Have Grade 12 outcomes become more equitable between 2002 and 2016?

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EXECUTIVE SUMMARY

There has been little analysis of the long-range changes that have occurred in South Africa with respect to the inequality of educational performance (as opposed to just inequality of grade attainment). The current report helps to address this gap.

Careful analysis of learner-level results in the Grade 12 examinations data of 2002, 2009 and 2016 reveal that there have been important equity gains across this entire period. The focus is on the achievement of relatively high levels of performance in mathematics. Whilst mathematics is just one school subject, it is an important one. Moreover, improvements in mathematics are likely to be indicative of improvements across the curriculum, given the inter-dependence of subjects. The focus on a relatively high level of achievement is informed by the fact that there is not enough such achievement, and that this lies behind the skills shortfalls in the economy.

Very importantly, these reductions in inequality occurred whilst the overall, or average, quality of schooling was improving at the secondary level, according to the widely respected international TIMSS testing system.

Given that the examination system changed between 2007 and 2008, and given that even within one system marks are not entirely comparable across years, thresholds other than raw marks were used in the analysis. One key threshold was the mathematics mark reached or surpassed by 20% of white candidates, with candidates not taking mathematics being considered to have a mark of zero. This threshold was applied across the three years analysed. The racial inequities, even in 2016, were stark, but they were considerably worse in 2002. There has thus been progress.

Inequality arises in part out of the fact that fewer black African youths reach Grade 12 in the first place. The critical point of focus should thus be the percentage of *youths* of an age cohort, not just Grade 12 examination candidates, who reach critical levels of performance. It was found that in 2002 white youths stood 23 times as good a chance as black African youths of reaching a high level of mathematics performance (using the '20% of whites' threshold). In 2016, whites were still 7 times as likely as black Africans to attain this level of mathematics performance. There has thus been a large reduction in the inequalities, although even in 2016 the situation was not good. In fact, we could say that the degree of inequality between black African and white learners was in 2016 about a third, specifically 31%, of what it had been in 2002 (7 over 23).

A further indication of progress is the fact that whilst in 2002 just over half of high-level mathematics performers emerging from the public examination system were white, by 2016 just over two-thirds were *not* white. This development is important, in part because employment laws require employers to move towards a more demographically representative workforce, at all skills levels.

One factor which must be considered is participation in non-public examinations, in particular those of the Independent Examinations Board, and changes in the patterns of this participation. Because more whites than black Africans participate in the non-public examinations, taking this factor into account reduces the equity gains, but the gains are still

considerable. Specifically, the 2016 level of inequality turns out to be 38% of what it was in 2002 after some adjustments (and not the 31% referred to above).

What about Indian and coloured youths? Indian youths saw their probability of becoming high-level mathematics achievers reach that of whites by 2009. Coloured youths, however, saw very little progress. Their statistics improved to a much smaller degree than those of either Indians or black Africans.

What about gender-based inequalities? Here there was little progress. In both 2002 and 2016 a female Grade 12 learner experienced a probability of being a high-level mathematics performer which was about two-thirds of the probability experienced by male learners.

Schools were linked across the three years in order gauge patterns specific to being in an independent school, or being in one of the five poverty quintiles within the public system. The analysis confirms other research which has pointed to especially large gains in historically disadvantaged schools over the 2008 to 2015 period, specifically township and rural schools. Moreover, the analysis presented here indicates that this trend had begun in the years following 2002. To illustrate, the quintile with the largest percentage point increase in the percentage of Grade 12 learners becoming high-level mathematics achievers, over the full 2002 to 2016 period, was quintile 3. These increases were in fact weakest in quintile 5 schools. The closing of race-based performance gaps was thus driven largely by better performance of black African learners in historically disadvantaged schools, and not significantly by the performance of black African learners in historically *advantaged* quintile 5 schools. The geographical distribution of the improvements is also telling. Mpumalanga and Limpopo account for a disproportionately large share of the gains in high-level performance in disadvantaged schools.

The final section of this report presents the national trend in Grade 9 mathematics, broken down by socio-economic status, according to the international TIMSS data. This helps to contextualise the Grade 12 examinations analysis. The TIMSS data offer a far better basis for gauging absolute levels of performance, though the sample is too small to allow for the kinds of disaggregation permitted by the Grade 12 data. The patterns in the TIMSS data also point to improvements in the inequality of educational outcomes over the longer term (also since 2002).

