Chapter 5 Attainment by content and cognitive domains

Chapter outline

This chapter summarises pupils' attainment across the content and cognitive domains for each subject and by gender. TIMSS assesses content domains in mathematics and science, and the cognitive domains of Knowing, Applying and Reasoning in both subjects. More information about each domain is given in sections 5.1 to 5.4.

This chapter focuses on performance in England in mathematics and science in Year 5 (Y5, ages 9–10) and Year 9 (Y9, ages 13–14) in 2011 and over time. Further information about international performance on these domains is available in the international reports. Findings for mathematics are presented first, followed by findings for science.

Key findings

- In England, there were significant[49] differences in achievement across the content and cognitive domains for both subjects at both age ranges (see below). There were some significant differences over time.
- There were no gender differences in performance on either the content or cognitive domains at either age.
- International performance on the content and cognitive domains varied greatly, including among the high performers for each subject at each age range.

Mathematics Y5:

- Y5 pupils performed above England's average mathematics score in Data Display but below it for Number.
- They also performed above their average mathematics score in Knowing, but below it in Reasoning.
- There were no significant differences for Y5 mathematics between TIMSS 2007 and 2011.

Mathematics Y9:

- Y9 pupils scored above England's average mathematics score in both Number and Data and Chance, but lower in Algebra and Geometry.
- They performed below their average in Knowing.
- Performance in Y9 Geometry declined significantly between 2007 and 2011.

49 Findings listed as 'significant' throughout this report are statistically significant.

Science Y5:

- Y5 pupils did better than England's average on Physical Science but lower on Earth Science.
- They performed above their average in Applying science.
- Performance in Physical Science and Earth Science declined significantly between 2007 and 2011.
- Knowing and Reasoning in science also declined between 2007 and 2011.

Science Y9:

- Y9 pupils performed below England's average at Chemistry.
- They performed above their average at Reasoning in science.
- Their performance in Physics declined between 2007 and 2011.

5.1 Mathematics domains, Y5

What TIMSS assesses at ages 9–10

The content domains assessed for Y5 mathematics are:

- Number - Whole number; Fractions and decimals; Number sentences with whole numbers; Patterns and relationships
- Geometric Shapes and Measures - Points, lines and angles; Two- and three-dimensional shapes
- Data Display - Reading and interpreting; Organizing and representing.

The cognitive domains are:

- Knowing – Recall; Recognize; Compute; Retrieve; Measure; Classify/Order
- Reasoning – Select; Represent; Model; Implement; Solve Routine Problems
- Applying – Analyze; Generalize/Specialize; Integrate/Synthesize; Justify; Solve Non-routine Problems

More information is available in the TIMSS Assessment framework (Mullis *et al*, 2009).

5.1.1 Mathematics content domains, Y5

Table 5.1 shows that England's Y5 pupils scored significantly higher on Data Display (a scale score of 549) compared with their overall mean score of 542. They scored significantly lower on Number. Their mean score for Geometric Shapes and Measures was similar to their overall score for mathematics.

Internationally just over half of the 57 TIMSS participants[50] at this age range performed more highly on Number at Y5, including most of the countries which performed better than England: the exceptions were Korea and Japan which performed at their own average in Number. England was one of just 11 participants scoring less well on Number. International performance on the Geometric Shapes and Measures and Data Display domains was more mixed.[51]

Table 5.1 Y5 attainment in the mathematics content domains

Country	Overall Mathematics Average Scale Score	Number		Geometric Shapes and Measures		Data Display	
		Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score
England	542 (3.5)	539 (3.7)	-3 (1.1) ▼	545 (3.9)	3 (1.6)	549 (4.6)	7 (2.9) ▲

▲ Subscale score significantly higher than overall mathematics score

▼ Subscale score significantly lower than overall mathematics score

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

Source: Exhibit 3.1, international mathematics report

In TIMSS 2007, the only significant difference in attainment across the Y5 mathematics domains was for Number, for which the score was significantly lower than England's mean score in that survey. Scores for Data Display and Geometric Shapes and Measures were not significantly different from England's mean score in 2007.

