TIMSS 2019

Highlights of South African Grade 5 Results in Mathematics and Science

Building Achievement Bridging Achievement Gaps

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Achievement and Achievement Gaps

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SECTION A: TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

The Trends in International Mathematics and Science Study (TIMSS) is a recognized international assessment study designed to measure the effectiveness of an education system within a country in relation to mathematics and science. TIMSS 2019 was the 7th cycle of the International Association for the Evaluation of Educational Achievement (IEA) series of large-scale assessments. It is conducted every four years at the Grade 4/5 and Grade 8/9 levels. In addition to assessing learner knowledge in mathematics and science, TIMSS also gathers information in relation to the learners context for learning (website https://www.iea.nl/studies/iea/timss/2019).

TIMSS Assessment framework

The curriculum used by TIMSS is broadly defined as the major organising concept in considering how educational opportunities are provided to learners and the factors associated with how learners use these opportunities. The TIMSS Curriculum Model has three aspects: the intended curriculum, the implemented curriculum, and the attained curriculum (see Mullis & Martin, 2017, for details. These represent the mathematics and science knowledge that learners are expected to learn as defined by countries' curricula policies and publications, how the educational system should be organized to facilitate this learning, what is actually taught in classrooms, the characteristics of those teaching it, how it is taught, and, finally, what it is that learners have learned.

TIMSS at the Grade 5 level in South Africa

In 2015, South Africa extended the TIMSS programme and conducted the TIMSS 2015 Numeracy assessment at the fifth Grade, in order to gain an insight into education and achievement in primary schools. TIMSS Numeracy offered a 'less difficult' mathematics assessment at the fourth Grade than the mathematics assessment normally administered. TIMSS Numeracy asked learners to answer questions similar to those posed in TIMSS, except that easier numbers and more straightforward procedures were used. TIMSS Numeracy was reported on the same TIMSS Grade 4 scale. In TIMSS 2019, both mathematics and science assessments were included at the Grade 5 level. South Africa again opted for the less difficult mathematics assessment items, however, the science assessment was the same as all participating countries.

The 2019 TIMSS cycle provides the first opportunity to set up a trend line for mathematics achievement and a baseline measure for science achievement.

The TIMSS 2019 Grade 5 Sample

The Department of Basic Education (DBE) and the Human Sciences Research Council (HSRC) collaborated in conducting the TIMSS 2019. The TIMSS 2019 sample of schools was selected from the 2018 DBE List of Schools that offered Grade 5 classes (school population: 16 254 public and 1 031 independent). Statistics Canada selected the national sample based on province and school type (public or independent) as explicit stratification variables and school poverty ranking as the implicit stratification variable. The realised sample consisted of 297 schools, 294 mathematics educators, 295 science educators, 11 903 learners and 11 720 parents. We explain the methodology in detail in the forthcoming TIMSS 2019 Grade 5 National Report.

Structure of the Highlights of Grade 5 results report

The key questions informing the analysis of TIMSS 2019 data and the Highlights of Results Report are:

- What are the mathematics and science achievement and achievement gaps in TIMSS 2019?
- What influences mathematics and science achievement in South Africa?

Using the Interim TIMSS 2019 International Results in Mathematics and Science Report (Mullis, et al., 2020) published by the IEA, and with HSRC analyses, we constructed this TIMSS 2019 Highlights of Results Report.

Section A has provided a brief outline of TIMSS to orient the reader.

Section B describes the TIMSS 2019 mathematics and science achievements. We report on achievement patterns at three levels: (i) International, (ii) National, and (iii) Local (province, fee-status of schools, and gender).

Section C signals possible predictors of mathematics and science achievement. From the bivariate analyses, we identified the home, school and classroom factors (through IEA constructed scales of which the details can be found in the international report) that are associated with mathematics and science achievement. An important aspect of this section are the reports from parents about early literacy and numeracy activities in the home.

Section D outlines the key findings emerging from this analysis.

The HSRC will publish the TIMSS 2019 National Report by June 2021. The TIMSS 2019 National Report will include more comprehensive reporting and multivariate analyses to identify robust predictors of mathematics and science achievement.

SECTION B: ACHIEVEMENTS AND ACHIEVEMENT GAPS

1. INTERNATIONAL MATHEMATICS AND SCIENCE ACHIEVEMENT IN 2019

Table 1: Mathematics Achievement

Country	Mathematics Mean (SE)
Singapore	625 (3.9)
Hong Kong SAR	602 (3.3)
Korea, Rep. of	600 (2.2)
Chinese Taipei	599 (1.9)
Japan	593 (1.8)
Russian Federation	567 (3.3)
Northern Ireland	566 (2.7)
England	556 (3.0)
Ireland	548 (2.5)
Latvia	546 (2.6)
Norway (5)	543 (2.2)
Lithuania	542 (2.8)
Austria	539 (2.0)
Netherlands	538 (2.2)
United States	535 (2.5)
Czech Republic	533 (2.5)
Belgium (Flemish)	532 (1.9)
Cyprus	532 (2.9)
Finland	532 (2.3)
Portugal	525 (2.6)
Denmark	525 (1.9)
Hungary	523 (2.6)
Turkey (5)	523 (4.4)
Sweden	521 (2.8)
Germany	521 (2.3)
Poland	520 (2.7)
Australia	516 (2.8)
Azerbaijan	515 (2.7)
Bulgaria	515 (4.3)
Italy	515 (2.4)
Kazakhstan	512 (2.5)
Canada	512 (1.9)
Slovak Republic	510 (3.5)
Croatia	509 (2.2)
Malta	509 (1.4)
Serbia	508 (3.2)
Spain	502 (2.1)
TIMSS Scale Centrepoint	**500**
Armenia	498 (2.5)
Albania	494 (3.4)
New Zealand	487 (2.6)
France	485 (3.0)
Georgia	482 (3.7)
United Arab Emirates	481 (1.7)
Bahrain	480 (2.6)
North Macedonia	472 (5.3)
Montenegro	453 (2.0)
Bosnia and Herzegovina	452 (2.4)

A total of 64 countries (including the six benchmarking participants) took part in the study. Table 1 provides the mathematics and Table 2 the science average scale scores, together with the standard errors (SE) of the countries who participated in TIMSS 2019. The scores in the tables are in rank order to allow for cross country comparisons. The TIMSS achievement scale is set to a Centrepoint (point of reference which remains constant from assessment to assessment) of 500 and a standard deviation of 100.

In mathematics, the top three countries were Singapore (with an average scale score of 625), Hong Kong (602) and Republic of Korea (600) – all from East Asia. The three countries with the lowest achievements were South Africa (374), Pakis-tan (328) and the Philippines (297), with the South African achievement score significantly higher than Pakistan and Philippines.

In science, the top three countries are Singapore (595), Republic of Korea (588) and Russian Federation (567). The lowest achieving three countries are the same as with mathematics: South Africa with an average score of 324, Pakistan (290) and the Philippines (249). Again the South African science scores are significantly higher than both Pakistan and the Philippines.

Table 2: Science Achievement

Country	Science Mean (SE)
Singapore	595 (3.4)
Korea, Rep. of	588 (2.1)
Russian Federation	567 (3.0)
Japan	562 (1.8)
Chinese Taipei	558 (1.8)
Finland	555 (2.6)
Latvia	542 (2.4)
Norway (5)	539 (2.2)
United States	539 (2.7)
Lithuania	538 (2.5)
Sweden	537 (3.3)
England	537 (2.7)
Czech Republic	534 (2.6)
Australia	533 (2.4)
Hong Kong SAR	531 (3.3)
Poland	531 (2.6)
Hungary	529 (2.7)
Ireland	528 (3.2)
Turkey (5)	526 (4.2)
Croatia	524 (2.2)
Canada	523 (1.9)
Denmark	522 (2.4)
Austria	522 (2.6)
Bulgaria	521 (4.9)
Slovak Republic	521 (3.7)
Northern Ireland	518 (2.3)
Netherlands	518 (2.9)
Germany	518 (2.2)
Serbia	517 (3.5)
Cyprus	511 (3.0)
Spain	511 (2.0)
Italy	510 (3.0)
Portugal	504 (2.6)
New Zealand	503 (2.3)
Belgium (Flemish)	501 (2.1)
TIMSS Scale Centrepoint	**500**
Malta	496 (1.3)
Kazakhstan	494 (3.1)
Bahrain	493 (3.4)
Albania	489 (3.5)
France	488 (3.0)
United Arab Emirates	473 (2.1)
Chile	469 (2.6)
Armenia	466 (3.4)
Bosnia and Herzegovina	459 (2.9)
Georgia	454 (3.9)
Montenegro	453 (2.5)
Qatar	449 (3.9)