Contents

1 Introduction

This short report builds, in many ways, on an earlier report by the same author[1], Gustafsson (2016). That report explains how it is possible, if one employs considerable caution, to extract important information on national trends in the quality of education and educational inequalities using examinations data, specifically data from the public Grade 12 examinations. To many South Africans, it would be surprising to hear that our Grade 12 examinations, or the 'Matric', are in general not a good source of information for gauging national progress. Commonly these examinations are used for this purpose. However, this easily results in misleading information. For example, provincial 'pass rates' (Matric passes over Matric candidates) can mislead because provinces employ different approaches when it comes to allowing learners into Grade 12 in the first place[2]. Unesco, in promoting the use of national assessments, warns against the inappropriate use of examinations data[3]:

> Governments often consider their public examination system as equivalent to a national assessment system, even though it is mainly used to promote students between levels of education. National assessments should be a diagnostic tool that can establish whether students achieve the learning standards expected by a particular age or grade, and how this achievement changes over time for subgroups of the population.

This report will show that despite the drawbacks of examination data for systemic monitoring purposes, in some ways the data can assist in the monitoring process.

Gustafsson (2016) explains why it is important to consider trends in inequalities in terms of higher levels of performance in key subjects, and not just in terms of the attainment of basic pass marks. Attaining marks that allow youths access to, for instance, mathematically-oriented university programmes can change the future prospects of individual youths enormously. Moreover, increasing the number of youths, in particular black youths, with high-level skills in certain areas is vital to deal with the skills shortfalls in the economy. A key finding of Gustafsson (2016) is that between 2008 and 2015 there were substantial equity gains. The number of black African learners attaining of levels of mathematics performance which would allow entry into, for instance, engineering at university increased by 65% over the whole period. Moreover, it was found that these improvements occurred through the expansion of mathematics excellence into a wider variety of schools, in particular township and rural schools. Whilst these trends are all good for reducing social and economic inequalities, it is also clear that even in 2015 educational inequalities remained stark.

The current report focusses on equity trends, with respect to high-level achievement in mathematics, during the period 2002 to 2016. 2002 is the base year because this was the earliest year for which microdata (learner- and subject-level data) which included race were

[1] This report is produced by Martin Gustafsson (mgustafsson@sun.ac.za), who is based in the Department of Basic Education. It draws extensively from the advice and inputs of analysts and officials in the DBE, including Dr Rufus Poliah, Carol Nuga, Hilton Visagie, Willie Venter and Stephen Taylor.
[2] Department of Basic Education, 2016: 59.
[3] UNESCO, 2014: 6.

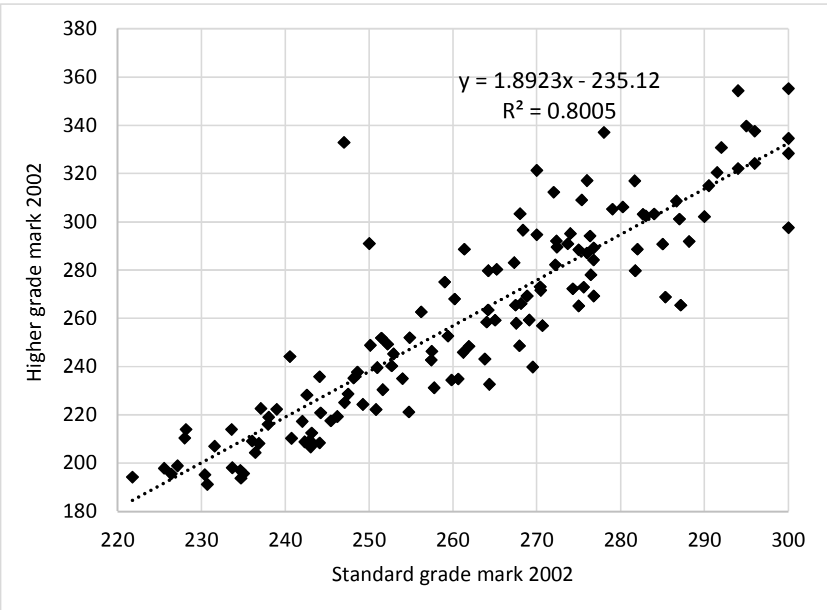
available. Microdata going back to 1999 were available, but these earlier data excluded race as a variable[4].

Focussing just on mathematics, as is done in this report, may seem very narrow. It should be remembered, however, that improvements in one subject tends to be accompanied by improvements in others. This is the nature of education. Reductions in inequality in mathematics performance are thus likely to be a sign of broader equity gains across the curriculum.

2 Equating standard grade and higher grade mathematics mark

In processing the 2002 data, a key task was to equate standard grade and higher grade marks (the distinction between the two difficulty grades existed up to 2007). In 2002, amongst the 470,778 full-time candidates in the public examination, 35,421 took higher grade mathematics whilst 224,856 took standard grade mathematics[5]. It was decided to use physical science higher grade as a basis for equating the two mathematics grades. Of the 224,856 learners taking mathematics standard grade, 26,330 also took physical science higher grade. The following graph draws from the results of 13,897 relatively well-performing learners, specifically learners obtaining at least 200 out of 400 for physical science higher grade. Points represent integer marks in physical science where there was at least one learner receiving this mark who also took mathematics standard grade, and at least one learner who took mathematics higher grade. The maximum possible mark in mathematics standard grade was 300, and for higher grade 400. The regression line provides a basis for adjusting standard grade marks to the higher grade scale.