Table 5.2 shows the mean scores for each content domain for England in TIMSS 2011 compared with TIMSS 2007. It records no significant changes in relative performance on the Y5 mathematics content domains. Despite the small change in the relative score for Data Display, the non-significant difference from the mean in 2007 has become significant in 2011.

Table 5.2 Y5 trends in the mathematics content domains, 2007 to 2011

Country	Number			Geometric Shapes and Measures		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	539 (3.7)	535 (3.1)	4 (4.8)	545 (3.9)	552 (3.3)	-6 (5.1)

Country	Data Display		
	2011 Average Scale Score	2007 Average Scale Score	Difference
England	549 (4.6)	551 (3.1)	-1 (5.6)

▲ 2011 average significantly higher

▼ 2011 average significantly lower

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

Source: Exhibit 3.5, international mathematics report

50 50 countries and 7 benchmarking participants at this age range.

51 See Exhibit 3.1, international mathematics report.

5.1.2 Mathematics cognitive domains, Y5

In TIMSS 2007, there were no significant differences in pupils' Y5 mathematics scores across the three cognitive domains of Knowing, Applying and Reasoning. However, there were some differences in TIMSS 2011. Tables 5.3 and 5.4 summarise the findings for the cognitive domains.

England's score on the Y5 Applying items was not significantly different from its overall Y5 mathematics score in 2011 (see Table 5.3). However, in TIMSS 2011, pupils did significantly better on the Knowing items and significantly less well on the Reasoning items.

Table 5.3 Y5 attainment in the mathematics cognitive domains

Country	Overall Mathematics Average Scale Score	Knowing		Applying		Reasoning	
		Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score
England	542 (3.5)	552 (4.3)	10 (2.7) ▲	542 (3.7)	0 (1.5)	531 (3.7)	-11 (2.2) ▼

▲ Subscale score significantly higher than overall mathematics score

▼ Subscale score significantly lower than overall mathematics score

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

Source: Exhibit 3.3, international mathematics report

Almost half of the 2011 participants had higher scores for Knowing (relative to their own mean scores for mathematics), including all of the participants doing better than England in mathematics at Y5. Relative performance on Applying and Reasoning was more variable across countries.[52]

The cognitive domains in 2011 did not show any significant changes in score when compared with TIMSS 2007 (see Table 5.4). However, there were some small changes in the scores on each of the cognitive domains in TIMSS 2011 and these have resulted in significant differences between England's overall Y5 mathematics score and its scores on the cognitive domains in TIMSS 2011.

Table 5.4 Y5 trends in the mathematics cognitive domains, 2007 to 2011

Country	Knowing			Applying		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	552 (4.3)	546 (3.7)	6 (5.6)	542 (3.7)	542 (3.3)	0 (5.0)

Country	Reasoning		
	2011 Average Scale Score	2007 Average Scale Score	Difference
England	531 (3.7)	539 (3.4)	-8 (5.0)

▲ 2011 average significantly higher

▼ 2011 average significantly lower

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

Source: Exhibit 3.7, international mathematics report

52 See Exhibit 3.3, international mathematics report.

5.1.3 Mathematics content and cognitive domains by gender, Y5

England had no significant gender differences in the TIMSS 2011 Y5 mathematics content domains (see Table 5.5) or cognitive domains (Table 5.6).

The international average pattern was for boys to do significantly better than girls in Number, and for girls to do significantly better than boys in Geometric Shapes and Measures and in Data Display. For the cognitive domains, there was more variability across countries, with an average gender difference only for Reasoning, on which boys internationally did significantly better at ages 9–10.

Table 5.5 Gender differences in the Y5 mathematics content domains

Country	Number		Geometric Shapes and Measures		Data Display	
	Girls	Boys	Girls	Boys	Girls	Boys
England	536 (4.3)	542 (3.8)	544 (4.6)	547 (4.1)	551 (6.3)	547 (4.9)
International Avg.	493 (0.5)	496 (0.6) ▲	485 (0.6) ▲	483 (0.7)	486 (0.7) ▲	482 (0.7)