Table 1: Mathematics Achievement *(continued)*

Country	Mathematics Mean (SE)
Qatar	449 (3.4)
Kosovo	444 (3.0)
Iran, Islamic Rep. of	443 (3.9)
Chile	441 (2.7)
Oman	431 (3.7)
Saudi Arabia	398 (3.6)
Morocco	383 (4.3)
Kuwait	383 (4.7)
South Africa (5)	374 (3.6)
Pakistan	328 (12.0)
Philippines	297 (6.4)

Table 2: Science Achievement *(continued)*

Country	Science Mean (SE)
Iran, Islamic Rep. of	441 (4.1)
Oman	435 (4.1)
Azerbaijan	427 (3.3)
North Macedonia	426 (6.2)
Kosovo	413 (3.7)
Saudi Arabia	402 (4.1)
Kuwait	392 (6.1)
Morocco	374 (5.8)
South Africa (5)	324 (4.9)
Pakistan	290 (13.4)
Philippines	249 (7.5)

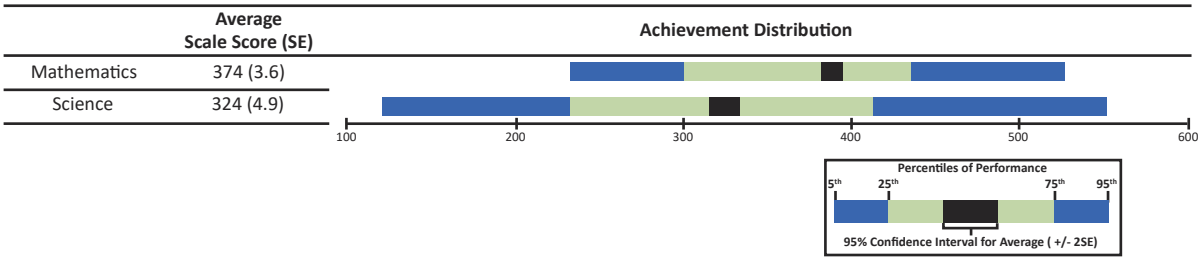
2. SOUTH AFRICAN MATHEMATICS AND SCIENCE PERFORMANCE, 2019

The TIMSS 2019 assessments both comprised 175 mathematics and science assessment items, but each learner responded to only part of the assessment. In order to provide comparable scores, TIMSS uses item response theory (IRT) scaling methods to create a set of plausible achievement estimates for each learner. This is used to calculate the average scale score achievement estimates. TIMSS also describes mathematics and science performance in a second way: TIMSS translates the achievement scale scores to describe the abilities learners demonstrate at particular points on the achievement scale, called international benchmarks.

2.1. Mathematics and science achievement and score distributions, 2019

South Africa's performance in both mathematics and science are amongst the lowest of the 64 countries and entities who participated at the Grade 4/5 level. Figure 1 presents the mathematics and science achievement scale score. The distribution graph is indicative of variation in achievement.

Figure 1: Average mathematics and science achievement and score distribution, 2019

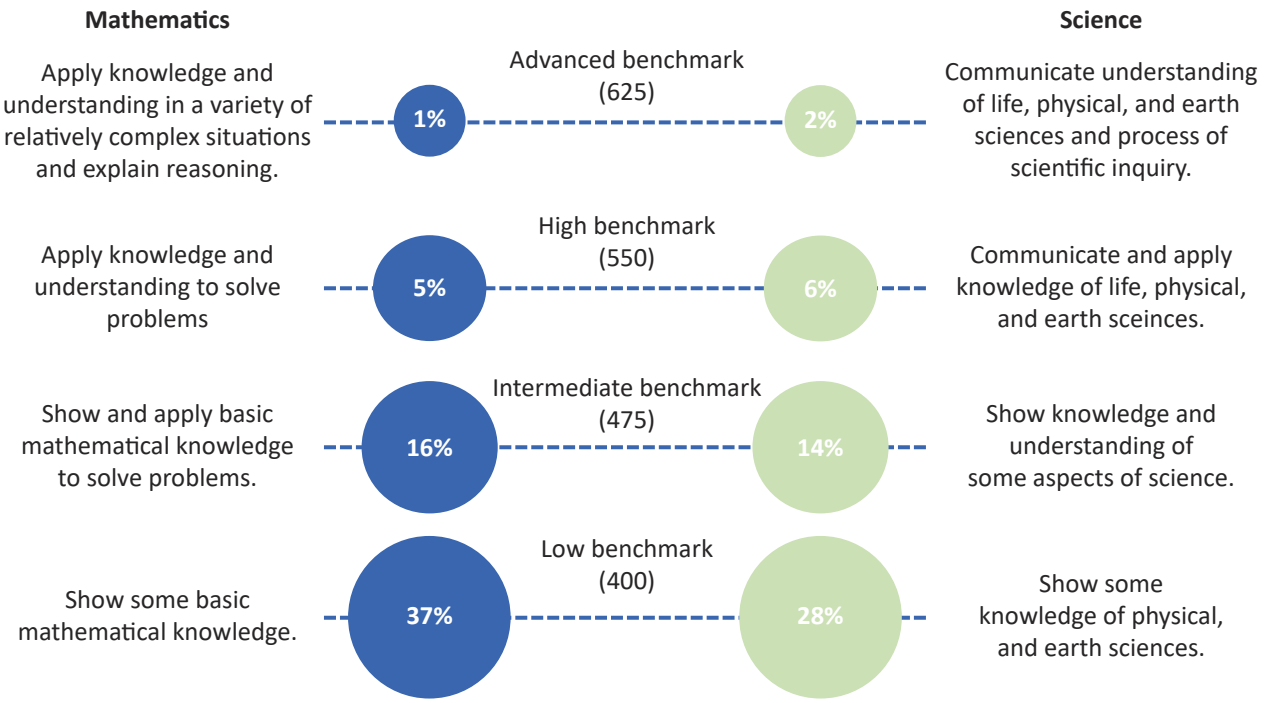


The average scale score for mathematics is 374 (3.6) and science is slightly lower at 324 (4.9). Further, the lengths of the distribution graphs for mathematics and science differ: Science has a wider distribution, meaning a larger variation in scores compared to mathematics. The achievement difference between the 95th and 5th percentile is 330 points for mathematics and 434 points for science. Science achievement scores at the 5th percentile is lower than the corresponding value for mathematics. The different mathematics and science distributions suggest that science learners experience additional problems in accessing the science content.

2.2. Mathematics and Science abilities by International Benchmarks, 2019

In order to interpret the TIMSS achievement scales, TIMSS describes four points on the scale called International Benchmarks in terms of mathematics and science abilities (skills or knowledge) that a learner would demonstrate. The four identified points are the Advanced International Benchmark (at or above 625), High International Benchmark (550 to Below 625), Intermediate International Benchmark (475 to Below 550) and Low International Benchmark (400 to Below 475). Figure 2 describes the abilities that learners would demonstrate at each of these points and also shows the cumulative percentage of South African Grade 5 learners who reached each of the levels.

Figure 2: Percentage of learners reaching International Benchmarks for mathematics and science, 2019



On the TIMSS scale, learners who achieve above 400 TIMSS points are described as having acquired the basic mathematical or science knowledge for that Grade. Higher achievements mean that learners possess the ability to apply knowledge in simple or complex situations and to communicate understandings. It is pleasing that 1% of mathematics learners and 2% of science learners demonstrated abilities at the Advanced Benchmark and noteworthy that 6% of mathematics learners and 8% of science learners scored higher than 550 TIMSS points (the High Benchmark). Around one in six learners (16%) scored higher than 475 TIMSS points in both mathematics and science assessments.

TIMSS sets the Low Benchmark at 400 points, and scores above that mark means that learners acquired basic mathematical and science knowledge: 37% of South African learners acquired basic mathematical knowledge and a lower 28% acquired basic science knowledge. This implies that 63% of learners had not acquired basic mathematical knowledge and 72% had not acquired basic science knowledge. South Africa still has a way to go to improve mathematics and science basic knowledge.

3. MATHEMATICS AND SCIENCE ACHIEVEMENT OF LOCAL RELEVANCE

Having looked at the South African mathematics and science results at both a national level and in relation to other participating countries, it is important to recognize how diverse the South Africa is and hence reporting on the national achievement statistics alone would not suffice. The next section details the results by province, poverty index of schools, the fee-status of schools, as well as outlines achievement by gender.

