was *mostly taught this year, not yet taught* or *just introduced*. Table 6.7 shows the percentage of pupils whose teachers reported that they had been taught the topics either prior to or during the year of the assessment, averaged across topics, presented both as overall percentages and according to content domain.[75]

Mathematics

According to teachers' reports, 91 per cent of pupils in England were taught the TIMSS mathematics topics either before or during the year of the TIMSS assessment. England's overall percentage was higher than in many of the countries performing significantly better, such as Singapore, Korea and Hong Kong. The most commonly taught domain[76] in England was Data Display. Across countries, and particularly in countries where average achievement was significantly higher than England's, the most commonly taught domain was Number. For example, in Singapore, where 85 per cent of pupils were taught the TIMSS mathematics topics either before or during the year of assessment, 100 per cent were taught the Number topics.

Science

In England, 71 per cent of pupils were taught the TIMSS science topics, a higher percentage overall than most of the higher performing countries. In Korea, the highest performing country in this age group, the equivalent figure was 50 per cent and in Japan it was 38 per cent. In the Netherlands, Sweden, Denmark and Germany, as well as in Alberta, fewer pupils were taught the TIMSS science topics. For most of these participants, the most commonly taught domain was Life Science but for Sweden it was Earth Science. The most commonly taught domain in England was Physical Science, whereas in Chinese Taipei, Korea, Finland and Czech Republic, it was Life Science.

Table 6.7 Percentage of Y5 pupils taught the TIMSS topics*

Mathematics

Reported by Teachers

Country	All Mathematics (18 Topics)	Number (8 Topics)	Geometric Shapes and Measures (7 Topics)	Data Display (3 Topics)
England	91 (0.9)	91 (0.8)	89 (1.5)	96 (1.2)
International Avg.	72 (0.2)	76 (0.2)	65 (0.2)	76 (0.4)

* Percentage mostly taught before or in the assessment year averaged across topics.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Source: Exhibit 8.8, international mathematics and science reports

75 For a full list of the topics, refer back to the boxes below Table 6.4 and Table 6.5.

76 'Most commonly taught domain', here and in section 6.8.2, refers to the content domain within which the highest proportion of pupils had been taught topics before or in the assessment year.

Reported by Teachers

Country	All Science (20 Topics)	Life Science (6 Topics)	Physical Science (8 Topics)	Earth Science (6 Topics)
England	r 71 (1.7)	r 72 (2.4)	r 78 (1.8)	r 62 (2.9)
International Avg.	64 (0.2)	75 (0.2)	57 (0.3)	63 (0.3)

* Percentage mostly taught before or in the assessment year averaged across topics.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.

Source: Exhibit 8.8, international science report

Year 9

6.5 Teaching time

This was calculated in the same way as for Y5; please refer to section 6.1 for further details.

Mathematics

At Y9, England's average achievement score for mathematics was 507, not significantly different from the centre point of the achievement scale. Table 6.8 shows that, in England, mathematics teaching time for Y9 pupils was 116 hours per year, 12 per cent of a total 992 teaching hours per year.

England was the fourth lowest country overall on this indicator. In contrast, at Y5, it was one of the highest, at 188 hours out of 970 (19 per cent). In most of the countries where average achievement was significantly higher than England's, teaching time for mathematics was higher. However, Japan was the exception: teaching time for Y9 mathematics in Japan was lower at 108 hours.