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

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

Source: Exhibit 3.9, international mathematics report

Table 5.6 Gender differences in the Y5 mathematic cognitive domains

Country	Knowing		Applying		Reasoning	
	Girls	Boys	Girls	Boys	Girls	Boys
England	550 (4.6)	554 (5.0)	540 (4.1)	544 (4.2)	529 (5.0)	533 (3.8)
International Avg.	492 (0.6)	492 (0.6)	488 (0.6)	489 (0.6)	487 (0.6)	489 (0.6) ▲

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

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

Source: Exhibit 3.11, international mathematics report

5.2 Mathematics domains, Y9

What TIMSS assesses at ages 13–14

The content domains assessed for Y9 mathematics are:

- Number – Whole numbers; Fractions and decimals; Integers; Ratio, proportion and percent
- Algebra – Patterns; Algebraic expressions; Equations/formulas and functions
- Geometry - Geometric shapes; Geometric measurement; Location and movement
- Data and Chance - Data organization and representation; Data interpretation; Chance.
- The cognitive domains are as for Y5 mathematics (see section 5.1).

More information is available in the TIMSS Assessment Framework (Mullis *et al*, 2009).

5.2.1 Mathematics content domains, Y9

Table 5.7 shows that England's Y9 pupils scored significantly higher than their own mean score (507) in two content domains: Number (512) and Data and Chance (543). They scored significantly lower on the remaining two domains: Algebra (489) and Geometry (498).

Table 5.7 Y9 attainment in the mathematics content domains

Country	Overall Mathematics Average Scale Score	Number		Algebra	
		Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score
‡ England	507 (5.5)	512 (5.8)	5 (1.4) ▲	489 (5.7)	-17 (1.5) ▼

Country	Geometry		Data and Chance	
	Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score
‡ England	498 (5.7)	-9 (2.7) ▼	543 (6.8)	36 (2.8) ▲

▲ Subscale score significantly higher than overall mathematics score

▼ Subscale score significantly lower than overall mathematics score

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

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

Source: Exhibit 3.2, international mathematics report

International profiles against the Y9 mathematics content domains were variable. None of the countries or benchmarking participants[53] that did better than England in Y9 mathematics had a flat profile: all scored better on some domains than others.[54]

As was the case for Y5 mathematics, England's Y9 profile in 2011 differed from that of TIMSS 2007, when the only significant difference across domains was for Data and Chance (significantly higher than England's mean score in 2007).[55] The trends in Y9 mathematics performance are summarised in Table 5.8.

The change in the profile of attainment in Y9 mathematics coincided with two policy changes: the demise of the National Strategies in 2011; and a change to the key stage 3 (KS3) mathematics curriculum. The intended content of the newer version of the KS3 curriculum is similar to that of the previous version but is summarised, whereas the previous version gave a more detailed outline of the content to be taught.

53 42 countries and 14 benchmarking participants participated at this age range.

54 See Exhibit 3.2, international mathematics report.

55 Although England's Algebra score has not changed significantly between 2007 and 2011, the 2011 Algebra score is significantly different from England's 2011 mean score.

Table 5.8 Y9 trends in the mathematics content domains, 2007 to 2011

Country	Number			Algebra		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	512 (5.8)	511 (5.4)	1 (7.9)	489 (5.7)	496 (5.1)	-7 (7.6)

Country	Geometry			Data and Chance		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	498 (5.7)	513 (5.0)	-15 (7.6) ▼	543 (6.8)	552 (6.0)	-9 (9.1)

▲ 2011 average significantly higher

▼ 2011 average significantly lower

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

Source: Exhibit 3.6, international mathematics report

5.2.2 Mathematics cognitive domains, Y9

In TIMSS 2007, there were no significant differences in pupils' Y9 mathematics scores on the three cognitive domains of Knowing, Applying and Reasoning. However, one difference arose in TIMSS 2011: the score for Knowing was lower than the other domains, relative to England's mean score. Although England's score on the Y9 Knowing items in 2011 was not significantly different from its Knowing score in 2007, the change in the scores on these items was sufficient to create a significant difference between England's overall Y9 mathematics score and its scores on the 2011 Knowing items. Tables 5.9 and 5.10 summarise the findings for the cognitive domains.