3.1. Mathematics and Science Achievement by Provinces, 2019

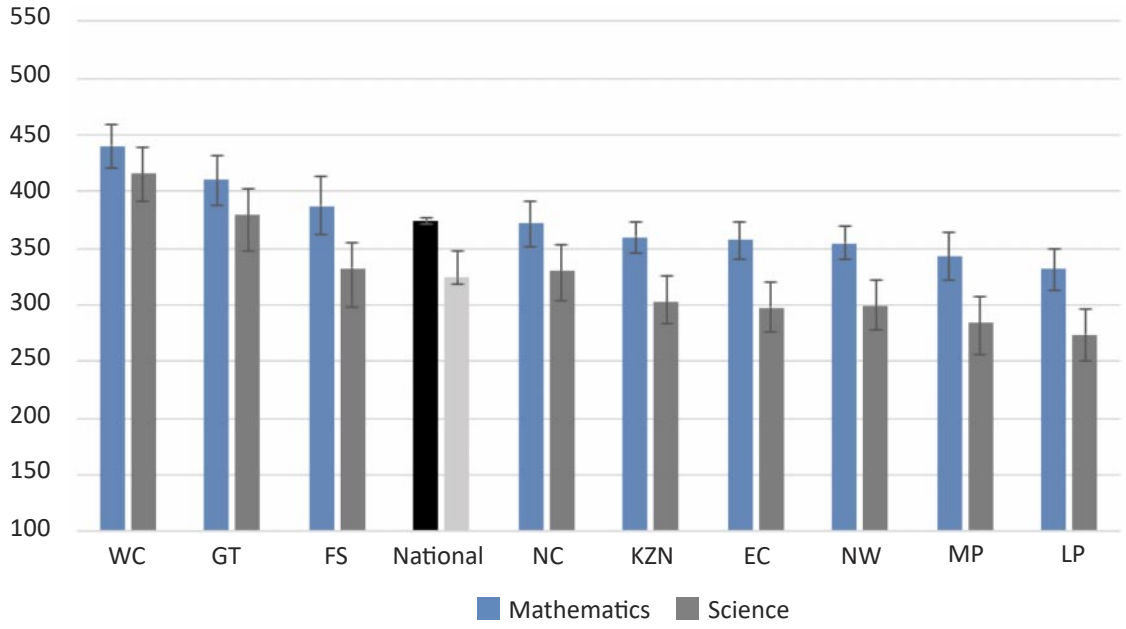
One of the functions of provincial education departments in South Africa is the management and financing of schools. Another is to efficiently implement and monitor policies developed by the DBE. Mathematics and science score estimates are useful to provincial policy makers to monitor area-level progress and plan improvement programmes in schools. Figure 3 presents the mathematics and science achievement scores and confidence intervals for each of the nine provinces.

The estimates were derived from a sample of around 30 schools per province. This smaller sample - relative to the national one - results in higher standard errors (Figure 3). For mathematics, Western Cape (441), Gauteng (410) and Free State (387) are the three top performing provinces, with North West (355), Mpumalanga (343) and Limpopo (331) the lowest performing. In science, the three top performing provinces were again Western Cape (415), Gauteng (379) and Free State (337) and the lower performing provinces are Eastern Cape (297), Mpumulanga (284) and Limpopo (274).

Three provinces, Western Cape, Gauteng and Free State, obtained scores above the national average for mathematics, with Western Cape scores significantly different to all the other provinces. Four provinces obtained scores higher than the national average in science, although the difference between Western Cape and Gauteng is not significantly different. These two provinces are, however, significantly different from all other provinces.

The difference between the highest and lowest performing province is 110 points for mathematics and a wider 141 points in science.

Figure 3: Provincial mathematics and science achievement with confidence intervals, 2019



	WC	GT	FS	National	NC	KZN	EC	NW	MP	LP
Mathematics	441 (9.6)	410 (10.7)	387 (12.6)	374 (1.8)	372 (9.9)	360 (6.7)	357 (8.2)	355 (7.2)	343 (10.3)	331 (9.4)
Science	415 (12.1)	379 (15.6)	333 (17.4)	324 (2.5)	330 (13.2)	302 (9.2)	297 (10.8)	299 (10.7)	284 (14.2)	274 (11.5)

3.2. Mathematics and Science Achievement by School Poverty Index Rank, 2019

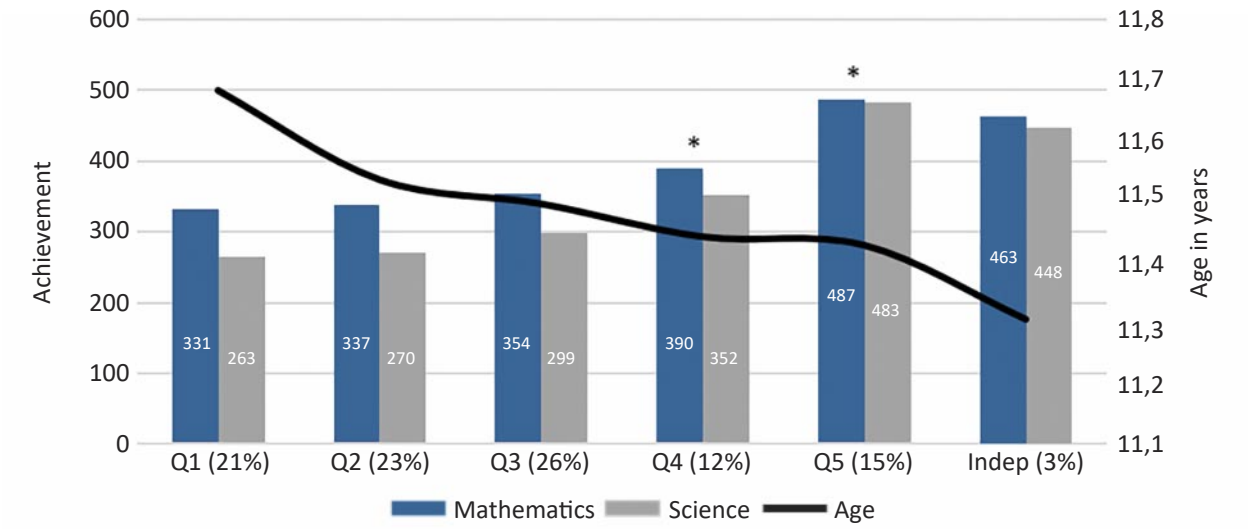
Public schools in South Africa are ranked into five poverty index groupings, commonly referred to as quintiles. This classification was done to assist the DBE with the allocation of financial resources to schools. The allocation of schools into these quintiles is dependent on factors like the poverty level of the community surrounding the school, as well as infrastructural factors within the school. The lower the quintile ranking, the more under-resourced the school is and learners are more likely to come from poorer households. Schools with quintile ranking of 4 or 5 are generally located in more affluent areas and learners generally come from homes with more economic resources. Independent schools are privately governed and make up 8% of the all schools in South Africa. Figure 4 sets out the average mathematics and science achievements for schools in each quintile category and for independent schools.[1]

[1] We over-sampled the number of independent to 30 schools to provide reasonable estimates.

The mathematics and science achievement for learners in Quintile 1, 2 and 3 schools are similar (no statistically significant differences). The achievement of learners in Quintile 4 schools is significantly higher than leaners in Quintiles 3 and significantly lower than learners in Quintile 5 schools. The average achievement for Quintile 5 schools is not significantly different from Independent schools. In Quintile 1, 2, 3 and 4 schools, the average mathematics achievement was significantly higher than science achievement with the gap narrowing with an increase in fee-status.

The average age of the Grade 5 learners in South Africa is 11.5 years: learners in Quintile 1, 2 and 3 schools are aged 11.7 years, 11.5 years and 11.5 years respectively. Learners in Quintile 4 and 5 schools are slightly younger, at 11.4 years, and in independent schools, the average age is 11.3 years. This suggests greater learner Grade repetition in Quintile 1, 2 and 3 schools.