Science

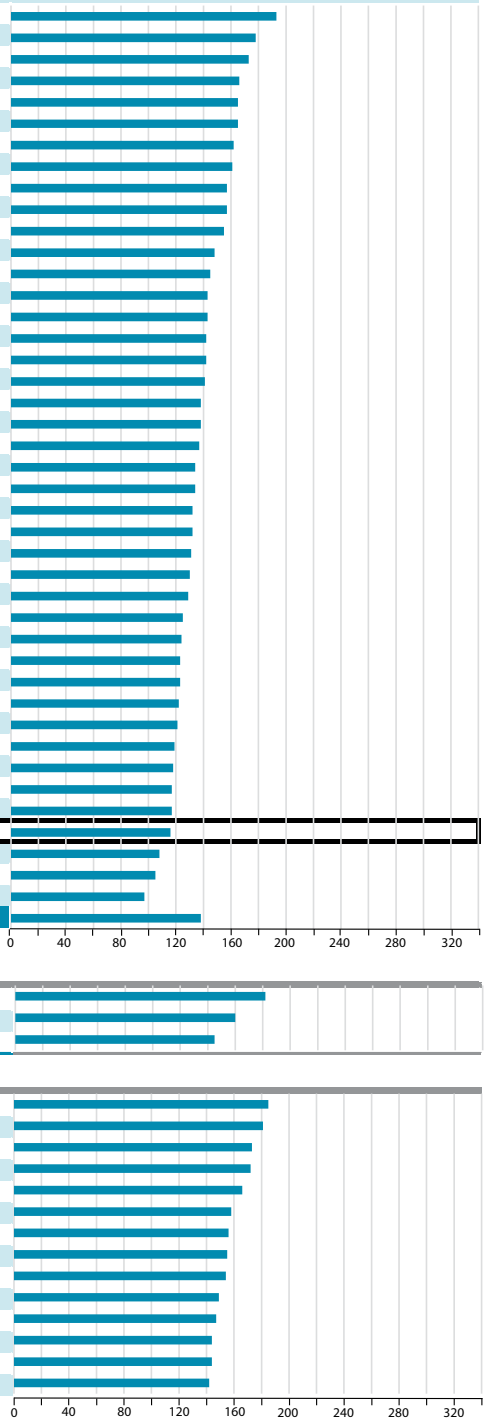
At Y9, England's average achievement score for science was 533, above the centre point of the achievement scale. Average science teaching time for Y9 pupils in England was 102 hours per year, 10 per cent of a total 992 hours (see Table 6.8). This was substantially lower than the international average (158 hours per year). In all of the high performing countries, teaching time for science was higher. For example, in Finland science teaching time was 190 out of 934 hours: around 20 per cent of the total yearly teaching time. However, high teaching time for science was also reported in countries whose average attainment was not significantly different from England's. For example, in the Russian Federation, Hungary and Slovenia, teaching time for Y9 science was even higher than in Finland.

Table 6.8: Teaching Time in Y9

Mathematics

Reported by Principals and Teachers

Country	Total Instructional Hours per Year	Hours per Year for Mathematics Instruction
Chile	r 1245 (23.5)	r 193 (4.5)
Lebanon	r 1028 (12.7)	r 178 (3.9)
Indonesia	r 1494 (40.9)	r 173 (7.9)
Chinese Taipei	1153 (11.7)	166 (2.4)
Israel	r 1108 (14.1)	r 165 (3.0)
Ghana	r 1153 (18.9)	r 165 (6.8)
Qatar	1054 (1.3)	162 (3.6)
Oman	r 1044 (17.7)	r 161 (5.1)
United Arab Emirates	r 1046 (8.0)	r 157 (2.9)
United States	1114 (6.6)	s 157 (3.2)
Italy	1085 (9.4)	155 (2.5)
Morocco	r 1303 (24.9)	r 148 (2.1)
Romania	984 (15.5)	145 (3.7)
Armenia	r 979 (12.8)	r 143 (3.0)
Australia	1039 (7.2)	s 143 (3.5)
Russian Federation	882 (8.7)	142 (2.0)
Bahrain	1019 (1.1)	r 142 (2.5)
New Zealand	959 (4.4)	141 (1.8)
Hong Kong SAR	r 1026 (11.3)	r 138 (2.9)
Singapore	1106 (0.0)	138 (1.7)
Korea, Rep. of	1006 (12.1)	137 (1.8)
Palestinian Nat'l Auth.	918 (7.3)	134 (4.0)
Saudi Arabia	r 1050 (20.9)	r 134 (5.4)
Ukraine	901 (10.7)	132 (3.5)
Lithuania	898 (13.9)	132 (2.7)
Tunisia	r 1299 (25.4)	r 131 (3.0)
Jordan	1041 (11.9)	130 (3.8)
Thailand	r 1270 (15.1)	129 (4.3)
Norway	880 (6.3)	125 (3.4)
Iran, Islamic Rep. of	994 (15.9)	124 (3.3)
Malaysia	r 1198 (13.7)	r 123 (3.4)
Georgia	r 833 (10.8)	r 123 (3.3)
Macedonia, Rep. of	r 1023 (21.4)	s 122 (4.6)
Slovenia	798 (0.0)	121 (1.5)
Hungary	836 (12.2)	119 (1.9)
Syrian Arab Republic	811 (14.2)	r 118 (4.7)
Turkey	889 (16.7)	117 (1.8)
Kazakhstan	920 (9.9)	117 (3.2)
England	r 992 (8.4)	r 116 (2.1)
Japan	1016 (6.7)	108 (1.4)
Finland	934 (11.7)	105 (1.8)
Sweden	r 969 (13.4)	s 97 (2.2)
International Avg.	1031 (2.3)	138 (0.5)
Ninth Grade Participants		
South Africa	r 1193 (11.3)	r 182 (6.7)
Honduras	r 1152 (27.1)	r 160 (5.7)
Botswana	r 1114 (20.1)	r 145 (3.9)
Benchmarking Participants		
North Carolina, US	1159 (16.0)	s 185 (9.7)
Ontario, Canada	r 971 (7.5)	r 181 (3.9)
Colorado, US	1148 (17.0)	r 173 (8.6)
California, US	r 1040 (15.2)	s 172 (8.0)
Alabama, US	r 1135 (16.0)	s 166 (8.9)
Abu Dhabi, UAE	r 1045 (16.6)	r 158 (5.8)
Alberta, Canada	1031 (10.0)	156 (4.2)
Dubai, UAE	r 1022 (1.5)	r 155 (3.6)
Massachusetts, US	1087 (13.6)	r 154 (5.4)
Indiana, US	r 1133 (14.9)	s 149 (6.9)
Quebec, Canada	913 (3.3)	147 (4.1)
Florida, US	r 1119 (17.0)	s 144 (7.4)
Connecticut, US	1071 (19.3)	r 144 (4.4)
Minnesota, US	1043 (14.8)	r 142 (7.5)



