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TIMSS 2011: Mathematics and science achievement in England

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The Trends in International Mathematics and Science Study (TIMSS) 2011 is an international comparison study of pupil performance and attitudes at ages 9-10 and 13-14 in mathematics and science. Sixty-two countries took part in TIMSS 2011. The National Foundation for Educational Research conducted the study in England on behalf of the Department for Education.

Main findings

England's average attainment in mathematics and science at age 13-14, and in mathematics at age 9-10, has not significantly changed since 2007. England's science performance at age 9-10 dropped from a mean score of 542 to 529 between 2007 and 2011, with a fall in rankings from 7th out of 36 countries to 15th out of 50. This represents both a relative and an absolute fall in performance. Compared with Year 5 mathematics teachers or Year 9 teachers in either subject, fewer Year 5 pupils have science teachers who report being well prepared to teach their subject.

Singapore, Korea and Chinese Taipei continue to lead the field. An addition to these top performers is a new entrant, Northern Ireland, which is the top-performing Western country in mathematics at age 9-10. Finland, making its first appearance in TIMSS since 1999, performs on a par with England in mathematics (Finland and England are ranked 8th and 9th respectively at age 9-10 and 8th and 10th at age 13-14). Finland is among the top performers in science at age 9-10 (3rd) and 14 (5th). Sweden continues its downward trend in mathematics at age 13-14, although it has seen some improvement in science at age 9-10.

Aims and coverage of TIMSS 2011

TIMSS assesses 9-10- and 13-14-year-old pupils' attainment in mathematics and science internationally. The 2011 study is the fifth in the series. TIMSS benchmarks a country's performance against other countries, measures trends over time, identifies factors that impact on pupil attainment, and enables countries to learn from others. Sixty-two countries and 14 jurisdictions (benchmarking participants) took part in TIMSS 2011. Pupils in England completed assessments in May-June 2011. The TIMSS 2011 year 9 cohort is the same as the one assessed in TIMSS 2007 when in Year 5.

TIMSS sample design aims for representativeness of the national population of pupils in the target age group. The Year 5 sample in England met the required standards. Of 150 primary schools sampled, 125 took part. The international report notes that England's Year 9 sample "nearly satisfied guidelines for sample participation rates after replacement schools were included". Analysis confirms that the 118 schools taking part (of 150 sampled) are nationally representative.

The TIMSS 2011 survey in England

The TIMSS 2011 survey is the fifth in the IEA's¹ series of comparative international surveys of mathematics and science achievement. TIMSS has been administered on a four-yearly cycle since 1995. England has taken part in all cycles,² allowing comparisons over time of mathematics and science achievement among its Year 5 and Year 9 pupils (9-10 and 13-14 year olds respectively).

England's Year 5 sample met the study's stringent participation targets and the IEA deems it as nationally representative of Year 5 pupils. England's Year 9 sample is 'annotated' in the international report. However, it emerges from analysis of possible bias as nationally representative.³ At Year 5, 125 schools and 3,397 pupils took part. At Year 9, 118 schools and 3,842 pupils participated.

Overview

In TIMSS 2011 England maintained the levels of performance seen in TIMSS 2007, with the exception of science at Year 5. England also continues to show gender equality in mathematics and science achievement.

Nevertheless, there are some areas of the curriculum in which pupils in England did well and others where they did less well, and these areas varied in 2011 compared with the differences seen in TIMSS 2007.

Countries performing better than England in 2011 have tended to maintain their previous levels of achievement or to improve on them.

Pupils' attitudes towards learning mathematics and science have not varied greatly since 2007. Pupils who were more confident in the subjects tended to do better at them.

Some pupils had teachers who were not specialists in mathematics and/or science. However, the majority had teachers who, as in 2007, reported feeling very well prepared to teach mathematics and/or science. (The size of the majority was a little lower for science at Year 5 than for mathematics, or for either subject at Year 9.)