Figure 1: Higher grade to standard grade mathematics 2002



Foxcroft (2006: 70) suggested that standard grade marks *expressed as a percentage* (for any subject) be multiplied by 0.75 to produce the equivalent higher grade mark. This would apply at one point in the range seen in Figure 1, namely at 265 on the horizontal and 266 on the vertical, so percentage marks of 88% (standard grade) and 67% (higher grade). Simkins

[4] The 1999 and 2002 data are the same data as those used by Perry (2003) for an unpublished report focussing on gender inequalities.

[5] These figures agree very closely with Perry's (2003) totals.

(2010) used regression analysis to find equivalences in the 2007 and 2008 examinations data, but does not make the 2007 correspondences across grades in mathematics explicit.

3 The race-based inequalities

The next two tables explore reductions in inequality seen in the examinations data. Each deals with a different level of performance, the first with a very high one, the second with a fairly high one. What was not done here was to identify a set of high performing and demographically stable schools as a basis for assessing the rest of the system. That was the method used in Gustafsson (2016). Given that data for the years 2003 to 2007 were not used here, and given difficulties around linking schools across years in the earlier data, the method was avoided. In its place, the level of performance reached or surpassed by 10% or 20% of white learners was used as a basis. The assumption is thus that at least roughly the performance and participation of white learners in the public system was stable over the full period. Problems with this assumption are discussed further down.

Table 1 used a '10% of whites' cut-off. In 2002, 10% of white learners obtained at least 67.0% in higher grades mathematics. If one converts standard grade results to the higher grade scale, the threshold mark moves slightly to 69.4%. In 2009 and 2016, 10% of white learners reached mathematics marks of at least 79.0% and 78.0% respectively. To get a sense of the meaning of these thresholds, a few requirements from a 2010 University of Cape Town prospectus are useful[6]. The minimum requirement for civil engineering was a 50% mark in higher grade mathematics, and 60% in mathematics within the new system existing from 2008. The threshold used in Table 1 is thus well above what one would need for these studies. On the other hand, the Table 2 information suggests that the University of Cape Town was being more demanding with respect to the old pre-2008 system relative to the new system (the threshold is below adequate for 2002, but above adequate for 2009 and 2016.)

Returning to Table 1, over the years the number of white learners attaining the threshold declined, from 5,064 in 2002 to 3,507 in 2016. This decline occurred because the overall number of whites in the public examination system declined over time (this is discussed below). The number of black Africans attaining the threshold increased from 839 to 4,493, a very large increase. The percentage of learners attaining the threshold who were white declined from 66% to 36%.

The percentages of all candidates, not just those taking mathematics, attaining the threshold mark are given in the middle column. The reason why the percentage for whites is not exactly 10.0% is due to the non-discrete nature of the marks (the percentage marks used from the data were already rounded to the closest percentage). In 2002, the probability for a white candidate of attaining the threshold was 44.6 times as large as the probability of a black African candidate. Clearly, this is a stark indication of the persistence of the apartheid legacy. Fortunately, this ratio had declined to 13.1 in 2016. There was still much inequality in 2016, but it was less than a third of what was seen in 2002. The 2009 figures confirm that one is dealing with an ongoing trend spread across many years.

The problem with focussing on percentages of candidates is that this ignores the fact that access to the examinations has been unequal, largely according to race. The last column attempts to monitor high-level performance relative to all youths. As one might expect, the inequalities in each year become starker when all youths are considered. The number of youths is from Stats SA mid-year population estimates. Specifically, 2016 official estimates were used, as well as earlier estimates accompanying the 2015 mid-year estimates. One fifth of the number of people aged 15 to 19 was used. Square brackets are used because it is clear that the mid-year population estimates are around 14% higher than one would expect, given

[6] https://www.uct.ac.za/downloads/uct.ac.za/apply/prospectus/uctugprospectus2010.pdf.

the official enrolment ratios[7]. The percentages in the last column of Table 1 would thus be under-estimates. Insofar as the gap between education and population numbers are equally large over time, this will not affect the statistics dealing with the equity *trend.*

