# What does TIMSS 2023 tell us about England's primary science?

**Jennie Golding** reports on what teachers and teacher educators might learn from the year 5 science findings in the large-scale international assessment TIMSS

TIMSS is a large-scale international assessment of mathematics and science learning, which has taken place every four years since 1997. For England, participants are typically around 4000 year 5 (ages 9–10, internationally 'grade 4') learners and a similar number of year 9 (ages 13–14, internationally 'grade 8') learners. The subject questions are based on areas likely to have been in national curricula, and there are in addition questionnaires around school and home resources, experiences, attitudes and aspirations, which sample pupils and their teachers and head teachers complete. Performance is reported as scores tied to a 'centrepoint' of 500 (reflecting the average performance in the 1995 assessment). Since then, average performance has varied, with different countries taking part each time, but the use of 'trend' items means scores can be scaled so as to show movement in average performance over time.

The structure of TIMSS means we can also make international comparisons, and try to understand why children in other countries perform differently from ours, or perhaps report greater enjoyment of science, and so on. Outcomes of the most recent cycle, with data collected in Spring 2023, have now been published; details are in the International Report (TIMSS, 2024); the England national report is published by the Department for Education (DfE, 2024) in two volumes, focused on attainment and questionnaire responses respectively. We at UCL Institute of Education led the analysis and reporting of England's TIMSS 2023 data, which has been fascinating. Importantly, our analysis of sample bias showed the sample was, on all available measures, really robust, and, if anything, the data might underestimate average attainment. However, this cohort were in year 2 in Summer 2020, so we do not have usual end-of-key-stage 1 data from which we could analyse representativeness in terms of prior attainment.

What do the outcomes tell teachers, or teacher educators, and how can those be harnessed to further improve what is happening in our primary classrooms?

## Headline finding

The **headline finding** is that the average science score for year 5 pupils in England increased significantly from 2019 to 2023 and was above those achieved in each previous TIMSS cycle (Figure 1). Given widespread slumps in attainment post-pandemic, that finding is cause for real celebration. In fact, England's year 5 pupils were 5th in the global TIMSS rankings of the 58 countries taking part at this level, performing well above the international mean. We know teachers and children have been working hard to recover from the pandemic impact on learning, and in recent years organisations such as the Primary Science Teaching Trust and the Primary Science Quality Mark have invested heavily in supporting primary science, but this shows the success of those combined efforts.

TIMSS data enable us also to probe a little deeper and ask, for example, what is the distribution of those scores: how well do our year 5 pupils perform at each of the TIMSS 'benchmark' levels, and is the average improvement reflected across the distribution? Do all groups of pupils perform equally well? Is what they know, can do and understand stronger in some parts of science than others? What about scientific processes – how do their knowledge, their application and their reasoning in science compare in strength? We'll look at each of those in turn.