( )Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70 but less than 85% of the students. An "s" indicates data are available for at least 50 but less than 70% of the students.

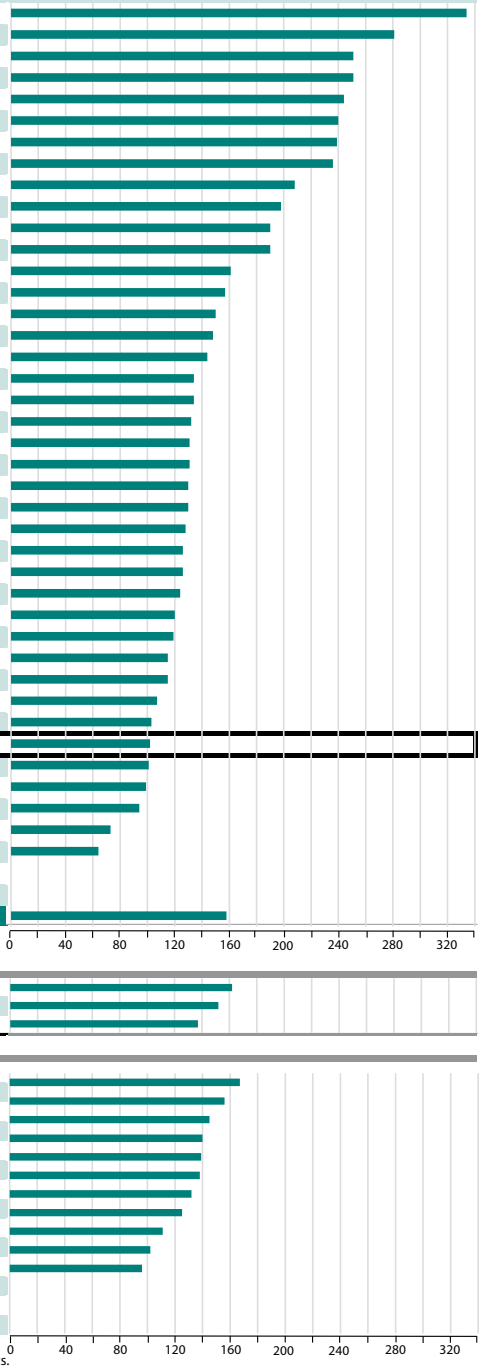
Source: Exhibit 8.7, international mathematics report

Table 6.8 Teaching time in Y9 (continued)