Table 1: Using the 10% cut-off

Mark X reached or surpassed by **10%** of white examination candidates			
	Number of candidates reaching mark X	% of all candidates reaching mark X	% of youths reaching mark X
2002: Higher grade only. X is **67.0%**			
White	5,064	10.1	[7.4]
Indian	1,210	7.8	[5.6]
Coloured	353	1.0	[0.5]
Black African	839	0.2	[0.1]
Other	164	9.3	
All	7,630	1.6	[0.8]
% white	66		
Ratio W / BA		44.6	65.9
2002: Both higher and standard grades, with latter adjusted. X is **69.4%**			
White	5,137	10.3	[7.5]
Indian	1,200	7.8	[5.5]
Coloured	433	1.3	[0.6]
Black African	1,570	0.4	[0.2]
Other	158	9.0	
All	8,498	1.8	[0.9]
% white	60		
Ratio W / BA		24.2	35.7
2009: X is **79.0%**			
White	4,932	11.4	[7.5]
Indian	1,617	11.2	[7.7]
Coloured	474	1.1	[0.6]
Black African	3,403	0.7	[0.4]
Other	118	12.3	
All	10,544	1.7	[1.0]
% white	47		
Ratio W / BA		17.1	19.3
2016: X is **78.0%**			
White	3,507	10.1	[6.0]
Indian	1,123	9.7	[5.9]
Coloured	535	1.2	[0.6]
Black African	4,493	0.8	[0.6]
Other	70	12.6	
All	9,728	1.4	[1.0]
% white	36		
Ratio W / BA		13.1	10.8

[7] Department of Basic Education, 2016: 59.

Table 2: Using the 20% cut-off

Mark X reached or surpassed by **20%** of white examination candidates			
	Number of candidates reaching mark X	% of all candidates reaching mark X	% of youths reaching mark X
2002: Both higher and standard grades, with latter adjusted. X is **55.4%**			
White	10,115	20.2	[14.7]
Indian	2,362	15.3	[10.9]
Coloured	1,158	3.4	[1.5]
Black African	4,721	1.3	[0.6]
Other	245	13.9	
All	18,601	4.0	[2.0]
% white	54		
Ratio W / BA		15.8	23.4
2009: X is **66.0%**			
White	9,333	21.5	[14.2]
Indian	3,062	21.2	[14.5]
Coloured	1,274	3.1	[1.5]
Black African	10,571	2.1	[1.2]
Other	197	20.6	
All	24,437	4.0	[2.3]
% white	38		
Ratio W / BA		10.4	11.8
2016: X is **65.0%**			
White	7,192	20.7	[12.3]
Indian	2,310	19.9	[12.1]
Coloured	1,464	3.2	[1.7]
Black African	13,958	2.4	[1.7]
Other	130	23.4	
All	25,054	3.7	[2.6]
% white	29		
Ratio W / BA		8.6	7.1

What about coloured and Indian learners? Both of the above tables indicate that whilst in 2002 Indian youths experienced a lower probability, relative to whites, of achieving the performance thresholds, from at least 2009 they were performing on a par with whites. The trend for coloured learners has been worrying. The percentage of coloured youths achieving the threshold used in Table 2 advanced from 1.5%, in both 2002 and 2009, to just 1.7%, in 2016. Black African youths saw much faster progress, though their point of departure was very low.

A number of complexities must be taken into account. One is the impact of levels of participation in non-public Grade 12 examinations. Some, but not all, independent schools, plus all home schoolers, participate in non-public examinations. If whites participate to a greater extent in non-public examinations, then the inequities seen in the above tables would be under-stated. Changes in this participation also influence the larger equity picture.

Numbers on participation in non-public examinations are not easily available, but Table 3 below provides a sufficiently reliable picture. The values are percentages of one age cohort in the youth population (in other words the denominator for the last column of the previous two tables). The 2014 values use a published number of 8,795 Independent Examinations Board (IEB) candidates[8] and information that two thirds of candidates are white, and one quarter black African[9]. Moreover, 1,200 candidates within the South African Comprehensive Assessment Institute (SACAI) system, which caters for home schoolers, are counted. It is assumed that virtually all of these are white. SACAI was established in 2012. Before that

[8] Department of Basic Education, 2016: 40.
[9] Information obtained through personal communication with Umalusi officials.

another small Afrikaans-language system, Erco[10], existed. The 2009 values use a lower and published IEB number of 8,000 candidates[11]. The 2011 and 2016 values are simply based on the 2009 to 2014 linear trend. The 2002 values draw from an analysis of race-specific enrolments using the 2002 and 2011 Annual Survey of Schools datasets of the Department of Basic Education (DBE). It was assumed that the 2002 to 2011 trend would roughly follow the trend in independent school enrolments.

Table 3: Percentage of whites and black Africans taking non-public examinations

	2002	2009	2011	2014	2016
White	7.3	8.3	9.8	11.9	12.7
Black African	0.1	0.2	0.2	0.2	0.2

The figures in the above table, plus one key assumption, allow for a few illustrative and necessary adjustments to the statistics from the last column of Table 2. The one key assumption is the degree to which learners, even white ones, enjoy better chances of achieving high levels of mathematics performance in schools using non-public examinations than in schools using public examinations. This pattern would be expected for two reasons: learners in the former schools would be from more socio-economically advantaged households than those from the latter group of schools, and the former group of schools are in general better resourced (and staffed) and thus more effective. It was assumed that 30% of learners in the non-public examinations schools would reach the level of performance reached by 20% of whites in public schools (this being the threshold used for Table 2). In part this was based on patterns seen in the 2014 IEB mathematics results[12].