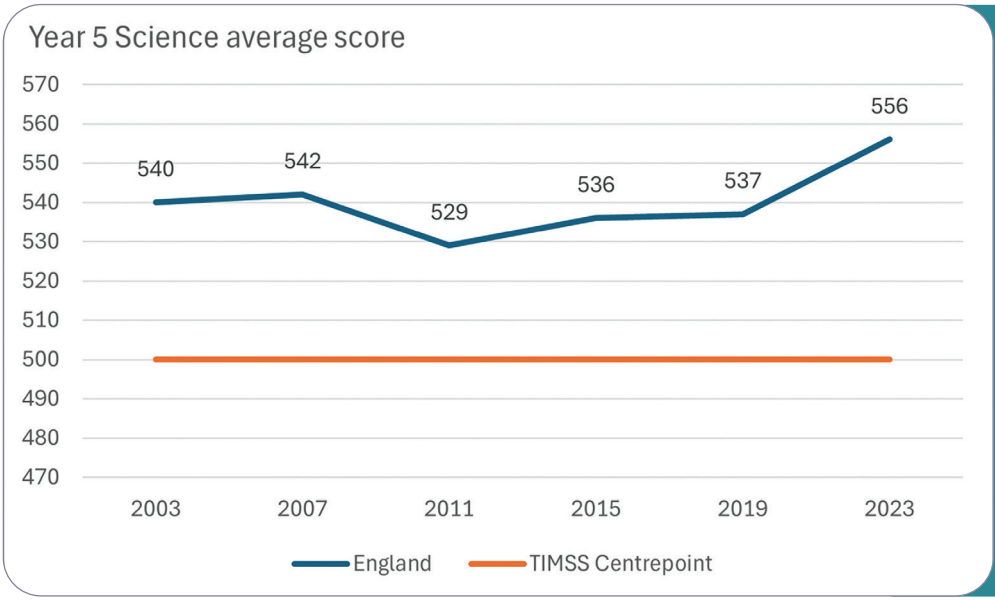



**Figure 1** TIMSS average performance over time (England year 5 science)

## Spread of performance

In terms of **'benchmark' performance** (TIMSS has low, intermediate, high and advanced benchmarks for performance – see *Useful links*), higher percentages of England's year 5 pupils reached each of the benchmarks in 2023, except the low benchmark, than in any previous TIMSS cycle (Figure 2). Note the significant increases in the percentage of pupils reaching both the high and the advanced benchmarks. However, it was still the case that 4% of year 5 pupils performed below the low benchmark level. Examples of items at different benchmarks are given below. Unsurprisingly given these reference points, TIMSS 2023 showed a bigger spread of year 5 performance in science in England than in 2019, driven by improved performance among high-attaining pupils, but fairly static performance among lower-attaining pupils. We come back to this below, when we analyse performance by socio-economic status.

## Curriculum match

TIMSS assessment items are a fairly good match to the England national curriculum (see *TIMSS 2023 Encyclopedia* – Reynolds *et al.*, 2024), and include an 'Earth science' focus – for example, climate change, environmental issues and the solar system – covering topics that in England go beyond the science curriculum. In TIMSS 2023, year 5 pupils in England showed a comparable level of grasp in each content

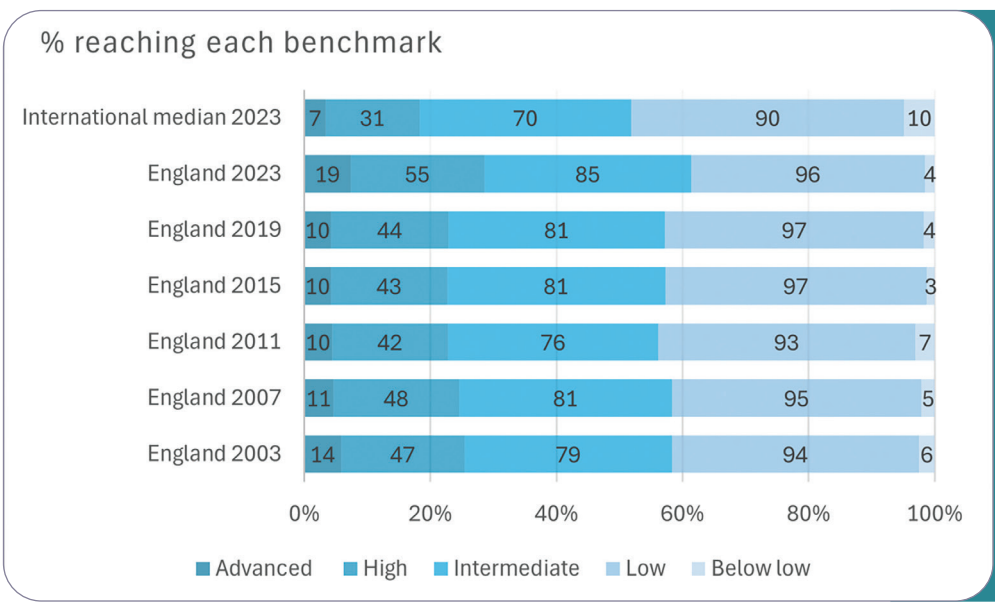



**Figure 2** Percentages of year 5 pupils reaching international benchmarks in science over time

area (life science, physical science, Earth science). They also showed a fairly balanced grasp of scientific process, with the average '*knowing, applying and reasoning*' scores all similar to the average overall score, in contrast to 2019, when those varied considerably, and pupils were also relatively weak in Earth science. Year 5 pupils, then, on average seem to be achieving a broad and balanced grasp of the science curriculum.