Figure 4: Average mathematics and science achievement and age by school poverty ranking, 2019



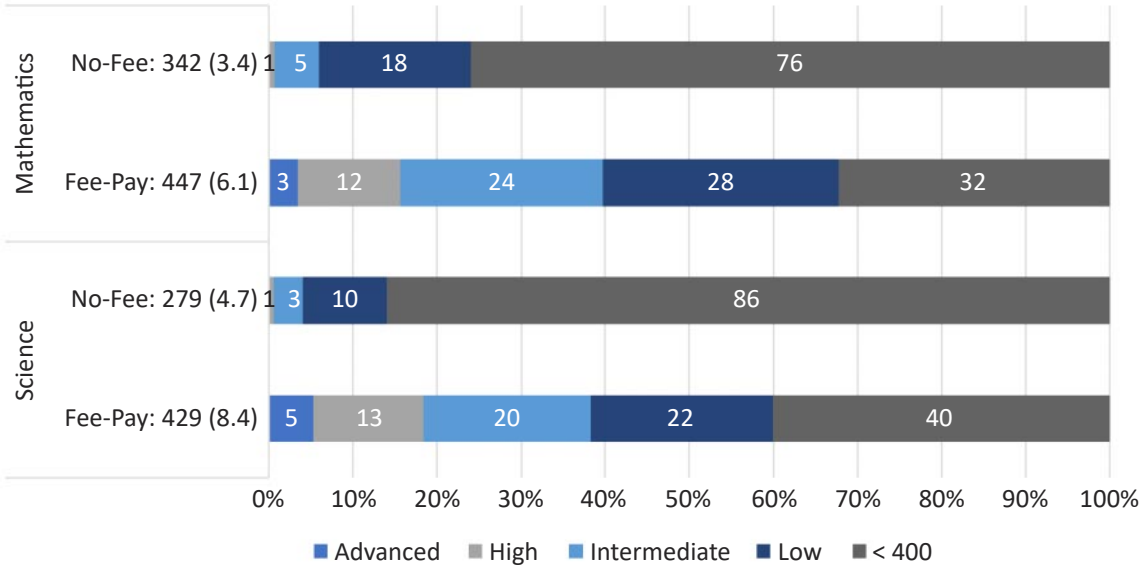
3.3. Mathematics and Science achievement and Ability by Fee-status of Schools, 2019

Government subsidises the school fees for learners in Quintile 1, 2 and 3 schools, usually termed 'no-fee' schools. Learners in Quintile 4 and 5 schools pay fees and so they are designated as 'fee-paying' schools. Learners in independent schools pay fees. Seventy percent of Grade 5 learners attend no-fee schools and 30% attend fee-paying schools.

The general description of learners in no-fee schools is that they come from lower income households, live in poorer communities, attend schools with fewer resources, and are largely taught by educators with less specialist knowledge. Learners in fee-paying schools, on the other hand, come from largely middle-class families, have better resourced homes, and attend schools with better qualified educators and a school climate that promotes better teaching and learning. In 2020, the learner population demographic in Quintile 4 and 5 schools was 62% African, 18% Coloured, 6% Asian/Indian and 13% White.

Figure 5 reports the average achievement scores and ability levels for learners in fee-paying (Q4, 5 and Independent) and no-fee (Q1, 2 and 3) schools in TIMSS 2019.

Figure 5: Mathematics and science achievement at international benchmarks by fee status, 2019



As expected, the differences in the material school and home conditions for learners attending fee-paying and no-fee schools leads to unequal achievements: Learners attending fee-paying schools achieve an average of 447 (6.1) for mathematics and 429 (8.4) for science and in no-fee schools score 342 (3.4) for mathematics and a low 279 (4.7) for science. Both the mathematics and science average scores were significantly different between fee-paying and no-fee schools. The score difference between these two groups is 150 points for science and 105 points for mathematics.

When the achievement scale scores are translated to ability levels using the benchmarks described above, 68% of mathematics learners in fee-paying schools and 60% of science learners show that they had acquired basic mathematical and science knowledge, that is, they score above 400. It is noteworthy that 15% of mathematics learners and 18% of science learners achieve scores above the High Benchmark level (550) and so have the ability to apply their mathematics and science knowledge to solve problems.

In no-fee schools, 86% of science learners and 76% of mathematics learners had not reached the Low Benchmark i.e. not demonstrated through the TIMSS assessment that they acquired basic mathematical and science knowledge. It is, however, noteworthy that 1% of mathematics and science learners in no-fee schools achieve a score above the High Benchmark level.

3.4. Mathematics and Science Achievement by Gender, 2019

International TIMSS 2019 results on gender differences is mixed. In twelve of the 64 participating TIMSS countries girls outperform boys in mathematics and in 35 countries they outperform boys in science. In South Africa, girls outperform boys by 20 points for both mathematics and science (Figure 6) and this achievement difference is statistically significant.

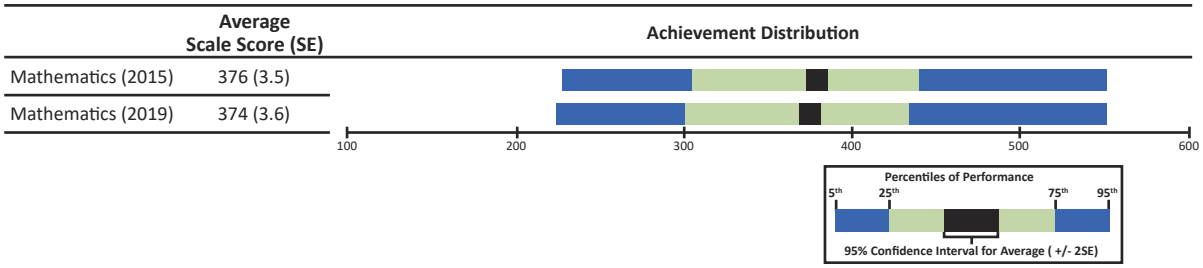
Figure 6: Mathematics and Science Achievement by gender, 2019

Girls achieve statistically significant higher mathematics and science scores than boys

4. TREND IN MATHEMATICS ACHIEVEMENT, 2015 to 2019

TIMSS 2015 and 2019 measured mathematics achievement, thus providing data for a trend line. The average mathematics scale score was 376 (3.5) in 2015 and 374 (4.7) in 2019 (Figure 7), a difference of two points that is not statistically significant.

Figure 7: Average Mathematics Achievement and scale score distributions, 2015 to 2019



Although the national achievement score and distribution between 2015 and 2019 did not change, we explored the data for any significant changes in provincial achievements or by the school poverty rank. The only statistically significant change between 2015 and 2019 was the decrease in mathematics achievement in Mpumalanga, by 40 points, and the decrease for independent schools by 46 points. In order to understand why the Grade 5 achievements did not improve, we may have to look outside the TIMSS dataset.

SECTION C: EXPLAINING MATHEMATICS AND SCIENCE ACHIEVEMENT

5. UNEQUAL HOME CONDITIONS AND ACHIEVEMENT

In both developed and emerging economies, structural factors, such as race and gender, parental wealth and educational attainment are the main determinants of their children's educational success (World Bank, 2018)[2]. Observations show that children from poor families, for example, are less likely to start, progress or successfully complete schooling.

In order to establish the socio-economic status of the home, and how the home supports learning, learners were asked about the availability of a number of possessions at home. We categorized these assets as basic, educational or digital (Figure 8). Having these assets is positively associated with higher educational outcomes. We report the availability of these assets, firstly, at the national level and then for learners in fee-paying and no-fee schools (Figure 8).

Figure 8: Percentage of learners having basic, educational and digital assets at home, 2019

Asset Type	Possession	National	Fee-Pay	No-Fee
Basic	Running tap water*	66	78	60
	Flush toilet*	65	91	53
	Child Support grant*	60	36	70
Educational	Own room*	58	67	53
	More than 25 books*	17	30	12
	Either parents has a post Grade 12 qualification*	29	47	21
	Always/almost always speak test language at home*	35	50	28
Digital	Internet connection*	37	55	29
	Computer or Tablet*	56	73	49

** Difference in availability of assets in fee-paying and no-fee schools is statistically significant*

There are statistically significant differences in the availability of all assets for learners in fee-paying and no-fee schools. In no-fee schools, 40% of learners still lack running tap water, and just under half the learners (47%) do not have flush toilets in their homes. Access to basic amenities is critical for learners to participate successfully in education.

Due to the high levels of poverty (56% in 2015, StatsSA (2015)[3], government provides social grants to homes in economic distress. Nationally, 60% of parents reported receiving a Child Support Grant (CSG). As expected, a higher proportion (70%) of children in no-fee schools are beneficiaries of the CSG. One third of learners in fee-paying schools are also beneficiaries of the CSG, pointing to socio-economic disparities in both no-fee and fee-paying schools.

While the availability of educational resources in the home is low for the majority of learners, there is still a statistically significant difference in the availability of educational resources for fee-paying and no-fee schools. Parental education is a signal of the wealth and social capital of the household and has strong positive links with learner achievement. Half the learners (47%) in fee-paying schools lived in a home where at least one parent had a post-secondary education (diploma or degree). In no-fee schools, one in five (21%) parents had the same education level.