Key figures for Table 2 would be as follows after adjustments. The 2016 percentage of youths achieving the Table 2 threshold, taking into account results from non-public examination systems, would be 16.1 (not 12.3) for whites and 1.8 (not 1.7) for black Africans. This produces a higher (and worse) inequality ratio for 2016 of 9.0 (against 7.1 in Table 2). Similar adjustments were done for 2002. Table 2 refers to levels of white-black inequality of 23.4 in 2002 and 7.1 in 2016, meaning inequality in 2016 was 31% what it was in 2002 (7.1 over 23.4). With adjustments, one arrives at a movement from 25.6 in 2002 to 9.0 in 2016, meaning inequality was reduced to 35% of what it originally was.

However, there is a further complexity. If one compares the enrolment figures to Stats SA population estimates, it seems like the Stats SA figures under-estimate to a large degree the extent of the decline between 2002 and 2016 in the number of white youths. The alternative interpretation that a smaller proportion of whites successfully completed twelve years of schooling in 2016, relative to 2002, does not seem plausible (and would not be supported by Stats SA household data). Stats SA population estimates suggest that the number of white youths declined by 15% between 2002 and 2016. This translates into a 1.2% decline a year (this is calculated with compounding). Grade 12 enrolment figures seen in the annual survey datasets referred to above suggest that the number of white youths has been declining by 2.4% (not 1.2%) a year. This is likely to be the result of a combination of declining fertility amongst whites and emigration.

If this further complexity is taken into account in the adjustments to Table 2, one finds a reduction in inequality between 2002 to 2016 that is still large, yet not quite as large as that seen in Table 2. Specifically, inequality in 2016 turns out to be 38% of what it was in 2002 (so not the 31% or 35% referred to earlier).

[10] Eksamenraad vir Christelike Onderwys.
[11] UK NARIC, 2010: 24.
[12] Department of Basic Education, 2016: 40.

A further consideration of relevance to the above analysis is that the quality of Grade 9 mathematics performance improved between 2002 and 2015 according to the international TIMSS[13] programme. On average, South Africa improved around 0.07 South African standard deviations per year between 2002 and 2015, the average mathematics test scores being 285 in 2002, 352 in 2011 and 372 in 2015[14]. What this means is that South Africa improved, off a very low base, about as fast as one could expect any country to improve. The magnitude of South Africa's improvement is on a par with that of Brazil in the PISA[15] mathematics tests between 2003 and 2012. Brazil's improvements have frequently been referred to as the most impressive of any country in recent times[16]. The South Africa TIMSS figures in fact under-estimate the gains in the sense that dropping out before the end of Grade 9 has been reduced. Thus, for instance, the percentage of youths successfully completing Grade 9 rose from 80% to 85% between 2003 and 2011 according to household data[17]. How is all this relevant for the above analysis? What it means is that educational outcomes became less unequal *whilst overall the quality of schooling, as measured by competencies in mathematics, experienced marked improvements.*

Finally, it should be noted that though opportunities over the fourteen-year period with respect to race shifted in important ways, gender inequalities remained essentially unchanged. In both 2002 and 2016, a female Grade 12 learner's probability of being a high-level mathematics performer, regardless of threshold used, remained around two thirds of the probability of her male peers.

4 The quality trends by geographical area and school quintile

As far as possible, schools were linked across the three years covered above, namely 2002, 2009 and 2016, to allow for a breakdown of Grade 12 mathematics trends by geographical area and school quintile. In all, 4,615 schools could be linked across all three years. This compares to, for instance, the total number of schools participating in the 2016 examinations, which comes to 6,814, of which around 550 are independent schools, according to the data. To link across the three years just over two-thirds of the schools existing in 2016 is not a bad success rate. Non-success would mainly be due to the records in the data not being linkable across years, despite adjustments made to cater for small and obvious adjustments to school identifiers, and reduced versions of the school name being used, with caution, to enhance the linking[18]. To a lesser extent, non-success would also be due to the opening and closing of schools. For the purposes of the current analysis, one can be fairly certain that the two-thirds of school linked across the years would be sufficiently representative of all schools existing in the three years.

The 4,615 schools are distributed as follows across the nine provinces, the public-independent divide and (for public schools) the five poverty quintiles. The province considered was that of 2016 and the quintile that of 2011 (for a small number of schools these characteristics would have changed over the 2002 to 2016 period).

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[13] Trends in International Mathematics and Science Study.

[14] Mullis, Martin and Loveless (2016: Exhibit 1.6) and Reddy *et al* (2012: 3). Note that South Africa wrote what is internationally referred to as the 'TIMSS 2003 tests' a year earlier, in 2002. It should also be noted that in 2002 South Africa also applied the tests to Grade 8 learners, apart from the Grade 9 learners referred to here.

[15] Programme for International Student Assessment.