Science

Reported by Principals and Teachers

Country	Total Instructional	Hours per Year for Science Instruction*
Macedonia, Rep. of	r 1023 (21.4)	s 334 (14.7)
Romania	984 (15.5)	281 (10.1)
Lithuania	898 (13.9)	r 251 (5.2)
Slovenia	798 (0.0)	251 (4.6)
Kazakhstan	920 (9.9)	244 (4.8)
Armenia	r 979 (12.8)	s 240 (4.9)
Ukraine	901 (10.7)	239 (4.0)
Hungary	836 (12.2)	236 (4.8)
Russian Federation	882 (8.7)	208 (1.6)
Georgia	r 833 (10.8)	r 198 (6.8)
Finland	934 (11.7)	r 190 (6.0)
Indonesia	r 1494 (40.9)	r 190 (12.2)
Oman	r 1044 (17.7)	s 161 (3.8)
Chinese Taipei	1153 (11.7)	157 (2.7)
Syrian Arab Republic	811 (14.2)	r 150 (7.5)
Ghana	r 1153 (18.9)	r 148 (6.1)
Morocco	r 1303 (24.9)	r 144 (2.0)
Chile	r 1245 (23.5)	r 134 (3.8)
Jordan	1041 (11.9)	134 (3.1)
Israel	r 1108 (14.1)	r 132 (3.9)
Australia	1038 (7.2)	s 131 (4.5)
Qatar	1054 (1.3)	131 (6.9)
New Zealand	959 (4.4)	r 130 (2.6)
Bahrain	1019 (1.1)	r 130 (2.8)
Japan	1016 (6.7)	128 (1.7)
Korea, Rep. of	1006 (12.1)	126 (2.5)
Malaysia	r 1198 (13.7)	126 (3.6)
Saudi Arabia	r 1050 (20.9)	r 124 (6.8)
Iran, Islamic Rep. of	994 (15.9)	120 (3.6)
Thailand	r 1270 (15.1)	119 (2.9)
United Arab Emirates	r 1046 (8.0)	s 115 (2.7)
Singapore	1106 (0.0)	115 (2.1)
Palestinian Nat'l Auth.	918 (7.3)	107 (3.4)
Hong Kong SAR	r 1026 (11.3)	r 103 (4.6)
England	r 992 (8.4)	s 102 (3.1)
Norway	880 (6.3)	101 (3.3)
Turkey	889 (16.7)	99 (1.1)
Sweden	r 969 (13.5)	s 94 (3.1)
Italy	1085 (9.4)	73 (1.0)
Tunisia	r 1299 (25.4)	r 64 (1.9)
Lebanon	r 1028 (12.7)	x x
United States	1114 (6.6)	x x
International Avg.	1031 (2.3)	158 (0.8)
Ninth Grade Participants		
Honduras	r 1152 (27.1)	r 162 (6.9)
South Africa	r 1193 (11.3)	s 152 (5.6)
Botswana	r 1114 (20.2)	r 137 (5.2)
Benchmarking Participants		
Alabama, US	r 1135 (16.3)	s 167 (6.0)
Massachusetts, US	1087 (13.6)	s 156 (6.1)
Alberta, Canada	1031 (10.0)	r 145 (4.0)
Minnesota, US	1043 (14.8)	s 140 (8.3)
Connecticut, US	1071 (19.3)	s 139 (6.2)
Colorado, US	1148 (17.0)	s 138 (6.0)
Indiana, US	r 1132 (14.9)	s 132 (6.5)
Dubai, UAE	r 1022 (1.5)	s 125 (3.6)
Abu Dhabi, UAE	r 1045 (16.6)	s 111 (4.8)
Quebec, Canada	913 (3.3)	r 102 (3.0)
Ontario, Canada	r 972 (7.4)	r 96 (3.5)
California, US	r 1040 (15.1)	x x
Florida, US	r 1119 (17.0)	x x
North Carolina, US	1159 (16.0)	x x



* For countries teaching science as separate subjects, total hours across subjects.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
A dash (-) indicates comparable data not available.
An "r" indicates data are available for at least 70% but less than 85% of the students. An "s" indicates data are available for at least 50% but less than 70% of the students.
An "x" indicates data are available for less than 50% of the students.