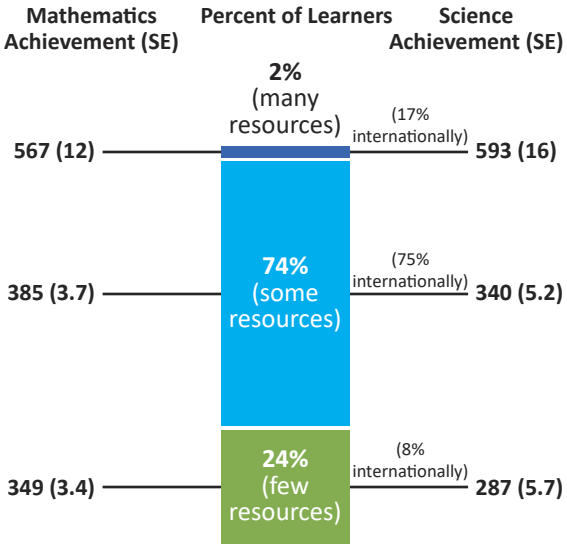
[2] World Bank (2018). Overcoming Poverty and Inequality in South Africa. An Assessment of Drivers, Constraints and Opportunities. www.worldbank.org

[3] Statistics South Africa (StatsSA). (2015). Poverty Trends in South Africa: An Examination of Absolute Poverty Between 2006 and 2015. Statistics South Africa: Pretoria. Retrieved 25 August 2020 from http://www.statssa.gov.za/publications/Report-03-10-06/Report-03-10-062015.pdf

Learners who speak the language of the test at home will have better linguistic access to the test and be able to respond to the TIMSS assessments successfully. Half the learners (50%) in fee-paying schools, and a quarter (28%) in no-fee schools, reported always or almost always speaking the language of the test at home.

In a world where digital learning is becoming more important, just over half (56%) of South African learners have the necessary digital hardware and 37% have an internet connection at home. These conditions are worse for the learners in no-fee schools than in fee-paying schools with three quarters of learners (73%) in fee paying schools and half the learners (49%) in no-fee schools indicating that they had a computer at home.

Average Mathematic and Science Achievement and Home Educational Resources scale, 2019



TIMSS constructed a *Home Resources for Learning scale* using data from both the learner and parents about availability of books (general and children's books); (ii) home study support (internet connection and own room); and (iii) parental education and occupation.

Only 2% of learners in South Africa reported having many resources compared to 17% internationally. Learners having may resources achieve a score of 567 (12.0) for mathematics vs. 349 (3.4) for those with a few resources. There is a positive and significant association between both mathematics and science achievement and having access to more educational resourmces in the home.

6. EARLY NUMERACY AND LITERACY DEVELOPMENT

While the physical resources present in the home are important predictors of achievement, so too are features of the early educational environment experienced by learners. Higher academic achievement is associated with learners who developed literacy and numeracy skills through early experiences in the home and by attending pre-primary education facilities. We will report on (i) early literacy and numeracy preparation in the home, (ii) pre-primary education at an institution, and (iii) the literacy and numeracy tasks learners were able to do before entering Grade 1. The analyses are based on parents' or guardians' responses to the questionnaires.

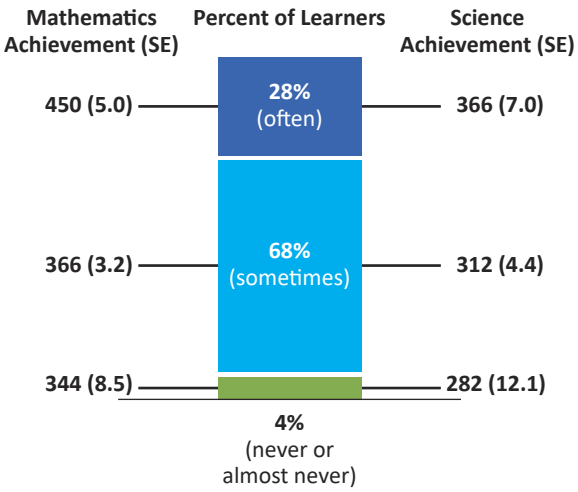
6.1. Early literacy and numeracy activities before school

Parents were asked: "Before your child began school, how often did you (or someone else at home) do the following with him or her". Figure 9 shows the proportion of parents who reported *often* engaging with six numeracy and literacy activities at home, all of which are positively associated with higher mathematics and science achievements. Parents whose children attend fee-paying schools spends significantly more time with their children on early educational activities than parents from no-fee schools.

Figure 9: Proportion of parents who 'often' engaged in selected early educational activities, 2019

	Read Books	Playing with Alphabets	Counting Songs	Playing with Number Toys	Games with Shapes	Playing with Building Blocks
National	35	34	37	35	41	34
No-Fee	34	30	33	33	37	29
Fee-Paying	38	44	45	41	51	45

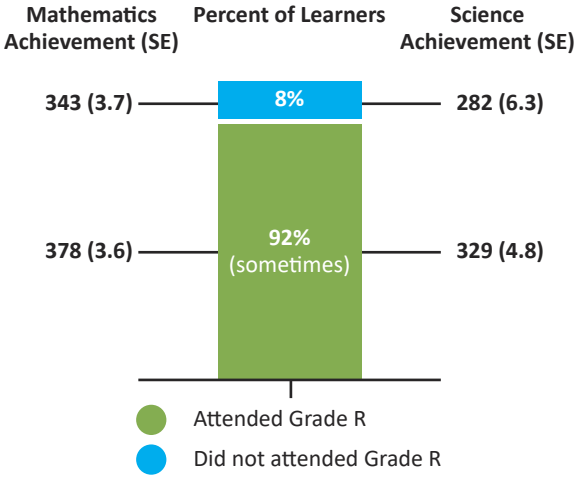
Percent of learners whose parents spend time on numeracy and literacy activities, and mathematics and science achievement



The 18 educational activities were combined to form a single *Early Literacy and Numeracy Activities scale*. A quarter (28%) of parents reported often spending time on numeracy and literacy activities, with the majority (68%) reporting that they *sometimes* did. A statistically significant and positive relationship exists between mathematics and science achievement and parents spending time on numeracy and literacy activities. Learners whose parents said they often spent time with their child on educational activities achieve a mathematics score of 405 (5.0) vs. 344 (8.5) where the parent never spends time on educational activities. Internationally; 42% of parents said they spent time with their child *often* with the associated achievement score being 516 (1.0) and 507 (1.0) for mathematics and science respectively.

6.2. Pre-primary education, including Grade R

Percent of learners attending Grade R and the mathematics and science achievement



Preschool attendance in South Africa is almost universal with 92% of learners having some schooling prior to Grade 1. A quarter of learners attend for one year or less, with 17% participating in pre-primary education for two years, and half (51%) for three years or more.

Three quarters (77%) of learners attended Grade R in the primary school they attended.

The figure presents the percent of learners attending Grade R and their related mathematics and science scores. The achievement of learners attending Grade R is significantly higher than those who do not attend Grade R with a difference of 35 points for mathematics and 47 points for science.

6.3. Literacy and numeracy readiness for Grade 1

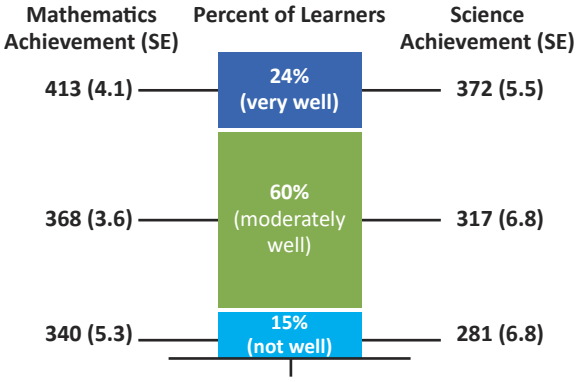
The literature informs us that a quality pre-school education will prepare learners for Grade 1 and their subsequent schooling journey. Parents rated their children's readiness for school literacy and numeracy. Figure 10 shows the proportion of learners who could perform the three literacy and three numeracy activities before commencing with Grade 1.

Figure 10: Percent of learners with strong literacy and numeracy skills prior to Grade 1

	Recognise most Letters of the Alphabet	Write Letters	Read some Words	Count by Themselves up to 100	Recognise Written Numbers up to 100	Write Numbers up to 100
National	52	49	38	28	24	27
No-Fee Pating	51	48	39	25	22	26
Fee-Paying	55	49	36	37	30	26

Parents reported that close to half the learners were able to recognize (52%) and write (49%) most of the letters of the alphabet and 38% were able to read some words. Fewer learners displayed numerical readiness, and only a quarter could count by themselves (28%), recognise written numbers (24%) and write numbers (27%). Parents reported literacy and numeracy readiness of their children for Grade 1 was surprisingly similar in fee-paying and no-fee schools, except for the item 'count by themselves up to 100' where more learners in fee-paying school showed that skill in particular.

Parents reports of Readiness for Literacy and Numeracy Tasks when beginning primary school



A *Literacy and Numeracy tasks* scale was developed based on parents' responses on how well their children could do 12 tasks before entering Grade 1. The figure on the left hand side reports the rating of the learners and their mathematics and science achievement.

Nationally, one in four parents said that their children were very well prepared before entering Grade 1. Higher mathematics and science scores were significantly associated with learners whose parents said they were well prepared for literacy and numeracy: Learners rated as very ready scored 413 (4.1) for mathematics vs. 340 (5.3)for learners not ready.