Teachers' reported levels of career satisfaction were similar to, or higher than, those of teachers in the highest achieving countries. Teachers rated their working conditions relatively positively compared with other countries.

England's overall attainment in TIMSS 2011

England's Year 5 and Year 9 pupils have maintained their levels of mathematics performance in

¹ International Association for the Evaluation of Educational Achievement (IEA): <http://www.iea.nl>

² NFER administered the TIMSS 2011 survey and previous cycles in England. Outcomes from previous cycles of TIMSS internationally and in England and other UK regions are available through the NFER website: www.nfer.ac.uk/timss

³ See Appendix A of England's national report (Sturman *et al*, 2012) for more information about the samples.

TIMSS 2007. They are above average at Year 5 and average at Year 9.

Year 5 and Year 9 pupils continue to achieve above the international average in science, despite lower attainment in science at Year 5 since 2007.

Some countries performing better than England in TIMSS 2011 have maintained their high level of performance over time and others have improved. Among some of the highest performing countries, performance has been volatile, showing improvement and decline over time.

Countries performing similarly to England in 2011 also show a range of trends: some have improved on their performance in previous cycles of TIMSS, while others have declined or maintained their previous level of attainment.

Distribution of TIMSS 2011 attainment

For both age groups and both subjects, the difference in attainment between England's highest and lowest performing pupils was just under 300 TIMSS scale points. For science at both ages, about half of the countries had wider ranges. For mathematics at Year 9, this was a narrow range relative to most other countries, but was wider than most at Year 5.

The highest performing countries tended to have ranges of attainment similar to or narrower than England, although there were a few exceptions.

For both subjects at both ages, distributions of attainment showed a wider range of attainment below a country's average score than above it.

For Year 5 mathematics and science and for Year 9 science, England had 40 to 50 per cent of pupils at the two highest benchmark levels.⁴ For Year 9 mathematics, the figure was lower at 32 per cent. The comparable figures for the highest performing Pacific Rim countries were generally between 60 and 80 per cent.

In England, 7 per cent failed to reach the lowest benchmark level for either subject at Year 5 and for science at Year 9. A larger proportion of 12 per cent failed to reach the lowest benchmark for Year 9 mathematics. The equivalent figures for the highest performing participants were 4 per cent or less.

England's proportions of Year 9 pupils at the top two benchmarks for mathematics and science have not changed significantly⁵ since 2007. There was also no significant change for Year 5 mathematics. The proportions at the top two benchmarks for Year 5 science in England decreased significantly since TIMSS 2007.

Most participants performing better than England had increased their percentages at the top two benchmarks for mathematics and/or science at both ages. However, Chinese Taipei and Hong

⁴ The international benchmark levels describe different levels of attainment in TIMSS. More information about the benchmarks is given in chapter 2 of the national report.

⁵ Findings listed as 'significant' are statistically significant.

Kong, like England, had fewer pupils at the top benchmarks for Year 5 science in 2011 compared with 2007.

TIMSS attainment by gender

For TIMSS 2011 in England, there were no significant gender differences for either subject at either grade. This was also the case in TIMSS 2007.

TIMSS attainment by language

The more frequently that pupils reported speaking English at home, the better they did at mathematics and science in Year 5 and at science in Year 9.

TIMSS attainment in the TIMSS content and cognitive domains⁶

In England, there were significant differences in achievement across the content and cognitive domains for both subjects at both age ranges. 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 domains varied greatly, including among the high performers for each subject at each age range.

Performance in the Year 5 mathematics domains

Year 5 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 between TIMSS 2007 and 2011.

Performance in the Year 9 mathematics domains

Year 9 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 Year 9 Geometry declined significantly between 2007 and 2011.