Source: Exhibit 8.7, international science report

6.6 Teachers' emphasis on science investigations

Teachers' emphasis on science investigations in Y9 was measured in the same way as described for Y5, using the *Emphasize Science Investigation* scale (see section 6.2). For Y9, an additional question was added to the scale: *use scientific formulas and laws to solve routine problems* (see Table 6.9). England's average scale score was 9.4; within the *Less Than Half the Lessons* category overall.

As Table 6.9 shows, in England, 37 per cent of Y9 pupils were taught by teachers who emphasised science investigations in *About Half the Lessons or More*, lower than the international average (48 per cent). The percentages of pupils in England taught by teachers who emphasised science investigations in *About Half the Lessons or More* appeared to be similar in England at Y5 and Y9. In terms of the difference between age groups, the picture was mixed among countries performing significantly better than England. For example, in Korea, Japan, Chinese Taipei and Singapore, the percentage of pupils taught by teachers who emphasised science investigations in *About Half the Lessons or More* was lower at Y9 than at Y5. However, in Finland, and on average internationally this was higher at Y9 than at Y5.

As for Y5, no clear picture emerged in England relating frequency of emphasis on science investigations to average science achievement. Among pupils in England whose teachers emphasised science investigations in *About Half the Lessons or More*, average achievement appeared to be higher than among the pupils taught by teachers who emphasised science investigations in fewer than half the lessons. However, this difference is unlikely to be statistically significant.[77]

As in section 6.2, since a scale was not used in 2007, comparisons were made between the percentages of pupils whose teachers reported doing the six individual activities that were measured in both surveys. Percentages of pupils whose teachers included each individual activity on the *Emphasize Science Investigation scale in About Half the Lessons or More* were higher in TIMSS 2011 than in TIMSS 2007,[78] apart from *relate what they are learning in science to their everyday lives*, which was slightly lower in 2011 than in 2007.[79]

Table 6.9 Teachers' emphasis on science investigations in Y9

Reported by Teachers

Students were scored according to their teachers' responses to how often they used each of seven instructional activities on the *Emphasize Science Investigation* scale. Students with teachers who emphasized science investigation in **About Half the Lessons or More** had a score on the scale of at least 10.2, which corresponds to their teachers using all seven activities in "about half the lessons," on average. All other students had teachers who emphasized science investigation in **Less than Half the Lessons**.

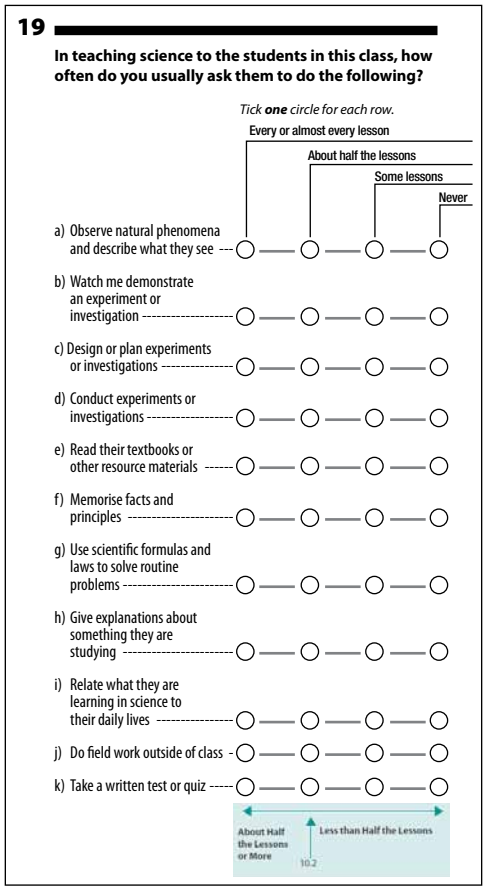
Country	About Half the Lessons or More		Less than Half the Lessons		Average Scale Score
	Per cent of Students	Average Achievement	Per cent of Students	Average Achievement	
England r	37 (2.9)	544 (9.1)	63 (2.9)	525 (6.4)	9.4 (0.12)
International Avg.	48 (0.5)	479 (0.9)	52 (0.5)	474 (0.9)	

Centre point of scale set at 10.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.

77 This difference has not been tested formally for statistical significance; this conclusion is drawn from the size of the standard errors relating to the average achievement scores of the two groups of pupils: see Table 6.9.