7. SCHOOL AS ENABLING LEARNING ENVIRONMENTS

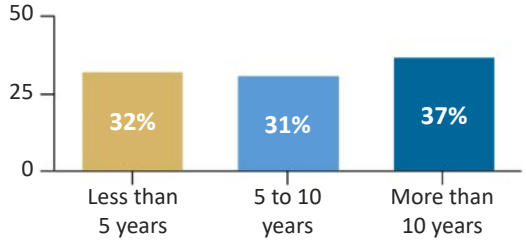
In context of high household poverty levels, parents and society often view schools and classrooms as institutions that can equalise opportunities for learners from poorer homes, and attempt to level the playing field of educational success. Thus schools must be managed by a principal with suitable skills, qualifications and good leadership skills, who is able to appropriately utilise the resources at their disposal. Good working conditions, facilities and sufficient resources are important for promoting a favourable learning environment.

School leadership

School leadership, resources and location

77% of learners attended schools where the Principal had at least a Bachelor degree

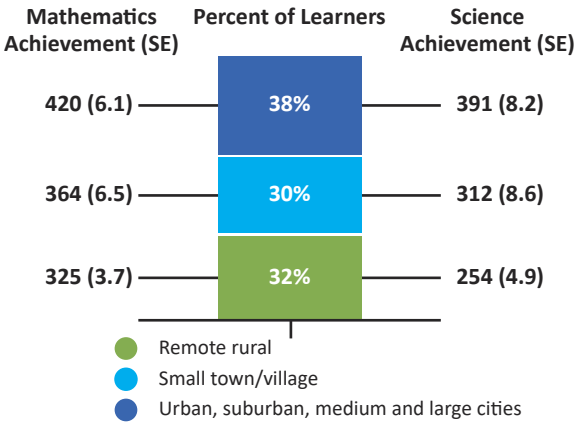
Percent of learners attending schools in relation to Principal's experience in years



The literature points to significant links between the principal's qualification and years of experience, and their leadership style. Three quarters (77%) of learners attended schools where the principal had at least a Bachelor degree (17% Bachelor, 49% Honours, 9% Masters and 2% Doctoral degree) and a quarter (23%) are in schools where the principal has a diploma qualification. On average, learners attended schools where the principals had nine years' experience as a principal, with broadly a third (32%) having less than five years' experience, a third (31%) between 5 and 10 years, and a third (37%) more than 10 years' experience).

Location

Mathematics and science achievement by school spatial location



Principals described the area surrounding their schools, where the schools' spatial location serves as a proxy of the socio-economic status of the surrounding community.

Roughly a third of learners attended schools in urban or suburban areas (38%), a third in small towns (30%), and a third in remote rural areas (32%). There are significant achievement gaps for both mathematics and science, with learners in urban schools scoring higher than learners in remote rural schools.

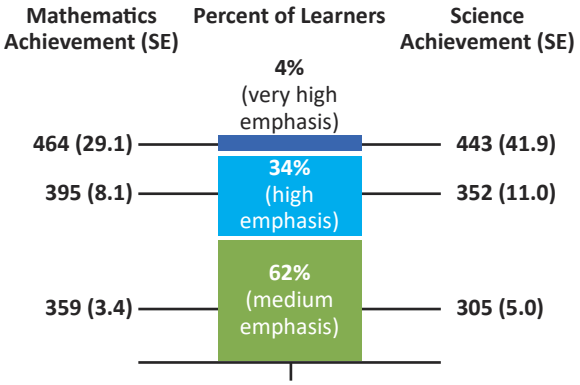
On average, mathematics scores for learners in urban schools is 420 (6.1) compared to 325 (3.7) in remote schools, a 95 point difference which equates to nearly one standard deviation.

8. SCHOOL CLIMATE PROMOTING ACADEMIC ACHIEVEMENT

School climate is a multidimensional construct that refers to the quality and character of school life, and echoes norms,values and interpersonal relationships. A school with a positive climate is one whetre emphasis is placed on academic success, learners feel safe, and disciplinary rules are adhered to. There are associations between school climate and both academic achievement and social-emotional development.

School emphasis on academic success

Mathematics and science achievement by the Emphasis on Academic Success scale

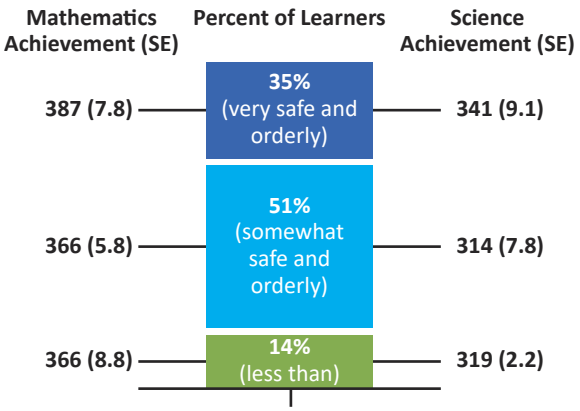


The *School Emphasis on Academic Success scale* was based on the principals' responses to 11 statements.

Four in ten South African learners (compared to six of ten internationally) attended schools which placed a higher emphasis on academic achievement. Learners in schools that placed a higher emphasis on academic success achieve significantly higher mathematics and science scores. On average, learners achieved a mathematics score of 464 (29.1) in schools that placed a very high emphasis vs. 359 (3.4) in schools with medium emphasis, a differnce of over one standard deviation.

Safe and orderly schools

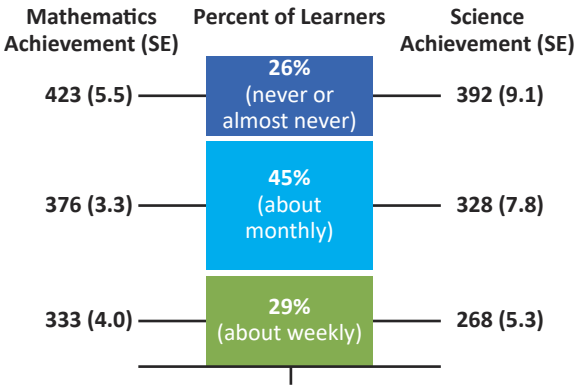
Mathematics and science achievement by Safe and Orderly Schools scale



Mathematics and science educators rated their schools on eight statements, for a *Safe and Orderly Schools* scale. One in three South African learners (35%) attended schools rated as 'very safe and orderly' (compared to 61% internationally). Learners in schools that are very safe and orderly achieve significantly higher mathematics and science achievement scores: the mathematics score for learners in very safe and orderly schools was 387 (7.8) vs. 366 (8.8) in less than safe and orderly schools. Figure also shows that there is no difference in mathematics scores between learners in "somewhat safe and orderly schools" (51%) and those in "less than safe and orderly schools" (14%)

Incidences of bullying

Mathematics and science achievement by the incidences of bullying in schools



Learners reported how often they had experienced 11 different forms of bullying (physical, verbal or through digital devices) from their school peers to create a *Student Bullying* scale.

South Africa experienced higher levels of bullying than most other participating countries: just over a quarter (26%) of South African learners say they were 'never or almost never bullied', compared to the international average of 63%. Learners who were never or almost never bullied have significantly score difference of 90 point for

9. CLASSROOMS: EDUCATORS AND RESOURCES

Successful learning is likely to be influenced by the calibre of educators, the quality of the classroom environment and instructional activities, as well as the resources available to support instruction. We will report on (i) Educators, and (ii) Resources and materials available to support mathematics and science instruction.

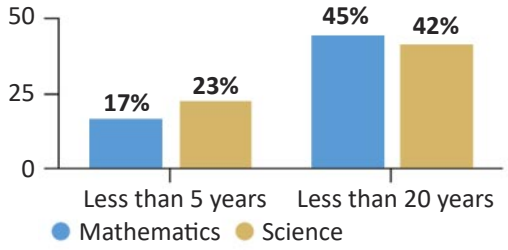
9.1. Educator preparation, experience and challenges

of learners were taught by mathematics and science educators with, at least, a Bachelors degree

Two thirds
of learners were taught by educators with a mathematics specialisation

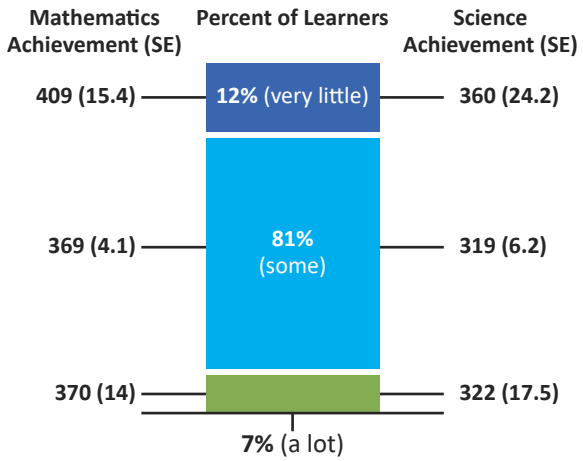
Half
of learners were taught by educators with a science specialisation

Percent of leaners taught by educators with less than 5 years, and more than 20 years, experience



Educators with the requisite subject knowledge and experience contribute to higher mathematics and science achievement. Educators with, at least a Bachelor degree, taught 62% of mathematics learners and 58% of science learners. Just over a third of learners were taught by educators with a post-secondary qualification. Educators with the respective specialization taught two-thirds of mathematics learners and half the science learners.