⁶ TIMSS assesses content domains in mathematics (Number, Geometric Shapes and Measures, and Data Display at Year 5; and Number, Algebra, Geometry, Data and Chance at Year 9) and in science (Life Science, Physical Science - incorporating materials - and Earth Science at Year 5; and Biology, Chemistry, Physics and Earth Science at Year 9). It also assesses the cognitive domains of Knowing, Applying and Reasoning in both subjects. More information about each domain is given in chapter 5 of the national report.

Performance in the Year 5 science domains

Year 5 pupils did better than England's average on Physical Science and Earth Science.

They performed above their average in Applying Science.

Performance in Earth Science declined significantly between 2007 and 2011.

Knowing and Reasoning in Science declined between 2007 and 2011.

Performance in the Year 9 science domains

Year 9 pupils performed below England's average in Chemistry.

They performed above their average at Reasoning in Science.

Pupils' engagement with mathematics and science

Year 5 and Year 9 pupils' responses to questionnaire items indicated that, on average, they *Somewhat Like* learning mathematics and science. They were also, on average, *Somewhat Confident in* mathematics and science and *Somewhat Engaged* in their mathematics and science lessons.

More Year 5 than Year 9 pupils were positive about learning mathematics and science. In England, just under half of Year 5 pupils *Like Learning Mathematics* and *Like Learning Science*.

The scales used to measure pupil attitudes towards mathematics and science have changed between the 2007 and 2011 TIMSS cycles. A comparison of the elements that have remained the same suggest that pupil attitudes towards mathematics and science have changed little. In England, for both science and mathematics, the Y9 pupils who were most positive about learning the subject also had the highest achievement. The same was not the case for Year 5.

More Year 5 than Year 9 pupils were *Confident* about their abilities in mathematics and science.

The pupils who were most *Confident* in mathematics and science were also those who had higher average achievement scores.

Just under half of Year 9 pupils in England were classified as *Valuing* mathematics. The equivalent figure for science was a little lower.⁷

Fewer than half of Year 5 pupils were classified as *Engaged* in their mathematics and science lessons. The comparable figures were lower at Year 9.

Low percentages of pupils *Engaged* in their mathematics and science lessons were not unusual internationally, even among the highest performing countries.

⁷ There was no equivalent question asked at Year 5.

For both grades and subjects, a relatively high percentage of pupils were taught by teachers who used the listed engagement practices in most lessons.

International analysis shows that high performance overall in a country was not necessarily linked to high percentages of pupils responding positively to questions about their attitudes towards mathematics and science.

The curriculum and teaching

England's national curriculum for mathematics and science up to Year 9 includes most of the content assessed by the TIMSS mathematics and science assessments. Compared with pupils in the highest performing countries, Year 9 pupils would typically have encountered more of this content in science, but less of it in mathematics.

In particular, fewer Year 9 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 Year 5, but relatively low in Year 9.

Teaching time for science was relatively low in England for both Years 5 and 9.

Year 9 pupils were more likely to have computers available in science lessons than in mathematics lessons. This was not so in Year 5, where availability was similar for both.

Teacher preparation and practice

Almost two-thirds of Year 5 pupils were taught by teachers who did not specialise in mathematics during their training. However, the vast majority had teachers who feel *very well prepared* to teach the TIMSS mathematics topics.

Fewer Year 5 pupils, approximately a third, were taught by teachers who specialised in science during their training. Just over two-thirds had teachers who feel *very well prepared* to teach the TIMSS science topics.

Three-quarters of Year 9 pupils had teachers who specialised in mathematics during their training. Almost all had teachers who feel *very well prepared* to teach the TIMSS mathematics topics.

Compared with mathematics, more Year 9 pupils were taught science by a science specialist. However, fewer pupils than for mathematics had teachers who feel *very well prepared* to teach the science TIMSS topics.

The science content domain that fewest teachers internationally feel prepared to teach is Earth Science. In England, only 70 per cent of pupils were taught by teachers who feel *very well*

prepared to teach this content domain (perhaps because some elements of Earth Science are taught through the geography curriculum in England).