As was the case for Y5 mathematics, international profiles against the Y9 mathematics cognitive domains were variable. None of the countries or benchmarking participants which did better than England in Y9 mathematics had a flat profile on the cognitive domains. All scored higher on some domains than others, and the domains in each case varied.[56]

Table 5.9 Y9 attainment in the mathematics cognitive domains

Country	Overall Mathematics Average Scale Score	Knowing		Applying		Reasoning	
		Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score	Average Scale Score	Difference from Overall Mathematics Score
‡ England	507 (5.5)	501 (5.4)	-5 (1.1) ▼	508 (5.5)	2 (1.2)	510 (5.5)	3 (2.0)

▲ Subscale score significantly higher than overall mathematics score

▼ Subscale score significantly lower than overall mathematics score

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡

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

Source: Exhibit 3.4, international mathematics report

56 See Exhibit 3.4, international mathematics report.

Table 5.10 Y9 trends in the mathematics cognitive domains, 2007 to 2011

Country	Knowing			Applying		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	501 (5.4)	508 (4.6)	-6 (7.1)	508 (5.5)	514 (5.1)	-5 (7.4)

Country	Reasoning		
	2011 Average Scale Score	2007 Average Scale Score	Difference
England	510 (5.5)	518 (4.9)	-8 (7.4)

▲ 2011 average significantly higher

▼ 2011 average significantly lower

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

Source: Exhibit 3.8, international mathematics report

5.2.3 Mathematics content and cognitive domains by gender, Y9

As was the case for Y5 mathematics, England had no significant gender differences in the TIMSS 2011 Y9 mathematics content domains (see Table 5.11) or cognitive domains (Table 5.12).

The international average pattern at Y9 was for boys to do significantly better than girls in Number, and for girls to do significantly better than boys in Algebra, Geometry and Data and Chance. For the cognitive domains, the international averages show that girls tended to do significantly better than boys at Knowing and Reasoning. This is different from Y5 internationally, where girls and boys scored the same on average for Knowing, but boys were better at Reasoning.

Table 5.11 Gender differences in the Y9 mathematics content domains

Country	Number		Algebra		Geometry		Data and Chance	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
‡ England	510 (6.0)	515 (6.9)	495 (5.8)	485 (6.6)	501 (5.8)	495 (6.7)	542 (7.2)	544 (8.8)
International Avg.	464 (0.7)	468 (0.7) ▲	476 (0.7) ▲	464 (0.7)	464 (0.7) ▲	461 (0.8)	459 (0.7) ▲	456 (0.8)

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

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

Source: Exhibit 3.10, international mathematics report

Table 5.12 Gender differences in the Y9 mathematic cognitive domains

Country	Knowing		Applying		Reasoning	
	Girls	Boys	Girls	Boys	Girls	Boys
‡ England	503 (5.4)	500 (6.5)	508 (5.6)	509 (6.5)	513 (5.8)	507 (6.5)
International Avg.	471 (0.7) ▲	464 (0.7)	465 (0.6)	465 (0.7)	466 (0.7) ▲	463 (0.8)

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

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

Source: Exhibit 3.12, international mathematics report

5.3 Science domains, Y5

What TIMSS assesses at ages 9–10

The content domains assessed in Y5 science are:

- Life Science – Characteristics and life processes of living things; Life cycles, reproduction and heredity; Interaction with the environment; Ecosystems; Human health
- Physical Science – Classification and properties of matter; Sources and effects of energy; Forces and motion
- Earth Science - Earth's structure, physical characteristics and resources; Earth's processes, cycles and history; Earth in the solar system.

In England, elements of TIMSS Earth Science are taught through other subjects, such as geography.

The cognitive domains are:

- Knowing – Recall/Recognize; Define; Describe; Illustrate with Examples; Demonstrate Knowledge of Scientific Instruments
- Reasoning – Compare/Contrast/Classify; Use Models; Relate; Interpret Information; Find Solutions; Explain
- Applying – Analyze; Integrate/Synthesize; Hypothesize/Predict; Draw Conclusions; Generalize; Evaluate; Justify.

More information is available in the TIMSS Assessment Framework (Mullis *et al*, 2009).

5.3.1 Science content domains, Y5

Table 5.13 shows that England's Y5 pupils scored significantly higher on Physical Science (535) and significantly lower on Earth Science (522), compared with their overall mean score for Y5 science of 529.