In terms of children's appreciation of global 'wicked problems', TIMSS 2023 science assessments singled out items focusing on pupils' **environmental knowledge**, and also assessed **environmental behaviour and attitudes** via a raft of related questions. Year 5 pupils in England overall showed that they were knowledgeable about the environment, and their knowledge corresponded well with their overall science average score. 93% of year 5 pupils in England either 'strongly valued' or 'very strongly valued' environmental preservation.

## Performance by different groups of pupils

By drawing also on the National Pupil Database, we explored the data in relation to pupils' gender, their language background and their **socio-economic status** (SES). TIMSS uses number of books in the home as a proxy for SES, whereas we in England tend to use eligibility for free school meals in the last six years. On either measure, we found there was a significant association between performance and children's socio-economic status: the more poorly resourced they are in material terms, the lower their average performance. Low economic status children are also disproportionately represented at the lower two benchmark levels, so often not benefiting from the significantly higher average attainment we have seen. That issue is common internationally, and seems to be fairly intractable, but the resultant gaps in evidenced attainment vary: there might be lessons we can learn from those countries where the gaps are smaller, such as Japan, Poland and Lithuania. It is likely that at primary level, as well as at secondary, there is considerable variation in SES-related science learning gaps by individual school in England; we potentially could learn from that, but we don't at present have easy access to data that would illuminate it.

**Gender**, too, is significantly associated with performance in more than half the countries taking part in TIMSS 2023 at year 5, but although in England boys slightly outperformed girls on average, that difference was not significant, continuing a long-term trend (Figure 3).

However, the average scores for year 5 pupils in England varied by language background: pupils whose **first language was English** on average scored significantly above the average for those with English as a second or third language. In fact, larger percentages whose first language was English reached each benchmark in science compared with their non-native speaking peers: fluency and confidence in the language used, both specialist and general, clearly plays a big part in science learning.

It seems, then, that in our year 5 classrooms in England we largely teach in ways that result in gender-equitable learning, but that we should perhaps continue to revisit our approaches with a greater awareness of making the science curriculum accessible to pupils for whom English is not their first language (ideas and resources

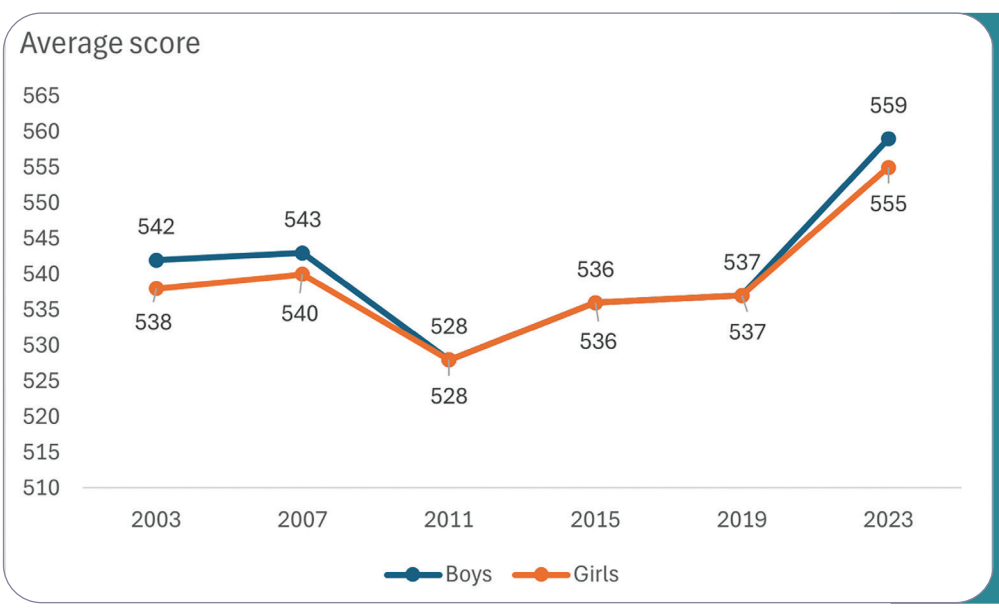



**Figure 3** Trends in performance by gender (England, year 5 science)

can be found on the Bell Foundation website – see *Useful links*), or whose background is relatively poorly resourced (a full discussion can be found in Nunes *et al*., 2017).

## Questionnaire responses

Analysis of sample year 5 pupils' **questionnaire responses** also enabled us to show that their reported confidence in their science ability, their reported 'clarity of instruction' and their liking for science (each assessed via a raft of related questions) were each significantly associated with their performance – and in year 5 science, there were no significant differences in responses to such questions by gender.

