TIMSS 2023 data adding to the mathematics and gender jigsaw in England

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Post-16 *participation* in mathematics in England has for many years been gendered in favour of boys, despite several targeted interventions. Recent *performance* by gender has become near gender-equal, including in international large-scale assessments. TIMSS 2023 exposed a large opening-up of the performance gender gap. While learners in the majority of participating countries showed year 9 (Grade 8) boys' performance on average exceeding girls', England's was the biggest such gap across all countries.

In this paper we explore analysis of wider TIMSS data as it relates to this emerging gap, and contextualise that within other England data. We show that in England, distinctively gendered patterns of *attitudes* and *aspirations* have emerged by year 5 (Grade 4) and analyse possible reasons. We scope key knowledge around ways policy actors and/or teachers might address identified issues, and identify existing gaps in relevant knowledge.

Keywords: gender; participation; performance; attitudes; aspirations

Introduction

In TIMSS 2023 mathematics, learners in England on average showed a pleasing 'bounce-back' to at least 2019 (pre-pandemic) levels of attainment. However, they also showed increasing gaps by gender (in favour of boys). Year 5 (Grade 4) boys' average score in mathematics (561) was significantly above Year 5 girls' (543), and Year 9 (Grade 8) boys' average score (538) was significantly above Year 9 girls' (512) – the biggest Grade 8 excess of boys' average scores over girls', of learners in any participating country. This paper shows how TIMSS 2023 data add to what is already known about gender and mathematics in England. Hereafter it uses international 'grade' terminology, and a coarse binary for 'gender'(boys/girls), reflecting usage in much of the available evidence. The paper informs wider discussion of the reasons underlying such gaps, and scopes ways to address those.

We synthesise at a high level what is known about gender and school mathematics in England, using a variety of measures of participation, attainment and affect, and contextualise those within global patterns. Among international large-scale studies (ILSAs), TIMSS measures Grade 4 and Grade 8 learners' performance in mathematical tasks comparatively close to most school curricula. We focus in particular on analysis of recent evidence from summative assessments at ages 16 and 18, and from the range of TIMSS 2023 mathematics performance and questionnaire data. Our synthesis shows a stubbornly persistent gender gap in *participation* and concerning indications of an increasing gap in *attitude*, but a more nuanced picture of *performance* by gender. We analyse such patterns in terms of England's national policy and normative practice, arguing that despite apparently good average levels of performance, the scale and scope of gender gaps is deeply damaging for both individual and national thriving, and suggest possible ways forward. The work is significant for the scope of its country-specific overview, and is in principle replicable for other countries and foci. We draw throughout on Golding et al. (2024) and

Richardson et al. (2025), which report on findings from the DFE-funded Pearson-UCL collaborative implementation of TIMSS 2023 in England.

Background

Mathematics education remains key in England's education policy, as it does across much of the globe. Indeed, the Royal Society's 'Mathematical Futures'_report (2024) argues that enhanced mathematical, data and computational participation and literacies are critical to nations' and individuals' thriving in the twenty-first century, in part since so many areas of human activity are now so dependent on mathematical skills and understanding. England's Department for Education has since 2012 invested large sums in developing the National Centre for Excellence in the Teaching of Mathematics, with its 'Maths Hubs' and recent focus on teaching 'mathematics for mastery'. The normative classroom practices promoted by these initiatives were adopted from practices prevalent in Singapore and in Shanghai, triggered by the persistently high mathematics performance of learners in those jurisdictions in ILSAs. Impact of education 'policy-borrowing' is notoriously unpredictable (Burdett & O'Donnell, 2016), though the encouraging average mathematics performance of England's grade 4 learners in TIMSS 2019, and of grades 4 and 8 learners in TIMSS 2023, may have been supported by such approaches.

A considerable corpus of evidence shows concern for the social, economic and institutional injustices that result from women's unequal participation in mathematics (e.g. Ceci & Williams, 2010; Hyde & Mertz, 2009). Such papers also often argue that their nation's economic health relies on increasing the proportion of the population with science, technology, engineering and mathematics (STEM) skills, and that within those, mathematical fluency is a linchpin. However, participation depends on curriculum structure and policy – and also on learner attitudes and aspirations.