78 The 2007 data was presented as *Percentage of Students whose teachers reported students doing the activity about half of the lessons or more;* in order to compare the 2011 data to this, the percentages in the response categories *about half the lessons* and *every or almost every lesson* were combined to make percentages for each activity that were directly comparable. In 2007 teachers were also asked about an additional activity, *work together in small groups on experiments or investigations*, whereas this was not included in the 2011 *Emphasize Science Investigation* scale. Percentages were only compared for the six activities reported by teachers in both surveys.

79 Another activity was added to the scale in 2011 for Y9: *use scientific formulas and laws to solve routine problems*. This could not be compared with the 2007 data.



Items e, f, i and j did not contribute to this scale.

Source: Exhibit 8.28, international science report

6.7 Use of computers in Y9 lessons

Mathematics

As shown in Table 6.10, 51 per cent of Y9 pupils in England were taught by teachers who reported that, in their school, computers were available for mathematics lessons, fewer than for Y5. Three of the best performing countries had slightly higher computer availability: Japan, Singapore and Korea. However, this was not the case in all countries performing significantly better than England. For example, in Hong Kong and Chinese Taipei, computer availability for mathematics lessons was just under half that in England. Among the pupils whose teachers said that computers were available during lessons, teachers also reported how frequently pupils did particular computer-based activities. The most frequent activities reported, as was the case at Y5, were *to practice skills and procedures* (38 per cent of pupils had teachers who reported that they did this at least monthly) and *to explore mathematical principles and concepts* (34 per cent of pupils had teachers who reported that they did this at least monthly). The most common activities for which pupils used computers in their mathematics lessons varied across countries.

Science

Table 6.10 shows that 63 per cent of pupils in England were taught by teachers who reported that computers were available for science lessons, fewer than in Y5. Among the highest achieving participants at this age group, generally over half of pupils

were reported to have computers available in their science lessons. In contrast to mathematics lessons, among pupils using computers at least monthly in science lessons, their main use was *to look up ideas and information*, in England and in most countries, as was the case at Y5.

Table 6.10 Computer activities in Y9 lessons

Mathematics

Reported by Teachers

Country	Computers Available for Mathematics Lessons			Per cent of Students Whose Teachers Have Them Use Computers At Least Monthly			
	Per cent of Students	Average Achievement					
	Yes	Yes	No	To Explore Mathematics Principles and Concepts	To Look Up Ideas and Information	To Process and Analyze Data	To Practice Skills and Procedures
England	51 (4.3)	510 (8.5)	501 (7.5)	34 (4.4)	27 (3.9)	24 (4.0)	38 (4.1)
International Avg.	36 (0.5)	470 (1.4)	467 (0.8)	22 (0.5)	23 (0.5)	21 (0.5)	24 (0.5)

Science

Reported by Teachers

Country	Computers Available for Science Lessons			Per cent of Students Whose Teachers Have Them Use Computers At Least Monthly				
	Per cent of Students	Average Achievement						
	Yes	Yes	No	To Look Up Ideas and Information	To Do Scientific Procedures or Experiments	To Study Natural Phenomena Through Simulations	To Process and Analyze Data	To Practice Skills and Procedures
England	r 63 (3.3)	529 (7.6)	538 (5.7)	r 57 (3.1)	r 25 (2.5)	r 37 (2.9)	r 41 (3.2)	r 31 (3.5)
International Avg.	46 (0.5)	481 (1.0)	475 (0.8)	39 (0.5)	28 (0.5)	30 (0.5)	31 (0.5)	33 (0.5)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.

Source: Exhibit 8.30, International mathematics and science reports

6.8 The Year 9 curriculum

6.8.1 The intended curriculum

As noted for Y5, National Research Coordinators (NRCs), or their designated contacts, were asked to indicate whether each of the TIMSS 2011 mathematics and science topics (listed below Table 6.11 for mathematics, and below Table 6.12 for science) was included in their countries' intended curriculum for pupils aged 13–14, and, if so, whether the topics were intended to be taught to *all* or *almost all pupils or only the more able pupils* by the end of Y9.[80]

Mathematics

As Table 6.11 shows, in England 18 of 19 TIMSS mathematics topics were intended to be taught to all Y9 pupils. The only exception was *Simultaneous (two variables) equations* (within Algebra), which was intended to be taught only to more able pupils (see the box below Table 6.11 for a full list of mathematics topics). Most of the countries with significantly higher average achievement than England included a similar number of topics in their intended curricula, although this was slightly lower in Chinese Taipei, and higher in Japan, Korea and the Russian Federation, where all 19 topics were included. In Chinese Taipei and Singapore, several Geometry and Data and Chance topics were not included. Among participants whose average score was not significantly different from England's (for example Australia, Hungary and Italy), it was typically Algebra topics that were not intended to be taught.