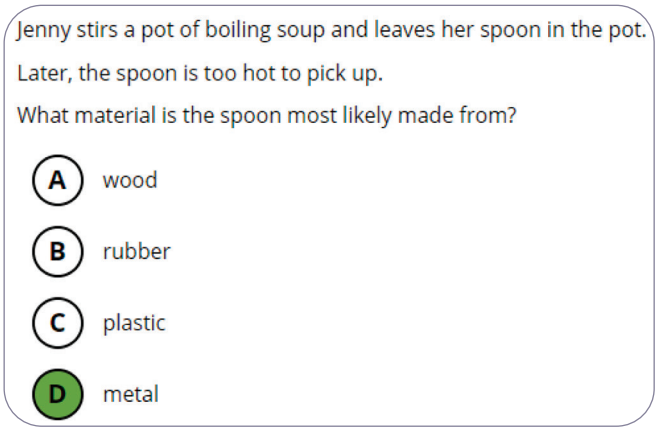
In relation to **school characteristics**, there was a positive and significant association between a reported emphasis on academic success and average scores. Across all reported aspects of discipline, disorderly behaviour and bullying, there was a negative and significant association with pupils' performance: the less that pupils were adversely impacted, the higher their performance. There was a significant positive link between pupils' reported sense of school belonging and their science scores. Children's attitudes and emotions, and especially their confidence, are intimately bound up with their learning (Siry and Brendel, 2016; White, Dickerson and Mackintosh, 2022), so schools are well justified in investing time and effort in ensuring pupils are emotionally secure, and that the learning of all pupils is valued and affirmed.

There was evidence of a significant positive association between **lower absence rates** and higher performance in science for year 5 pupils: the difference in average score between those reporting absence '*never, or almost never*', and '*about once a week*' was 101 scale points! There was also, unsurprisingly, a clear link between the level and frequency of **hunger** reported, and the average science score: prerequisites for sustained learning are that pupils are in school and physically fit to learn. Of course, we also know that both absence and hunger are associated with lower SES, compounding other challenges (Sosu *et al*., 2021).

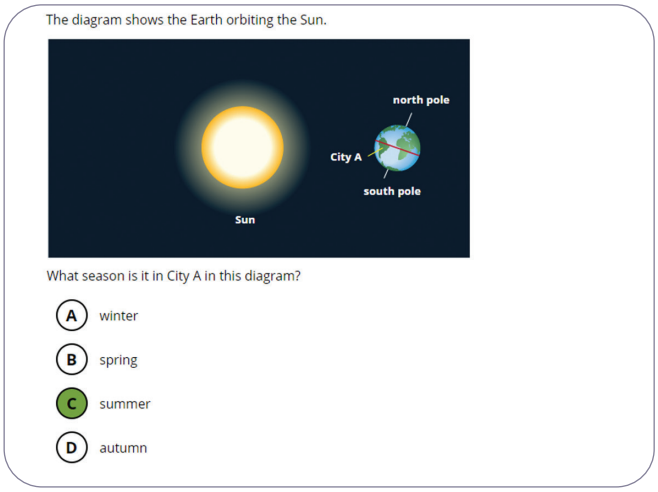
## Lessons for practitioners

The findings above suggest that much is going well for primary science in England, but also that children's belief in their ability to succeed in science, their enjoyment of it, and their senses of security and belonging in school are all strongly associated with performance – at least on TIMSS items. The data also serve to remind us that not all groups of children have equitable access to high attainment, and that family circumstances are profoundly associated with that. Wider evidence (e.g. Nunes *et al*., 2017) suggests many of those issues are fairly intractable, but also that there is between-school variation in their degree of impact, so there is certainly more we as a nation can do to achieve greater equity of opportunity for our children.