Internationally, England was one of just 11 participants scoring more highly on Physical Science. In contrast, like England, almost half of the TIMSS participants at this age range (26 of 57) had lower relative scores on Earth Science[57]. All but two of the participants which did better than England at Y5 science had relative strengths and weaknesses across the domains; only Finland and Alberta had a flat profile of achievement across all three domains.

In TIMSS 2007, there were no significant differences in England's attainment across the Y5 science content domains. However, in 2011, Y5 pupils scored less well than in 2007 on both Physical Science and Earth Science (see Table 5.14).

57 See Exhibit 3.1, international science report.

Table 5.13 Y5 attainment in the science content domains

Country	Overall Science Average Scale Score	Life Science		Physical Science		Earth Science	
		Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score
England	529 (2.9)	530 (2.8)	1 (1.5)	535 (3.5)	7 (2.2) ▲	522 (3.8)	-7 (2.2) ▼

▲ Subscale score significantly higher than overall science score
▼ Subscale score significantly lower than overall science score
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Source: Exhibit 3.1, international science report

Table 5.14 Y5 trends in the science content domains, 2007 to 2011

Country	Life Science			Physical Science		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	530 (2.8)	536 (3.1)	-6 (4.2)	535 (3.5)	546 (3.3)	-10 (4.8) ▼

Country	Earth Science		
	2011 Average Scale Score	2007 Average Scale Score	Difference
England	522 (3.8)	542 (3.4)	-19 (5.1) ▼

▲ 2011 average significantly higher
▼ 2011 average significantly lower
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Source: Exhibit 3.5, international science report

5.3.2 Science cognitive domains, Y5

In TIMSS 2007, there were no significant differences in pupils' Y5 science scores on the three cognitive domains of Knowing, Applying and Reasoning. However, one significant difference arose in TIMSS 2011: in Y5 science, England's pupils performed better at Applying relative to their overall average score. They performed at their own average level at Knowing and Reasoning. Y5 scores on Knowing and Reasoning in science have declined significantly since TIMSS 2007. Tables 5.15 and 5.16 summarise the findings for the cognitive domains.

There was a mixed picture internationally in terms of profiles across the cognitive domains. Of the highest achievers in science at Y5, only Alberta had a flat profile across all three cognitive domains.[58]

58 See Exhibit 3.3, international science report.

Table 5.15 Y5 attainment in the science cognitive domains

Country	Overall Science Average Scale Score	Knowing		Applying		Reasoning	
		Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score
England	529 (2.9)	529 (3.2)	0 (1.9)	532 (3.1)	4 (1.4) ▲	526 (4.4)	-2 (3.6)

▲ Subscale score significantly higher than overall science score
▼ Subscale score significantly lower than overall science score
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Source: Exhibit 3.3, international science report

Table 5.16 Y5 trends in the science cognitive domains, 2007 to 2011

Country	Knowing			Applying		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	529 (3.2)	547 (3.4)	-19 (4.7) ▼	532 (3.1)	537 (3.2)	-4 (4.5)

Country	Reasoning		
	2011 Average Scale Score	2007 Average Scale Score	Difference
England	526 (4.4)	540 (2.8)	-14 (5.2) ▼

▲ 2011 average significantly higher
▼ 2011 average significantly lower
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Source: Exhibit 3.7, international science report

5.3.3 Science content and cognitive domains by gender, Y5

As was the case for Y5 mathematics, England had no significant gender differences in the TIMSS 2011 Y5 science content domains (see Table 5.17) or cognitive domains (Table 5.18).

The international average pattern was for girls to do significantly better than boys in Life Science, while the converse was true for Physical Science and Earth Science: boys on average did better at these. All of the countries and benchmarking participants which did better than England in science at Y5 had at least one gender difference across the Y5 science content domains.[59]

For the cognitive domains, there was a more scattered picture. The international averages show that there were no significant gender differences overall for Knowing or Applying, but that Reasoning items were generally answered better by girls overall. Among the highest performers in science at this age range, all but one had at least one gender difference across the cognitive domains. The exception was Finland, with a flat gender profile across all three cognitive domains.[60]

