

# The Trends in International Mathematics and Science Study:

## Measuring the health of our education system

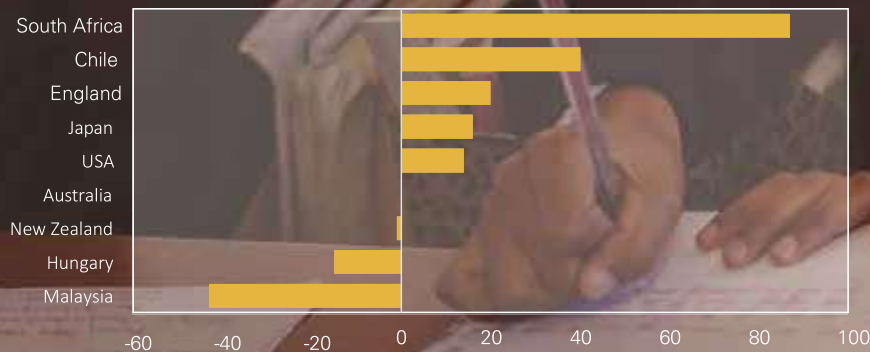
Over the last two decades, South Africa has made significant progress in transforming the education system and improving access to schools. Unfortunately, significant challenges remain, with vast numbers of primary school learners not becoming sufficiently literate and numerate to reach their potential. Mathematics and science pose a particular challenge. *Dr Vijay Reddy* writes about the HSRC's contribution to the Trends in International Mathematics and Science Study (TIMSS), a series of international assessments of the mathematics and science knowledge of students, globally.

Experts believe that academic performance in subjects related to science, technology, engineering and mathematics is an indication of the future economic strength of a country. Learning these subjects develops cognitive-reasoning abilities that equip students to navigate their way through life. In South Africa, the lack of skills in these subjects contributes to social inequalities of access to further education and income.

The HSRC first conducted TIMSS in South Africa in 1995 and again in 1999

and 2003. The Department of Basic Education supported the TIMSS 2011 study and subsequently adopted its achievement measures as an indicator of the performance of the educational system. TIMSS is now embedded in the department's monitoring and evaluation framework, and the HSRC was commissioned to conduct TIMSS in 2015 and in 2019. Table 1 provides a summary of how the findings of the study deepened our understanding of the education system over time.

**Figure 1: Difference in TIMSS mathematics achievement scores from 2003 to 2015**



*Tameca Lentoor hard at work doing mathematics at Westville Primary School, a public school in Mitchells Plain in the Western Cape*

*Photo: Antonio Erasmus*

**Table 1: South African Mathematics and Science Achievement: Summary of TIMSS since 1995**

National reports	Key findings from the national reports
Grade 7 and 8 in South Africa 1995	Participation, despite its methodological limitations and results not being widely distributed, provided the first indicative estimate of national mathematics and science achievement. The report helped establish the sampling frame and the appropriate grade for the test to be administered. Very low national mathematics and science achievement score.
Grade 8 in South Africa 1999	Very low national mathematics and science achievement scores and last position of 38 countries. Oversampling provided provincial estimates.
South African grade 8 and 9 performance in TIMSS 2003	<p>Very low national mathematics and science mean scores and last position on the rank order table of 46 countries.</p> <p>Of all the countries, South Africa had the widest range of scores between the 5th and 95th percentile. This reflected the wide disparities in society and in schools, and was evident in the educational outcomes of the students. This was indicative of two systems of education in the country.</p> <p>The disaggregation of the achievement scores by school type revealed that there was a strong correlation between socioeconomic status and achievement scores. Black South Africans, who had been most disadvantaged by the apartheid policies and lived in areas characterised by high levels of poverty and unemployment, had the lowest performance.</p>
TIMSS 2011: What 20 years of TIMSS data tells us about South African education	<p>Very low national mathematics and science mean score and the last of 42 countries. TIMSS was the only study that provided a scientifically rigorous methodology in the country to measure trends. Analysis of the four rounds of TIMSS participation showed that the average national mathematics scale score remained the same over the years 1995, 1999 and 2002. In contrast, from 2002 to 2011 the national average mathematics score increased by 67 TIMSS points.</p> <p>In 2011, the variance in the range of mathematics scores decreased, suggesting that the country was progressing (albeit slowly) towards more equitable educational outcomes. The analysis also showed the influence of contextual conditions with achievement.</p>
TIMSS 2015 Grade 9	Mathematics achievement improved by a further 20 TIMSS points from TIMSS 2011, but performance was low. The descriptive, inferential and psychometric analysis showed the effects of over-age learners, the role of language of learning and teaching and that, while resources matter, the role of climate of learning in achievement scores is also significant.
TIMSS 2015 Grade 5	Mathematics achievement at the grade 5 level provides a new indicator to measure the quality of the educational system. It allows us to understand pre-school attendance and early home-learning environments.

### Indication of improvement

Our research has shown that from 1995 to 2015 the quality of education improved by close to one standard deviation (Figure 1). We also calculated the changed achievement for countries who participated in TIMSS 2003 and 2015; and South Africa showed the biggest improvement (starting from a low base).

### Potential impact

HSRC researchers have used the TIMSS data to identify leverage points where better investments may have the most impact on achievement scores. Examples include ways to harness the positive effect of being taught in a home language and the value of early stimulation at home. Other factors that played a role in learners' performance in mathematics and science include school resources, textbook provision, bullying, and teacher challenges, as well as specific school and individual characteristics that contribute to learner resilience and confidence in these subjects (Table 2).

**Table 2: Some learnings from the TIMSS**

- Attitudes** - Factors such as having a high sense of school belonging, enjoyment in learning mathematics, engagement in teaching lessons and valuing mathematics all contribute to higher performance, especially for learners who attend low socioeconomic status public schools. The researchers recommend that schools invest in, and support, interventions to promote learner attributes such as self-efficacy, self-confidence and positive attitudes towards their school, teachers and subjects.
- The early years** - Grade 5 parents were asked about the different types of early educational activities that were commonplace in their homes before children started grade 1, including reading books, singing songs, and playing with number toys and word games. Learners whose parents reported frequent engagement across a range of 17 such activities had significantly higher scores in grade 5 mathematics.
- Home language** - The researchers found clear advantages for grade 5 and grade 9 learners who reported speaking the test language at home. They recommend steps that need to be taken to improve resources, education quality and literacy development. Early educational contexts and schools need to include adequate stimulation, resources and infrastructure as well as sound bilingual instruction in the foundation years to ensure that all learners are proficient in their home language and in the test language. The Department of Basic Education has introduced the Incremental Introduction of African Languages policy to expand the use of, and access to, African languages in schools.
- Confidence** - Learners' confidence in their science ability was positively associated with achievement. Their confidence in their science ability and achievements may be enhanced through teaching practices that provide feedback and promote self-evaluation, and goal setting. Strategies may be as simple as asking learners to solve problems out loud. This slows down the process of critical thinking and analysis, encouraging deliberate thinking and reasoning. Teachers can also pose open-ended, dialogic questions to learners, in the form of a conversation, rather than providing the answers.
- Parents** - Parental involvement in checking science homework was positively related to learners' confidence in their science ability, and school practices should focus on encouraging parents' active involvement in the educational process. Strategies may include requiring that parents sign their children's homework books.

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