In England, participation in mathematics is normally compulsory through to the GCSE examination at age 16, and beyond that for young people who have not yet achieved a 'standard pass' in GCSE Mathematics (~30% of the age group). Opt-in mathematics participation post-16 is dominated by those choosing mathematics 'A Level(s)' as part of an academic track (~14% of the age group). Mathematics is formally assessed at the end of primary school (age 11) and via GCSE (age 16), A Level (age 18) and other post-16 qualifications.

Here, we ask how TIMSS 2023 adds to evidence around gender differential participation, attainment and affect among pre-university learners in England; to what extent global evidence suggests these differences are inevitable, and what is known about policy and practice approaches to address related issues?

Findings and Discussion

Smith's (2014) review of global evidence around mathematics and gender showed that there were few, if any, inevitable gender-related differences in mathematics participation, performance or affect. However, social and systemic factors influence young people's experiences and attitudes differentially, in turn affecting their later participation and their performance, and mathematically gendered stereotypes are evidenced in some countries from a range of early years home and pre-school settings onwards. Recent findings in ILSA mathematics assessments show common occurrences of broadly comparable performance (with some exceptions).

More persistent in many countries are gender-differential responses to questionnaire items around mathematics-related *experiences and affect*, though those

are mixed, internationally – and the associations between affect and performance are complex (e.g. Ghasemi and Burley, 2019). In England, girls' and boys' *performance* in mathematics at age 11 has become gender-comparable (DfE, 2024). However, there is limited large-scale evidence around primary school learners' *affect*, except via TIMSS, which shows some longstanding gendered differences in favour of boys.

Golding's (2022) overview shows English *performance* by gender in GCSE and A Level Mathematics has recently also been comparable by gender – except in the pandemic 'centre-assessed' and 'teacher-assessed' assessments of 2020 and 2021, where girls widely outperformed boys. At these ages (16-18), there is again little large-scale evidence of England's learner *affect* except via ILSAs. Choice-impinging *attitudinal factors* across genders include enjoyment of lessons, perceived teacher-competence, perceived self-competence, intrinsic interest in mathematics and awareness of the utility of mathematics for accessing other areas (Smith & Golding, 2018); successive studies have found that girls in England on average score all these lower (e.g. Richardson et al., 2025) and that they affect girls' choices more markedly (Mujtaba & Reiss, 2016).

Post-16 in England, *participation* in mathematics A Level(s) is stubbornly gendered: about 40% of A Level Mathematics students, and 30% of A Level 'Further Mathematics' students, are girls – but their summative performance has usually been similar to boys' except at the very highest levels, where boys have somewhat outperformed girls. These patterns were again disrupted during 2020/21, to girls' benefit and towards approaches that appear broadly valued (Golding 2022, 2021). However, neither *participation* nor *attainment* by gender is an issue in the main, though still small-scale, English alternative to mathematics A Levels, the 'Core Maths' post-16 qualification (Golding, 2022). Evidence of Core Maths student *affect* is sparse, though Homer et al. (2021) cite evidence of promise and challenge.

Post-16 participation in (effectively compulsory) courses still working towards GCSE is comparable across genders for ages 16-19. *Attainment* in those courses has also been broadly comparable for those learners except in the pandemic years. Women dominate participation among adult students, on average also significantly outperforming men. The *affect* of learners working towards GCSE is under-explored, though there is some evidence the picture is quite complex (Boli & Golding, 2024).

The scale and scope of England mathematics gender gaps in TIMSS 2023 scores were unexpected. At Grade 4, the gap was statistically significant from the 'Intermediate benchmark' upwards, and at Grade 8, at every benchmark. It was also significant across every content and cognitive domain in both cohorts. In most of the highest-performing countries average performance showed no significant differences by gender. However, in other English-speaking and most European comparator countries boys' performance significantly exceeded girls', especially at Grade 8.

TIMSS 2023 showed boy-favouring patterns of *mathematics-related attitudes* and *aspirations* in England have also strengthened further. Data in both cohorts showed there was a significant positive association between mathematics performance and each of reported instructional clarity, pupils' confidence in their ability in mathematics, valuing mathematics (asked in Grade 8 only) and liking mathematics. In each case, though, boys reported significantly more favourably than girls (girls responded significantly more negatively than boys). Further, in most cases and particularly at Grade 8, the gender gap has worsened: for example, the percentage of pupils in England who either very much liked or somewhat liked learning mathematics has decreased: 53% in 2015, 50% in 2019 and 41% in 2023. The percentage of England's pupils who very much like learning mathematics (11%) was

also much lower than the corresponding group internationally (21%), and a larger percentage of pupils in England did not like learning mathematics. TIMSS 2023 additionally featured two England-only aspiration-related questions – to what extent do pupils aspire to study mathematics after age 16? And to what extent do they aspire to do work that involves mathematics after school? Figure 1 shows sample responses.