59 See Exhibit 3.9, international science report.
60 See Exhibit 3.11, international science report.

Table 5.17 Gender differences in the Y5 science content domains

Country	Life Science		Physical Science		Earth Science	
	Girls	Boys	Girls	Boys	Girls	Boys
England	534 (3.6)	527 (4.1)	532 (3.5)	538 (4.9)	520 (4.5)	524 (3.9)
International Avg.	489 (0.6) ▲	481 (0.6)	484 (0.6)	485 (0.7) ▲	479 (0.7)	483 (0.7) ▲

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

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

Source: Exhibit 3.9, international science report

Table 5.18 Gender differences in the Y5 science cognitive domains

Country	Knowing		Applying		Reasoning	
	Girls	Boys	Girls	Boys	Girls	Boys
England	527 (3.9)	530 (4.0)	533 (3.7)	532 (3.9)	533 (6.3)	521 (4.4)
International Avg.	486 (0.6)	485 (0.7)	485 (0.6)	484 (0.6)	485 (0.7) ▲	478 (0.7)

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

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

Source: Exhibit 3.11, international science report

5.4 Science domains, Y9

What TIMSS assesses at ages 13–14

The content domains assessed in Y9 science are:

- Biology - Characteristics, classification and life processes of organisms; Cells and their functions; Life cycles, reproduction and heredity; Diversity, adaptation and natural selection; Ecosystems; Human health
- Chemistry - Classification and composition of matter; Properties of matter; Chemical change
- Physics - Physical states and changes in matter; Energy transformations, heat and temperature; Light and sound; Electricity and magnetism; Forces and motion
- Earth Science - Earth's structure and physical features; Earth's processes, cycles and history; Earth's resources, their use and conservation; Earth in the solar system and the universe.

In England, elements of TIMSS Earth Science are taught through other subjects, such as geography.

The cognitive domains are as for Y5 science (see section 5.3).

More information is available in the TIMSS Assessment Framework (Mullis *et al*, 2009).

5.4.1 Science content domains, Y9

Table 5.19 shows that England's Y9 pupils scored significantly lower than their own mean score (533) on one science content domain: Chemistry (529). They scored at their average level on the remaining three domains: Biology (533), Physics (533) and Earth Science (536). This is a different profile from Y5 science, where pupils scored more highly on Physical Science (which includes elements of chemistry at Y5) and less well on Earth Science.

International profiles against the Y9 science content domains were variable. None of the countries or benchmarking participants which did better than England in Y9 science had a flat profile: all did better, or less well, in some domains than others.[61]

England's Y9 pupils performed less well in Physics in TIMSS 2011, relative to their 2007 performance (see Table 5.20). No other domains showed significant differences from 2007.[62]

Table 5.19 Y9 attainment in the science content domains

Country	Overall Science Average Scale Score	Biology		Chemistry	
		Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score
‡ England	533 (4.9)	533 (4.9)	0 (1.1)	529 (5.2)	-4 (1.6) ▼

Country	Physics		Earth Science	
	Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score
‡ England	533 (4.6)	0 (2.0)	536 (5.3)	3 (2.8)

▲ Subscale score significantly higher than overall science score

▼ Subscale score significantly lower than overall science score

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

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

Source: Exhibit 3.2, international science report

61 See Exhibit 3.2, international science report.

62 Although England's Chemistry score has not changed significantly between 2007 and 2011, the 2011 Chemistry score is significantly different from England's 2011 mean score.

Table 5.20 Y9 trends in the science content domains, 2007 to 2011

Country	Biology			Chemistry		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	533 (4.9)	544 (4.8)	-11 (6.9)	529 (5.2)	539 (4.6)	-11 (6.9)

Country	Physics			Earth Science		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	533 (4.6)	549 (4.4)	-15 (6.4) ▼	536 (5.3)	531 (5.0)	5 (7.3)

▲ 2011 average significantly higher

▼ 2011 average significantly lower

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

Source: Exhibit 3.6, international science report.

5.4.2 Science cognitive domains, Y9

In TIMSS 2007, there were no significant differences in pupils' Y9 science scores on the three cognitive domains of Knowing, Applying and Reasoning. However, one difference arose in TIMSS 2011: Reasoning showed a higher score than the other domains, relative to England's mean score. This is a different profile than seen for Y9 mathematics (where Knowing was lower) and for Y5 science (where Applying was higher).