Teacher career satisfaction in England was similar to or higher than in the highest achieving countries. However, higher levels of career satisfaction did not appear to be associated with increased pupil achievement.

More collaborative teaching practices were reported in primary schools compared with secondary schools. Nearly half of Year 5 pupils were taught by teachers who had very collaborative teaching practices whereas the equivalent percentage for Year 9 pupils was approximately a quarter.

The school environment

In England, headteachers' and teachers' reports indicated a higher emphasis on academic success compared with other participating countries. This was found at both primary and secondary level for both subjects.

There was a positive association between average achievement in Year 5 mathematics and science and attending a school perceived to be safe and orderly. This relationship was not seen for Year 9 mathematics and science.

Most Year 5 pupils attended schools where there were hardly any perceived discipline or safety issues. This was not so for Year 9 pupils: fewer than a fifth of Year 9 pupils were in schools perceived to have *Hardly Any* discipline or safety issues.

For both subjects at Year 5, there was a difference in the average achievement scores between pupils whose teachers reported that their ability to teach is limited *a lot* (by disruptive or uninterested pupils) and those who reported that their teaching is limited *to some extent* or *not at all*. The same only applied to mathematics at Year 9.

Sizeable proportions of pupils (just under half at Year 5 and just over two thirds at Year 9) reported that they *almost never* experienced bullying behaviours. However, 20 per cent of Year 5 pupils in England reported that they experienced some form of bullying behaviour *about weekly*, corresponding to the international average.

School resources

Mathematics and science teachers in England rated their working conditions relatively positively compared with other countries.

England had the highest computer availability of all participating countries in both mathematics and science.

Although the data for England appeared to show an association between the extent of computer availability and achievement for Year 5, this is unlikely to be significant. Computer availability was too high for a similar comparison to be made at Year 9.

According to their headteachers, no pupils in England attended schools in which mathematics or science teaching was perceived as affected *a lot* by resource shortages.

The home environment

The proportion of Year 5 pupils reporting having more than 100 books at home was lower than in 2007, while internet access was higher in 2011.

Year 9 pupils with access to more educational resources at home achieved higher scores on average in TIMSS 2011 in both subjects.⁸ This was the case in England and for the majority of TIMSS participants.

The extent to which teachers perceived that pupils' lack of prerequisite knowledge or skills limits teaching was similar across age groups and subjects. The majority of pupils (close to 60 per cent in both age groups and subjects) were taught by teachers who reported that this limits their teaching to some extent.

According to teachers' reports, their teaching was more commonly limited by pupils' lack of sleep than by pupils' lack of basic nutrition. This was true for both ages and subjects.

Just over half of Year 9 pupils⁹ reported spending up to 2 hours on a normal school day using social networking sites, with the highest proportion reporting *from 1 to 2 hours per day*. Sixteen per cent of pupils reported spending *no time* at all using such sites.

For both mathematics and science, increases in reported use of social networking sites up to six hours a day appear to have no association with average achievement. However, pupils who reported using social networking sites for more than six hours a day had lower average scores than those who reported using them for less time or not at all.

References

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⁸ Achievement data on this measure are not yet available for Year 5.

⁹ There was no equivalent question asked at Year 5.

Additional Information

The PIRLS 2011 national report of findings for England and links to IEA international reports are available free of charge from www.NFER.ac.uk/PIRLS

Copies of the full report are available on a print-on-demand basis by writing to: Publications Unit, NFER, The Mere, Upton Park, Slough, Berks., SL1 2DQ. Email: book.sales@nfer.ac.uk Tel: 01753 637002. There is an administration charge of £20 plus postage and packing for a single copy, with a 10% discount for bulk orders of 10 copies or more.

The research brief can be accessed at <http://www.education.gov.uk/publications/>

Further information about this research can be obtained from Adrian Higginbotham, 53-55 Butts Road, Earlsdon Park, Coventry, CV1 3BH. adrian.higginbotham@education.gsi.gov.uk

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