Figure 1: *Indicative responses to England-only aspiration questions (Richardson et al., 2025, 2020) *: significant difference by gender*

To what extent do pupils aspire to study mathematics after age 16?		
Grade 4	~50%*	Agree or strongly agree
in 2019, grade 4	*~64%**	*Agree or strongly agree*
Grade 8	43%*	Agree or strongly agree
in 2019, grade 8	*50%**	*Agree or strongly agree*
To what extent do aspire to do work that involves mathematics after school?		
Grade 4 boys	27%*	Strongly agree
Grade 4 girls	19%*	Strongly agree
Grade 8 boys	14%*	Strongly disagree
Grade 8 girls	29%*	Strongly disagree

Gendered attitudes and aspirations in England are therefore already established by Grade 4, so any approaches to address the raft of related issues need to begin well before that. However, in relation to TIMSS and other data for which there are international comparisons available, none of these gender gaps appears inevitable - though they are widespread and often related to unhelpful stereotypes (Golding, 2022). Figure 2 shows Golding's (2022) overview of known productive approaches:

Figure 2: *Approaches evidenced to differentially positively impact girls (from Golding, 2022)*

Pedagogy	Support mathematical interactions with a range of others (peers and near-peers, teachers, influential others)
	Offer opportunity for working in a range of both collaborative and independent, discursive ways.
	Ambitious, connection-making teaching: teaching mathematic for meaning-making and for internal and external connections, including to realistic uses of mathematics in across a wide range of contexts
	Challenge, encourage, support and specifically affirm the mathematical identity and capabilities of all students.
Curriculum	Develop curricula (and pedagogies) that build on gender-specific preferences and interests in harnessing digital tools for mathematical purposes.
Policy at all levels, including school	Small-scale interventions that target the range of influences on young people's pathways decisions: their peers, their parents and other influential figures, extra-curricular activities, the resources they use and images and roles they encounter, to promote gender-inclusive messaging.
Organisation	On occasion, consider single-sex mathematical activities

More recently, Spinner et al. (2022) showed school-level interventions can reduce gender-stereotyping. Further, OECD (2024) argues that while England's average mathematics performance is relatively strong internationally, the normative pedagogical, assessment, curriculum and accountability approaches to age 16 can undermine student confidence and aspirations, while the mathematics curriculum offer post-16 needs refreshing and broadening. Related evidence (Smith & Golding, 2018) suggests addressing any of those issues might differentially benefit girls.

In England, then, gendered gaps in participation, performance attitudes and aspirations appear to be both persistent and often widening. In principle, the national

Maths Hub-supported 'teaching mathematics with mastery' initiative supports a number of the productive approaches identified – for example, teaching mathematics for meaning-making and for connections; challenging, encouraging, supporting and specifically affirming the mathematical identity and capabilities of all students; offering opportunity for working in a range of both collaborative and independent, discursive ways. However, teaching for such aspirations is complex (e.g. Schoenfeld et al., 2023) - and such approaches can be undermined by non-coherent high-stakes assessments (Drake et al., 2012), as well as by unproductive cultural or organisational norms (Venkat & Brown, 2009). Recent conversations with experts posit that other contributory factors might include gender-differential (maybe domestic or digital) in-pandemic experiences, peri-pandemic pedagogic approaches focused on 'catch-up', or small changes to the nature of TIMSS items to accommodate online assessment. Further work is clearly needed to understand, and address, issues.

Conclusion

TIMSS 2023 England data complement existing evidence to deeply illuminate patterns of gendered participation, attitude, attainment and aspirations, exposing disappointingly intractable or widening gender gaps in all four areas. Significant investment in mastery approaches to teaching has been accompanied by strong but heavily gendered average performance; the details of any impact may have been masked by pupils' experiences during the global pandemic, or by unhelpful cultural, assessment, curriculum or accountability approaches known to differentially impact girls. More could be done to respond, in policy and practice, to the evidence base around productive approaches to such tensions – and to pay attention to affect.

Researchers internationally could adopt similar research approaches to issues of national interest. In particular, they might find the 'England-only' questions around mathematics aspirations are useful to adopt for their own context.

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