Although England's Y9 score on the science Reasoning items in 2011 was not significantly different from its Reasoning score in 2007, its difference from the overall score in 2011 was statistically significant. Tables 5.21 and 5.22 summarise the findings for the cognitive domains.

As was the case for Y5 science, there was a mixed picture internationally in terms of profiles across the cognitive domains. Of the highest achievers in science at Y9, only Minnesota and Singapore had a flat profile across all three cognitive domains: all other high performers did better in some domains than others, and the domains in each case varied.[63]

Table 5.21 Y9 attainment in the science cognitive domains

Country	Overall Science Average Scale Score	Knowing		Applying		Reasoning	
		Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score	Average Scale Score	Difference from Overall Science Score
‡ England	533 (4.9)	533 (5.1)	0 (1.6)	531 (4.7)	-2 (1.3)	537 (4.8)	4 (1.5) ▲

▲ Subscale score significantly higher than overall science score

▼ Subscale score significantly lower than overall science score

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

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

Source: Exhibit 3.4, international science report

63 See Exhibit 3.4, international science report.

Table 5.22 Y9 trends in the science cognitive domains, 2007 to 2011

Country	Knowing			Applying		
	2011 Average Scale Score	2007 Average Scale Score	Difference	2011 Average Scale Score	2007 Average Scale Score	Difference
England	533 (5.1)	536 (5.4)	-3 (7.4)	531 (4.7)	540 (4.3)	-8 (6.4)

Country	Reasoning		
	2011 Average Scale Score	2007 Average Scale Score	Difference
England	537 (4.8)	548 (4.5)	-12 (6.5)

▲ 2011 average significantly higher

▼ 2011 average significantly lower

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

Source: Exhibit 3.8, international science report

5.4.3 Science content and cognitive domains by gender, Y9

As was the case for Y5 science, England had no significant gender differences in the TIMSS 2011 Y9 science content domains (see Table 5.23) or cognitive domains (Table 5.24).

The international average pattern at Y9 was different from that at Y5. At Y9, girls on average performed better at Biology and Chemistry (at Y5, they did better only at Life Science; chemistry is subsumed under the Physical Science domain at Y5). Internationally, boys did better at Earth Science (as was the case at Y5) while there was no gender difference for Physics (boys did better at Physical Science at Y5).

All but one of the countries and benchmarking participants which did better than England in science at Y9 had at least one gender difference across these content domains; Singapore was the exception with no gender differences on the Y9 science content domains.[64]

For the cognitive domains internationally, there was an average trend towards girls doing better than boys on all three cognitive domains. Among the highest performers in science at this age range, all but one had at least one gender difference across the cognitive domains. The exception was Singapore, with a flat profile across all three cognitive domains, corresponding to its flat profile across the content domains.[65]

Table 5.23 Gender differences in the Y9 science content domains

Country	Biology		Chemistry		Physics		Earth Science	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
‡ England	538 (5.4)	529 (6.2)	530 (5.9)	527 (6.2)	531 (5.5)	535 (5.6)	531 (5.6)	541 (6.7)
International Avg.	481 (0.7) ▲	469 (0.8)	482 (0.7) ▲	472 (0.8)	473 (0.7)	474 (0.8)	473 (0.7)	475 (0.8) ▲

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

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

Source: Exhibit 3.10, international science report

64 See Exhibit 3.10, international science report.

65 See Exhibit 3.12, international science report.

Table 5.24 Gender differences in the Y9 science cognitive domains

Country	Knowing		Applying		Reasoning	
	Girls	Boys	Girls	Boys	Girls	Boys
‡ England	532 (5.3)	535 (6.4)	531 (4.8)	532 (5.9)	540 (5.2)	534 (5.9)
International Avg.	479 (0.7) ▲	476 (0.8)	478 (0.6) ▲	473 (0.7)	478 (0.7) ▲	470 (0.8)

▲ Average significantly higher than other gender

▼ Average significantly lower than other gender

See Appendix C.9 in the international report for sampling guidelines and sampling participation notes † and ‡.

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

Source: Exhibit 3.12, international science report