Table 6.11 Number of TIMSS mathematics topics intended to be taught by the end of Y9

Reported by National Research Coordinators

Country	All Mathematics (19 Topics)			Number (5 Topics)			Algebra (5 Topics)		
	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8
England	18	1	0	5	0	0	4	1	0
International Avg.	16	1	2	5	0	0	4	0	1

Country	Geometry (6 Topics)			Data and Chance (3 Topics)		
	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8
England	6	0	0	3	0	0
International Avg.	5	0	1	2	0	0

Because of rounding some results may appear inconsistent

80 NRCs were asked: "According to the national mathematics/science curriculum, what proportion of grade 8 students should have been taught each of the following topics or skills by the end of grade 8?" For countries with no national curriculum, NRCs were advised to "summarize for your state or provincial curricula".

TIMSS 2011 Mathematics Topics

A. Number

1) Computing, estimate, or approximating with whole numbers
2) Concepts of fractions and computing with fractions
3) Concepts of decimals and computing with decimals
4) Representing, comparing, ordering, and computing with integers
5) Problem solving involving percents and proportions

B. Algebra

1) Numeric, algebraic, and geometric patterns or sequences
2) Simplifying and evaluating algebraic expressions
3) Simple linear equations and inequations
4) Simultaneous (two variables) equations
5) Representation of functions as ordered pairs, tables, graphs, words, or equations

C.Data Display

1) Geometric properties of angles and geometric shapes
2) Congruent figures and similar triangles
3) Relationship between three-dimentional shapes and their two-dimentional representations
4) Using appropriate measurement formulas for perimeters, circumferences, areas, surface, and volumes
5) Point on the Cartesian plane
6) Translation, reflection, and rotation

D.Data and Chance

1) Reading and displaying data using tables, pictographs, bar graphs, pie charts, and line graphs
2) Interpreting data sets
3) Judging, predicting, and determining the chance of possible outcomes

Source: Exhibit 8.11, international mathematics report

Science

Table 6.12 shows that, in England, 19 out of 20 TIMSS science topics were intended to be taught to all Y9 pupils (see the box below Table 6.12 for the full list of science topics). The one topic not included was *Reasons for increase in world's human population (e.g., advances in medicine, sanitation), and the effects of population growth on the environment* (within Biology). For most participants, much of the science content assessed by TIMSS was included in their intended curricula. Across all participants, there were very few topics that were taught only to more able pupils. Korea was an exception to this, with a quarter of the topics taught only to more able pupils. Among the countries whose average achievement was significantly higher than England's, topics not covered in the curriculum were often within the domain of Biology and at least one other domain, which varied.

Table 6.12 Number of TIMSS science topics intended to be taught by the end of Y9

Reported by National Research Coordinators

Country	All Science (20 Topics)			Biology (7 Topics)			Chemistry (4 Topics)		
	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8
England	19	0	1	6	0	1	4	0	0
International Avg.	17	1	3	6	0	1	3	0	1

Country	Physics (5 Topics)			Earth Science (4 Topics)		
	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8	Topics Taught to All or Almost All Students	Topics Taught to Only the More Able Students (Top Track)	Not Included in the Curriculum Through Grade 8
England	5	0	0	4	0	0
International Avg.	4	0	1	4	0	0

Because of rounding some results may appear inconsistent

TIMSS 2011 Science Topics

A. Biology

1) Major organs and organ systems in humans and other organisms (structure/function, life processes that maintain stable bodily conditions)
2) Cells anf their functions, including respiration and photosynthesis as cellular processes
3) Reproduction (sexual and asexual) and heredity (passing on of traits, inherited versus acquired/learned characteristics)
4) Role of variation and adaptation in survivial/extinction of species in a changing environment
5) Independance of populations of organisms in an ecosystem (e.g., energy flow, foodwebs, competition, predation) and the impact of changes in the physical environment on populations (e.g., climate, water supply)
6) Reasons for increase in world's human population (e.g., advances in medicin, sanitation), and the importance of diet and exercise in maintaining health