Learners are taught by experienced educators: mathematics educators report having an average of 17 years and science educators 16 years' experience. Educators with less than five years' experience taught 17% of mathematics learners and 23% of science learners, while educators with over 10 years' experience taught two-thirds of learners. There is no association between years of experience and mathematics or science achievement.



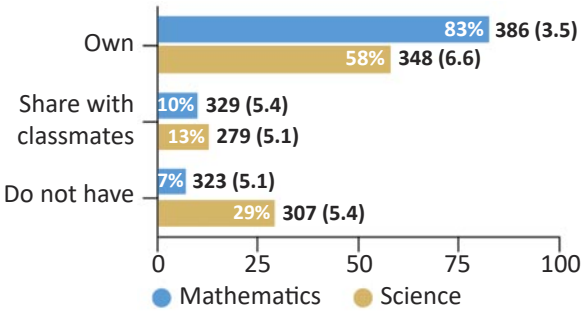
Educators reported on eight attributes related to the extent to which teaching is limited by learners not being ready for instruction (e.g. lacking pre-requisite skills, nutrition, sleep etc) on the *Classroom Teaching Limited by Students Not Ready for Instruction* scale.

Only a small number (12%) of learners were unaffected ('very little") and deemed to be ready for instruction (compared with 36% internationally). They achieve significantly higher mathematics and science scores than those affected 'a lot' or 'some'. The mathematics scores of learners ready for instruction is 409 (15.4) in comparison with 370 (14.0) for those least ready.

10. MATHEMATICS AND SCIENCE RESOURCES AND MATERIALS

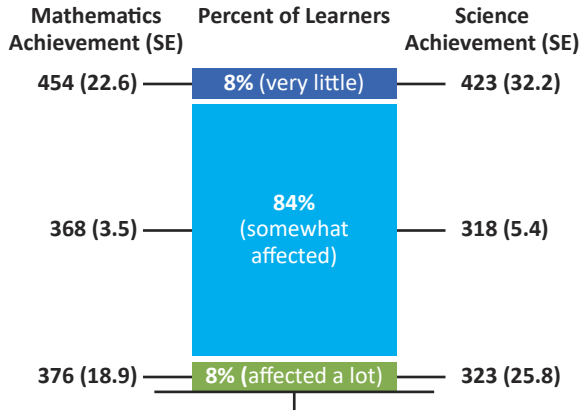
The extant literature has long since found a strong association between academic achievement and availability of resources in schools.

Percentage of learners with access to workbooks and related achievement



Central to providing quality basic education, the DBE is required to provide learners with high quality learning materials, like workbooks. Nine in ten mathematics learners and seven in ten science learners either had their own, or shared, a workbook). Significant achievement differences exist between learners who have access to a workbook to their own workbook and those who do not. Mathematics learners who have their own workbook score 386 (3.5) points in comparison with learners who share and score 329 (5.4) points, a difference of 57 points.

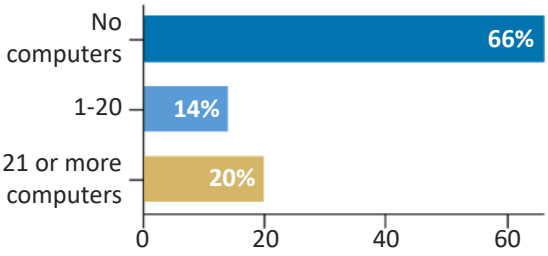
Mathematics and science achievement by mathematics and science resource shortages, 2019



Principals responded to questions on how the schools capacity to provide instruction was affected by a shortage of 13 different resources (8 general school resources and 5 mathematics/science resources) to create the Instruction *Affected by Mathematics/ Science Resource Shortages* scale.

In South Africa, only 8% of learners attend schools that are not affected by resource shortages (compared to 26% internationally), while the majority are somewhat affected (84%). Learners in schools with adequate resources achieved significantly higher mathematics- 454 (22.6) and science- 423 (32.2) scores than learners attending schools *somewhat and affected a lot* by resource shortage.

Technology access in schools



Pre-Covid, educational systems invested in digital technology to promote learning. The coronavirus pandemic put a spotlight on digital learning and highlighted the inequalities in access to digital resources.

According to principals, two thirds of Grade 5 learners (66%) do not have access to computers, 14% have access to between 1 and 20 computers, and 20% have more than 20 computers.

SECTION D: KEY FINDINGS

Having administered TIMSS for the first time at the Grade 5 level in 2015, the data from TIMSS 2019 provides a methodologically sound measure to establish the trend in mathematics performance, as well as set a baseline for achievement in science. This will contribute to monitoring progress in the primary education system. In this final section we draw together the main findings from the most recent analysis.

Findings from mathematics and science achievement data

1. **Mathematics and Science Achievement:** Of the 64 countries and regional entities who participated in TIMSS, South Africa continues to be one of the lower performing countries in both mathematics and science with scores of 374 (3.6) and 324 (4.9) respectively. Variations in achievement for mathematics and science differ considerably when looking at the distribution of scores between the 5th and 95th percentiles. Science has a wider distribution, meaning a larger variation in science scores compared to mathematics. The different mathematics and science distributions suggests that science learners experience additional problems in accessing the science content. (See point 7 for further discussion here).

2. **Mathematics and Science ability:** TIMSS achievement scores can describe mathematics and science abilities that learners are able to demonstrate (referred to as International Benchmarks). On a positive note, 16% of mathematics and science learners scored higher than the 475 points (Intermediate Benchmark) meaning that they are able to apply knowledge to solve problems.

   Just over one-thirds (37%) of South African learners demonstrated that they had acquired basic mathematical knowledge and 28% had acquired basic science knowledge. By way of contrast; this means that 63% of learners had not acquired basic mathematical knowledge and 72% had not acquired basic science knowledge.

3. **Achievement trends:** The TIMSS 2015 and 2019 cycles provided the first trend measure for mathematics achievement. The difference of average mathematics score of 376 (3.5) in TIMSS 2015 and 374 (4.7) in TIMSS 2019 is not statistically significant. This means that there was no change in the achievement performance over these two periods.

   In order to meet the country's developmental objectives, the Medium Term Strategic Framework (2019–2024) (DPME, 2014)[4] set the target for the TIMSS average mathematics score, in Grade 5, of 426 in 2023. Currently, this target does not look attainable.

   From the TIMSS data, we are unable to explain, why achievement scores did not increase. The Grade 5 results are particularly perplexing as the TIMSS mathematics and science achievements increased at Grade 9. We recommend an investigation into the primary school education sector, including issues such as the support provided to primary schools in relation to secondary schools, nature of teaching, learning and assessments in primary schools.

4. **Achievement gaps:** Achievement in South Africa continues to be unequal with significant achievement differences between learners attending no-fee or fee-paying schools. The achievement gap between learners attending fee-paying and no-fee schools is 109 points for mathematics and 150 points for science. This confirms the well-known narrative that advantage begets advantage, and there is a compounding continuity of home disadvantage to schools.The disadvantage appears to affect the learning of science more than it does mathematics.

[4] DPME. (2014). Medium Term Strategic Framework 2014-2019.
https://www.dpme.gov.za/keyfocusareas/outcomesSite/MTSF_2019_2024/2019-2024 MTSF Comprehensive Document.pdf

5. **Provincial achievement gaps:** The provincial achievement gaps (difference between the highest and lowest performing province) is 110 points for mathematics and 141 points in science. To achieve an increase in learner achievement requires improvements in both school and outside school conditions.

6. **Gender Gaps:** The mathematics and science achievement scores are significantly higher for girls than for boys. This significant differences are also apparent in fee-paying and no-fee schools for mathematics and in no-fee schools for science. Schools (and policy) must pay additional attention to the learning patterns of boys and the support that must be provided to them.

Findings from curriculum data (see the Curriculum Analysis Highlights Report)

7. Science achievement is lower than mathematics achievement and the wider science distribution points to higher variation in Grade 5 science abilities. The lower science achievement scores must be viewed against the backdrop that the curriculum includes the Numeracy learning area from Grade 1, while the Natural Science and Technology learning area is only introduced in Grade 4. Our analysis also reveals that there is an 80% match between the TIMSS and the South African Currculum and Policy Assessment Statement (CAPS).