[16] Bruns *et al,* 2012.

[17] Department of Basic Education, 2013: 11.

[18] A reduced version of the school name would be for instance 'Amahlubi', as opposed to 'Amahlubi Secondary School' or 'Amahlubi SS'.

Table 4: Schools linked across three years

	EC	FS	GP	KN	LP	MP	NC	NW	WC	SA
Quintile 1	168	91	21	298	369	63	22	47	5	1,084
Quintile 1	169	61	43	247	322	72	26	36	10	986
Quintile 1	204	52	131	281	216	58	23	104	54	1,123
Quintile 1	106	34	143	114	42	43	14	5	82	583
Quintile 1	108	50	132	101	13	24	19	5	152	604
Quin. unknown	10		1	20		29	2	9		71
Independent	13	8	87	13	8	7	2	2	24	164
Total	778	296	558	1,074	970	296	108	208	327	4,615

Table 5 below provides statistics by category of school, with public schools being broken down by the official poverty quintile. No fee schools are essentially quintiles 1, 2 and 3 schools, though there are a few deviations from this rule. Here the '20% cut-off for whites' threshold used for Table 2 above applies. Gustafsson (2016: 15) found that over the period 2008 to 2015 gains in the number of high-level mathematics achievers were two to three times as large in township and rural schools as in historically white suburban schools. Table 5 confirms this general pattern, and indicates that the trend of faster improvements in historically disadvantaged schools was occurring already in the years following 2002. In fact, quintile 5 schools (the quintile within which most historically white schools would fall) displays a negative trend for some statistics. For instance, the percentage and number of all Grade 12 learners becoming high-level mathematics achievers dropped across the three years (top two panels in the table). The other quintiles saw increases, with the strongest being that of quintile 3 (from 1.4% of all Grade 12 learners in 2002 to 2.1% in 2016). Once again, a picture emerges of inequalities that were still stark in 2016, raising the question of how these trends could be speeded up, in part by strengthening the factors that contributed to past improvements. One positive trend is seen in the fact that a greater range of historically disadvantaged schools are producing high-level achievers. For instance, the percentage of quintile 1 schools producing such learners rose from 23% to 41% over the period, with the average high-level achievers per 'non-zero' school rising from 1.9 to 2.7 (the last two panels of the table). Figure 2 illustrates this trend.

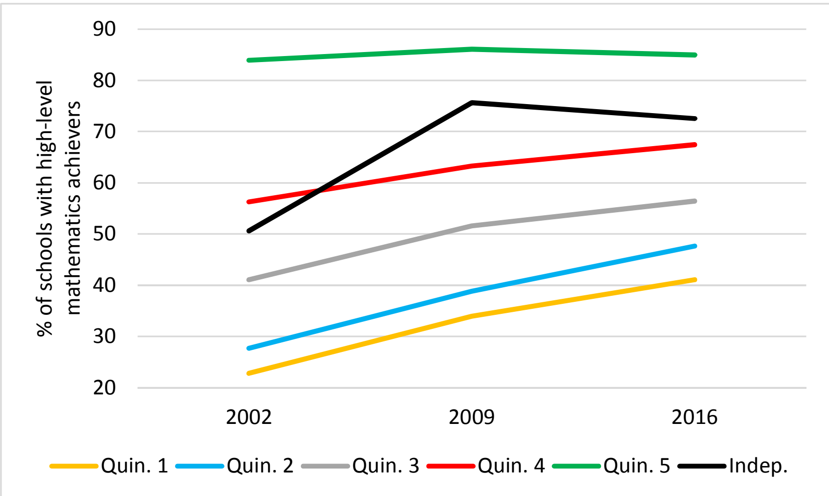
Independent schools, which have displayed ratios fairly similar to those of public quintile 5 schools, have seen improvements in the first two panels, where quintile 5 schools saw losses. This could in part be because of the migration of better performing learners from quintile 5 schools to the expanding (though still small) independent school sector.

Table 5: Mathematics achievement by school category

	2002	2009	2016	Annual change (slope)	Overall 14-year change (previous column × 14)
Mathematics high-level achievers over *all* Grade 12 candidates (whether mathematics students or not), as a %					
Quintile 1	0.7	1.0	1.3	0.04	0.6
Quintile 2	1.1	1.2	1.5	0.03	0.4
Quintile 3	1.4	1.8	2.1	0.05	0.7
Quintile 4	2.5	2.7	2.8	0.03	0.4
Quintile 5	13.2	12.3	10.3	-0.21	-2.9
Independent	9.8	9.7	10.7	0.07	0.9
Number of mathematics high-level achievers					
Quintile 1	465	782	1,209	53	744
Quintile 2	687	957	1,294	43	607
Quintile 3	1,403	2,115	2,670	91	1,267
Quintile 4	1,476	2,043	2,292	58	816
Quintile 5	10,107	10,325	8,978	-81	-1,129
Independent	948	1,207	1,100	11	152
Percentage of schools with at least one high-level mathematics achiever					
Quintile 1	23	34	41	1.3	18
Quintile 2	28	39	48	1.4	20
Quintile 3	41	52	56	1.1	15
Quintile 4	56	63	67	0.8	11
Quintile 5	84	86	85	0.1	1
Independent	51	76	73	1.6	22
Average number of mathematics high-level achievers per school (counting only schools with at least one such learner)					
Quintile 1	1.9	2.1	2.7	0.1	0.8
Quintile 2	2.5	2.5	2.8	0.0	0.2
Quintile 3	3.0	3.7	4.2	0.1	1.2
Quintile 4	4.5	5.5	5.8	0.1	1.3
Quintile 5	19.9	19.9	17.5	-0.2	-2.4
Independent	11.4	9.7	9.2	-0.2	-2.2