B. Chemistry

1) Classification, composition, and particulate structure of matter (elements, compounds, mixtures, molecules, atoms, protons, neutrons, electrons)
2) Solutions (solvent, solute, concentration/dilution, effect of temperature on solubility)
3) Properties and uses of common acids and bases
4) Chemical change (transformation of reactants, evidence of chemical change, conservation of matter, common oxidation reactions - combustion, rusting, tarnishing)

C.Physics

1) Physical states and changes in matter (explanation of properties in terms if movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)
2) Energy forms, tranformations, heat, and temperature
3) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)
4) Electrical circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets
5) Forces and motion (types od forces, basic description of motion, effects of density and pressure)

D. Earth Science

1) Earth's structure and physical features (Earth's crust, mantle and core; composition and relative distribution of water, and composition of air)
2) Earth's processes, cycles, and history (rock cycle; water cycle; weather patterns; major geological events; formation of fossils and fossil fuels)
3) Earth's resources, their uses and conservation (e.g., renewable/nonrenewable resources, human use of land/soil, water resources)
4) Earth in the solar system and the universe (phenomena on Earth - day/night, tides, phases of moon, eclipses, seasons; physical features of Earth compared to other bodies; the Sun as a star)

Source: Exhibit 8.11, international science report

6.8.2 Percentage of Y9 pupils taught the TIMSS topics

As for Y5, teachers were asked to indicate, for their class, whether each of the TIMSS topics was *mostly taught this year, not yet taught* or *just introduced*, for each subject. The percentages reported in Table 6.13 represent the proportion of pupils taught by teachers who reported that topics were mostly taught before or in the assessment year, averaged across topics, overall and by content domain.

Mathematics

In England, according to teachers' reports, 84 per cent of pupils were taught the TIMSS mathematics topics either before or during the year of the assessment (see Table 6.13). This is lower than the equivalent percentage at Y5 (91 per cent). England's percentage was lower than some of the countries performing significantly better than England at this age group, including Japan, Korea and Singapore. Across all countries, the most commonly taught content domain was Number, and in most of the highest performing countries, 99 or 100 per cent of pupils were taught these topics.

There were marked differences in the topics taught in Y9 mathematics between England and some of the higher performing countries. This was particularly the case in Chinese Taipei where, for example, 97 per cent of pupils were taught the TIMSS Algebra topics, compared with 77 per cent in England. Conversely, whereas 86 per cent of pupils in England were taught the Data and Chance topics, the comparable figure was 4 per cent in Chinese Taipei.

Science

In England, according to teachers' reports, 87 per cent of pupils were taught the TIMSS science topics (see Table 6.13). This is higher than the equivalent percentage at Y5 (71 per cent). The most commonly taught domain was Chemistry. England's percentage was higher than in all the countries that performed significantly better, as well as in Slovenia and Hong Kong (which performed at a similar level). Among the participants that performed significantly better than England there was variation in the most commonly taught science domain. For example, in Singapore and Korea, Physics was most commonly taught, whereas in Finland, Japan and Chinese Taipei it was Chemistry and in Alberta, Minnesota and Massachusetts, it was Earth Science.

Table 6.13 Percentage of Y9 pupils taught the TIMSS topics*

Mathematics

Reported by Teachers

Country	All Mathematics (19 Topics)	Number (5 Topics)	Algebra (5 Topics)	Geometry (6 Topics)	Data and Chance (3 Topics)
England	84 (1.3)	97 (0.7)	77 (1.8)	78 (2.0)	86 (2.1)
International Avg.	80 (0.1)	98 (0.1)	75 (0.2)	75 (0.2)	66 (0.3)

* Percentage mostly taught before or in the assessment year averaged across topics.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Science

Reported by Teachers

Country	All Science Topics (20 Topics)	Biology (7 Topics)	Chemistry (4 Topics)	Physics (5 Topics)	Earth Science (4 Topics)
England	r 87 (1.3)	r 86 (1.5)	r 91 (1.7)	r 89 (1.9)	r 83 (2.0)
International Avg.	72 (0.2)	68 (0.2)	81 (0.3)	75 (0.2)	68 (0.3)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.

Source: Exhibit 8.9, international mathematics and science reports