   The lower science scores is much more visible in the most disadvantaged schools and provinces, and suggests that additional challenges (e.g. language, resources and educator knowledge) may have an impact on the teaching and learning of science. In addition to mathematical improvement programmes, national and provincial authorities must focus on providing support for the science subjects.

8. In order to answer the TIMSS assessment successfully, 60% of the Grade 5 items require learners to use higher cognitive skills of application and reasoning. The South African assessment framework places a greater focus on the skills of knowing and solving routine problems and there is limited emphasis applying and reasoning skills. School and national assessments should include more items at higher cognitive levels.

9. Learners performed better in items that required them to select a response (multiple choice question) than in items where they had to write a response (constructed response). Learners were unable to coherently write descriptions or explanation. The national reading strategy should be expanded to become a reading and writing strategy.

Findings from contextual data

Many home, school and classroom factors influence mathematics and science achievement. Parents and society expect schools and classrooms to ameliorate home disadvantages.

10. The availability of educational resources in the home is significantly correlated with mathematics and science achievement. Learners from homes who lack basic services like running tap water and flush toilets in their homes obtain lower achievement scores. In order to improve achievement the starting point for some learners is improved home conditions.

11. Early numeracy and litearcy development is significantly associated with achievement in school mathematics and science. A quarter (28%) of South African parents, as compared to 42% internationally, often engaged with their children on literacy and numeracy tasks. Learners who are exposed to these engagements achieve significantly higher mathematics and science scores.

    For parents who may be unable to participate in educational play with their children, an alternative could be high quality engaging and interactive educational programmes through the public radio and television system.

12. A quarter of learners are rated as numerically ready and half as literacy ready when they enter school. The foundation phase classes must recognise the school readiness gradient amongst learners and classes need to be designed to provide additional support to learners who may otherwise be left behind.

13. The educational qualifications of both principals, and mathematics and science educators, has improved over time. Currently, three-quarters of learners are in schools where the principal had, at least, a Bachelor qualification and 60% of mathematics and science learners were taught by educators with, at least, a Bachelor degree. Two thirds of learners were taught by educators who indicated a specialisation in mathematics or science. Compared with other countries, South African educators attended the highest number of professional courses. However, the learners' mathematics and science achievements do not match the level of tertiary education and the extent of professional development courses that educators have attended. Education and training is a massive investment, and the quality of this investment should be investigated and strengthened.

14. School climate continues to explain significant variations in achievement. A positive school climate is one where schools place an emphasis on academic success, where learners feel safe and are not bullied. Compared with other countries, South African learners experienced higher levels of disciplinary, safety and bullying problems. Improving the school climate will be dependent on both what happens within the school and the community surrounding it.

15. Mathematics and science resource availability in the classroom is significantly and positively associated with academic achievement. Principals, educators and learners responded to questions about resource shortages. Learners achieve higher results in schools with better resources. As a starting point, all learners must have their own mathematics and science workbook. This is especially so for science where just 6 in 10 learners have their own workbook.

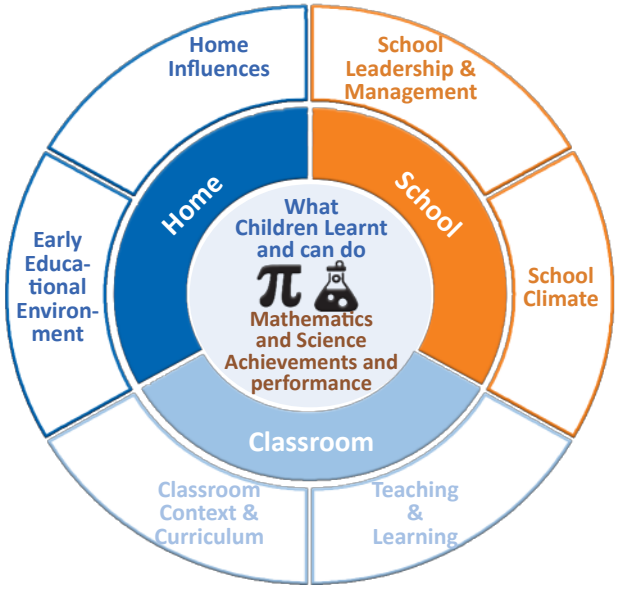
16. As the world moves toward digital platforms for learning, South Africa falls far short of adequate access to digital resources in both homes and schools. Half of South African homes and two thirds of schools do not have access to a computer. This will further disadvantage South African learners.

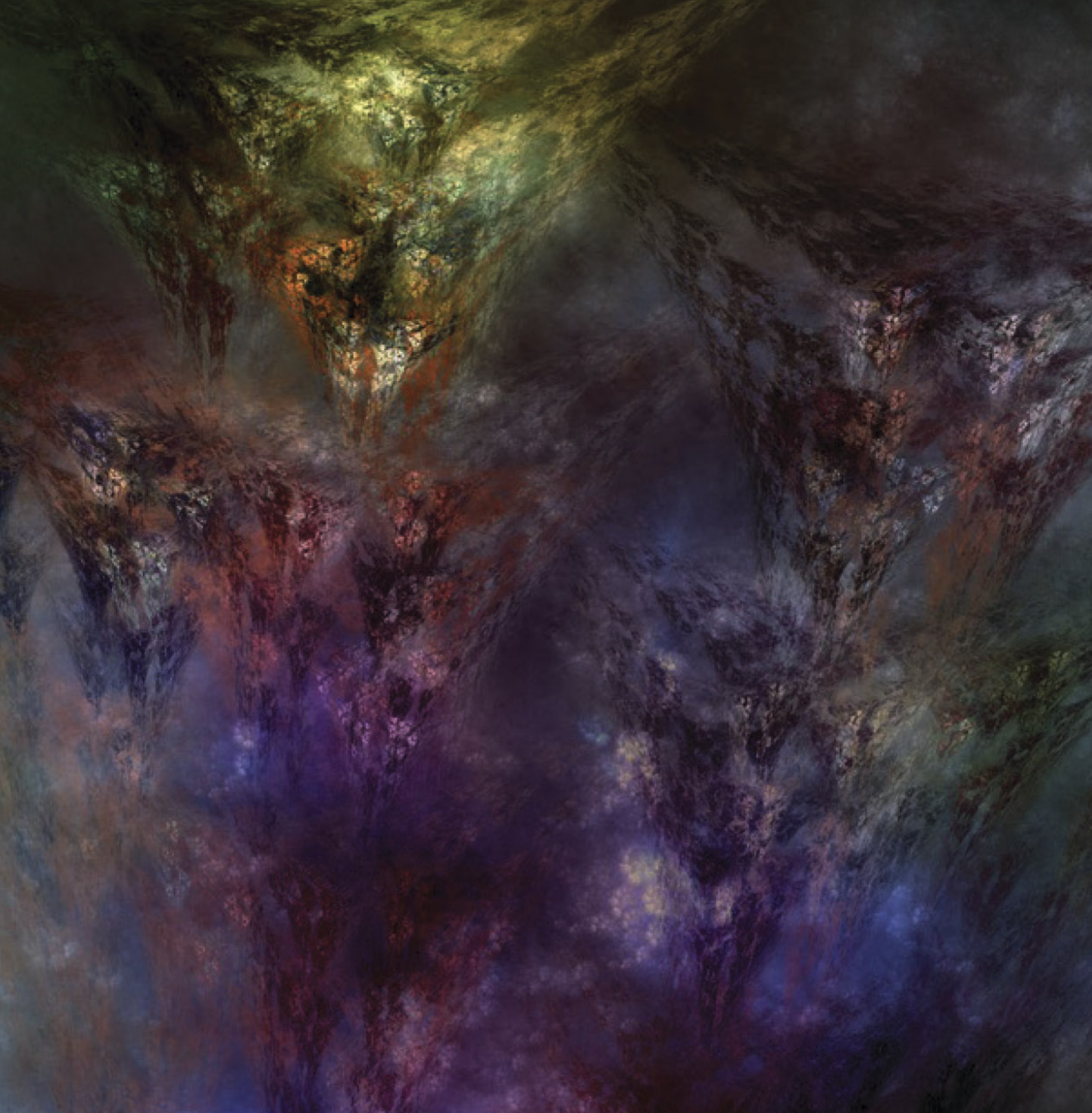
Notes

Notes

TIMSS Conceptual Framework

TIMSS uses the curriculum as the organising principle of how educational opportunities are provided to learners. The curriculum model has three aspects: (i) the intended curriculum, (ii) the implemented curriculum and (iii) the attained curriculum. The intended curriculum refers to the mathematics and science knowledge that society intends learners to learn; the implemented curriculum refers to how the educational system is organised (curriculum coverage) and the attained curriculum refers to what learners have learnt (learner achievement scores).





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