Note: A learner is considered a 'high-level achiever' here if a mark was achieved which would place him or her within the performance range of the top 20% of white Grade 12 learners. The approach here thus follows that of Table 2. Roughly, the cut-off used is what would permit a learner entry into a mathematically-oriented university programme. The current table draws from the 4,615 schools referred to in Table 4 (public schools with missing quintile were excluded).

Figure 2: Schools with high-level mathematics achievers



Note: Graph reflects values from the previous table.

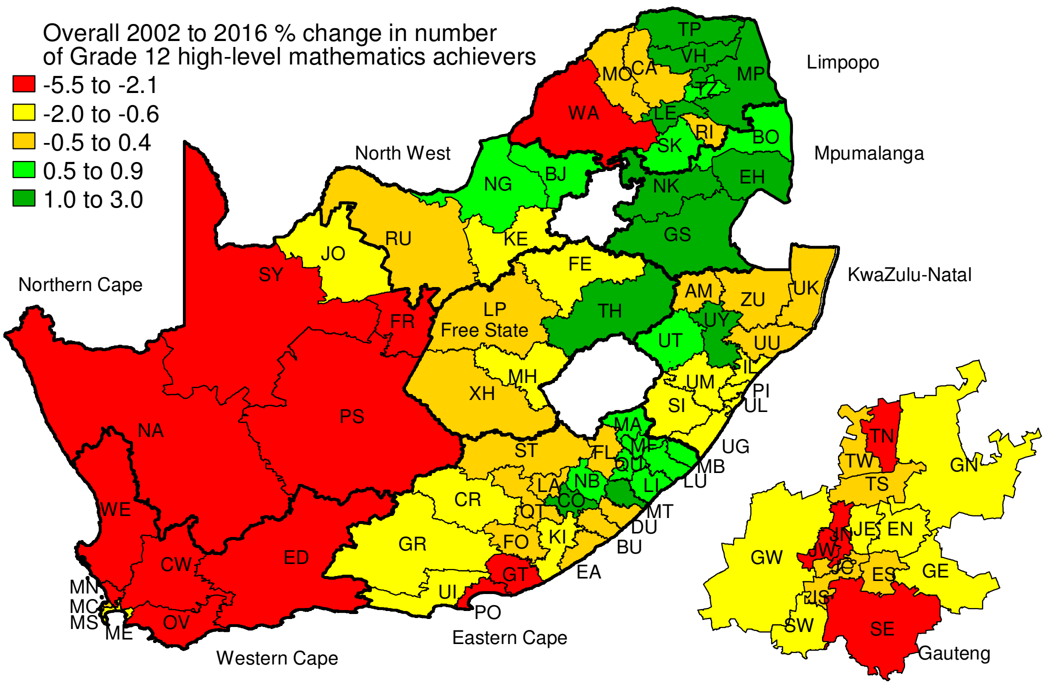
Table 6 below, which repeats the first panel of the previous table, but with statistics broken down by province, reveals a few important trends. The negative overall change values for three provinces (Gauteng, Northern Cape and Western Cape), and for the country as a whole, should be interpreted with caution. They do not necessarily point to performance that worsened over time. The '20% cut-off for whites' threshold is useful as a basis for gauging inequality, but a rather rough basis for talking about absolute levels of performance. A more reliable picture of the latter appears in the brief analysis of TIMSS data that follows. What is telling about the figures in Table 6 is that certain provinces with high levels of poverty fared much better than others. Limpopo and Mpumalanga in fact surpassed KwaZulu-Natal over the fourteen years.