Finally, practitioners might also ask whether the investment (of time, effort – and money) in TIMSS is justified, beyond the above findings, and in particular, *to what extent does TIMSS measure what we in England value in our science curriculum?* TIMSS 'trend' items are not released, but the TIMSS website (see *Useful links*), does include a range of TIMSS items from each cycle, together with a summary of the related benchmark and performance data, so that the reader can understand both how difficult pupils found the task and how TIMSS measures attainment. Those

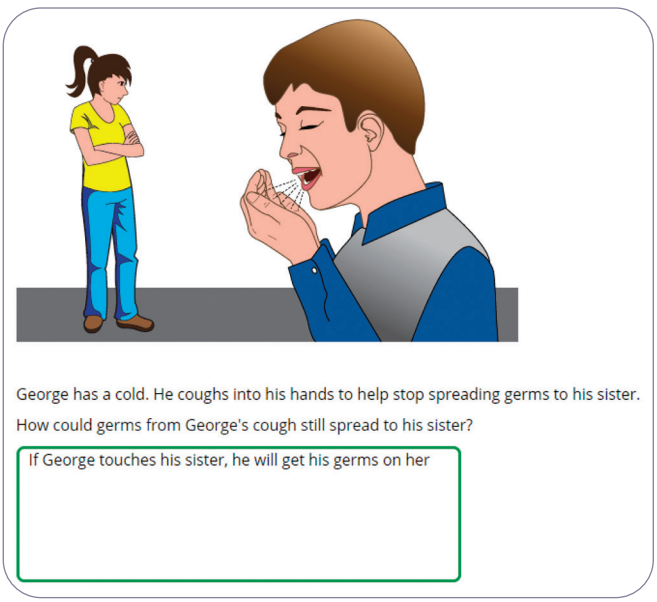



▲ **Figure 4** Sample TIMSS 2023 item for year 5 science (low benchmark, physical science, applying) (source: TIMSS, 2024)

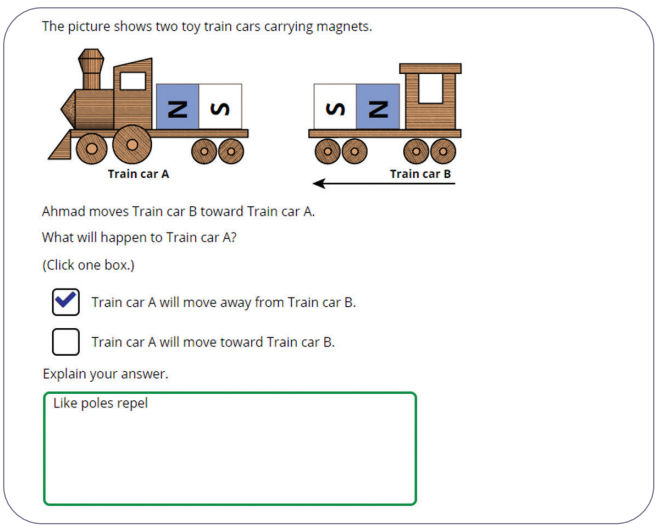



▲ **Figure 5** Sample TIMSS 2023 item for year 5 science (high benchmark, Earth science, applying) (source: TIMSS, 2024)

sources show that most are interesting, well-trialled little items, often ripe to 'drop in' to a lesson, or to use in teacher development: *Why is that task relatively straightforward? What is it that makes this item so tricky, on average internationally? What are the likely misconceptions surrounding that (incorrect) response, and how can a class teacher respond constructively and formatively to that?* The TIMSS website also gives access to the details of the questionnaires used, and, via the *TIMSS 2023 Encyclopedia*, an outline of each participating country's education system. Example released items, from a variety of benchmarks, and content and cognitive areas, complete with solutions, are given in Figures 4 to 7.




▲ **Figure 6** Sample TIMSS 2023 item for year 5 science (high benchmark, life science, knowing) (source: TIMSS, 2024)




▲ **Figure 7** Sample TIMSS 2023 item for year 5 science (advanced benchmark, physical science, applying) (source: TIMSS, 2024)

## USEFUL LINKS

Bell Foundation, *Teaching EAL learners in science*: www.bell-foundation.org.uk/resources/guidance/curriculum-subject/teaching-eal-learners-in-science

TIMSS: www.iea.nl/studies/iea/timss

TIMSS benchmark descriptors: https://timss2023.org/results/grade-4-science-achievement-benchmarks

## REFERENCES AND FURTHER READING

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Sosu, E., Dare, S., Goodfellow, C. and Klein, M. (2021) Socioeconomic status and school absenteeism: a systematic review and narrative synthesis. *Review of Education*, **9**(3), https://doi.org/10.1002/rev3.3291

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