Table 6: Mathematics achievement by school category

	2002	2009	2016	Annual change (slope)	Overall 14-year change (previous column × 14)
Mathematics high-level achievers over *all* Grade 12 candidates (whether mathematics students or not), as a %					
EC	2.3	2.6	2.1	0.0	-0.2
FS	4.8	3.4	4.9	0.0	0.1
GP	6.9	6.2	5.9	-0.1	-1.0
KN	2.6	2.6	2.2	0.0	-0.4
LP	1.6	2.4	2.5	0.1	0.9
MP	1.0	1.6	2.4	0.1	1.4
NC	6.2	2.5	3.0	-0.2	-3.2
NW	2.0	2.9	2.4	0.0	0.4
WC	10.4	9.6	8.3	-0.2	-2.1
SA	4.0	3.8	3.6	0.0	-0.4

The following map reflects the statistics from the last column of the above table, but by district. Again, several provisos apply. For instance, a red shading in the map could be the result of an expansion in access to schooling in a district, perhaps through migration from other districts, meaning more socio-economically learners would be enrolled, which could produce a decline in the percentage of high-level achievers. Yet the patterns are telling. The historically most deprived districts of Eastern Cape (those in the east of the province) have seen the largest improvements (using the percentage increase statistic), which would be consistent with a reduction in inequality. Moreover, it is noteworthy that districts in the northern half of KwaZulu-Natal appear to have seen more progress than the districts in the south of this province.

Figure 3: 2002-2016 mathematics trends by district

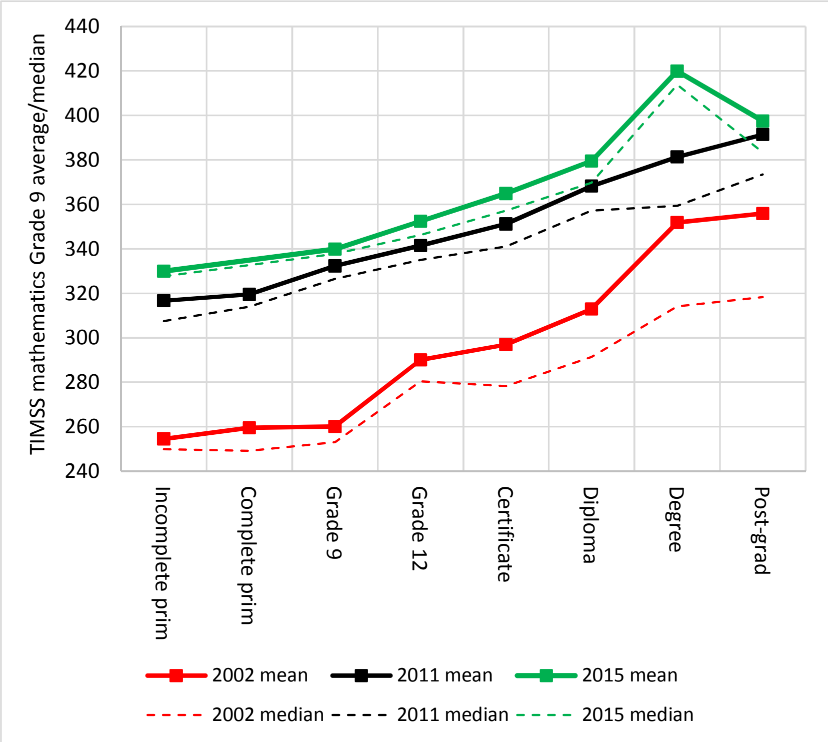


Note: The smallest geographical units shown in the map are the 86 education districts. Codes are explained in Department of Basic Education (2016c: 47).

5 Equity trends seen in the Grade 9 TIMSS mathematics data

To conclude the current report, one graph using TIMSS data is discussed, as this contextualises the above Grade 12 mathematics analysis in important ways. Figure 4 expands on a graph published by the Department of Basic Education (2016: 70), by adding the latest 2015 trends. The graph shows that improvements over time occurred for all socio-economic levels, where the latter is measured by the highest level of education of anyone in the learner's household. Mathematics improved for the children of the rich and the poor, to put it plainly. This is a vital point for understanding a few of the statistics seen above. The best data South Africa has, for the country as a whole, to measure progress over time, does not indicate that the rich experienced performance declines. If that appears in previous statistics, it is because of the relatively crude thresholds used. Of course a key advantage with the previous statistics is that they can be broken down to a low level, for instance the education district. The TIMSS sample makes even the measurement of progress at the province level problematic.

Figure 4: TIMSS 2002 to 2015 trends by parent education



Source: Calculated from the raw TIMSS data downloadable at https://timssandpirls.bc.edu. The 'Complete prim' point is missing from the 2015 curve as this category seems to have been merged with 'Incomplete prim' in the 2015 data.

But did the poor gain more than the rich, according to TIMSS? The answer is yes. If one takes the vertical distance between the 2002 means and 2015 means in the graph, this is found to be largest for the lowest socio-economic levels. To illustrate, it is a gain of 76 for 'Incomplete prim' and 80 for 'Grade 9'. These are the largest of all the vertical gaps. For the category 'Degree' it is 68. Thus households with less educated adults, meaning less advantaged households, saw the largest gains. By definition, this points to a reduction in the inequality of educational performance. This is in line with the findings of the above Grade 12 analysis.

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