

Academic Apartheid; a Longitudinal Analysis of Educational Output Inequality
in Post-Apartheid South Africa

Aaron Orelowitz

Stuyvesant High School

Academic Apartheid; A Longitudinal Analysis of Educational Output Inequality in Post-Apartheid South Africa

Aaron S. Orelowitz, 245 West 104th Apt.9A, New York, NY 10025

Stuyvesant High School, New York, NY

Teacher and/or Mentor: Ellen Schweitzer, Nic Spaul

Educational inequality has persisted in South Africa since the nation's inception. Conceived in the systemic inequality of imperialism, the learning gap continued to flourish under Apartheid law and played a major role in the oppression of South Africa's black majority. In 1994, the Apartheid era ended with the election of Nelson Mandela. Although this led to the abolition of legalized racism, the effects of structural racism lingered through educational inequality. The role of this study is to use the data from the "Trends in International Mathematics and Science Study" (TIMSS) in order to exemplify the resolution of the learning gap. The TIMSS data is a cross-national assessment which uses math and science multiple choice questions to evaluate the outputs of different educational systems. Alongside these tests, students must fill out surveys. By using survey responses in tandem with math and science results, I am able to illustrate the disparity and better inform policy in the future.

INTRODUCTION

“Education is the most powerful weapon which you can use to change the world.”

-Nelson Mandela, July 16, 2003

During the 46 years between 1948 and 1994, South Africa was governed by the National Party, an oppressive regime. This lengthy administration was notorious for its discriminatory legislature which sought to subjugate an unrepresented black population by economic, educational, political, and violent means. In 1953, the Minister of Native Affairs, Hendrik Verwoerd, approached Parliament with the intention of lowering the quality and tightening the government control of black schools. This led to the passage of the Bantu Education Act of 1953 which further segregated the ruptured nation. It lowered the quality and grade to which blacks were taught under the racist pretense that they were not fit for a European curriculum and were born to a lower class of society. This ruling also led to the assimilation of charitable mission schools into the state public system. The nature of this institutional racism grew more and more oppressive as the country neared what seemed to be the beginnings of a civil war (Fiske and Ladd).

The transition from apartheid to a free democratic state can be shown by the election of the African National Congress (ANC) in 1994. From this election the world would see a surprisingly peaceful end to this geopolitical crisis. The ANC preceded their election with the writing of *A Policy Framework for Education and Training* which outlined a number of goals that the ANC would hope to execute (Christie). The South African Schools Act was then passed in 1996 and the reformers would hopefully begin to see an equal standard of education for the first time. The ratification of a new constitution also brought about a new philosophy on education with

the inclusion of Article 29 section 2. It states, “Everyone has the right to receive education ... in public educational institutions where that education is reasonably practicable... taking into account equity, practicability, and the need to redress the results of past racially discriminatory laws and practices.” Many believe that this has not been the case. South Africa has Gini coefficient of 0.7 making it one of the most consistently unequal countries in the world (Bhorat 2004). This fact has led many skeptics to sense that South Africa has not broken from its durable inequality and infer that discrimination still runs deep in the education system. Currently South Africa is still governed by the African National Congress, but it seems as though there is still quite a distance before educational equity can be achieved.

Lack of educational equity can be severely detrimental to the nation’s development. It has been shown that students living in societies with structural inequality receive lower results in school both because of the student’s lack of opportunity and also due to a less visible lack of confidence (Pickett). This means that the existence of inequality is in of itself holding back a lot of potential by engineering a less confident generation of young minds. Thus, education inequality can actually be self-perpetuating turning it into an even more irreversible situation for a country.

Human Capital Theory states that educated workers are more productive and as a result will be more valuable to a society (Mincer). This continues to be true in modern South Africa as those with higher levels of education make distinctly greater incomes (Leibbrandt). Not only are the economic effects injurious, but from a more ethical standpoint, the learning gap prevents social mobility for the lower class black families. Education may be one of South Africa’s greatest chances of shaking their apartheid past, and the first step is closing the gap.

ABOUT THE DATA

The Trends in International Mathematics and Science Study (TIMSS) has been acquiring information on the state of South Africa's primary and secondary schooling since the fall of Apartheid in 1994. Through a series of tests, this international study to allow countries to use their data for various reasons including motivating curriculum reforms and allowing countries the opportunity to contextualize outputs. For the purposes of this project, I used their assessments from 1995, 1999, and 2011 measure the extent of the output disparity. I used the surveys that students fill out alongside the exams as a metric of their wealth to see if the less wealthy population is still being deprived of the education which their constitution had promised them.

The assessment is split into five tests which evaluate the math and science abilities of the students. The math tests cover areas of understanding including background knowledge, performing routine procedure, using complex procedure, and problem solving. The science tests cover understanding simple information, understanding complex information, theorizing, using tools, using scientific processes, and investigating the natural world. For the purposes of my research, I used the each student's average score on the five tests to indicate aptitude and in turn their quality of schooling.

The TIMSS supplementary surveys contain no questions about race or economic status. This lack of this information has forced me to create a method of measuring household wealth. I used a section of questions that asks about what assets each student's household possesses. Although these questions differ on each year of tests I can still give every student a relative "asset index." The questions include whether the student owns a calculator, computer, desk, and many other essential school items. For the purposes of this project I will assume that each student's asset index is an accurate measure of wealth and that there is a direct connection between household wealth and the index.

ANALYSIS OF SCIENCE SCORES

The science test includes a wide array of topics which range between earth science, life science, physical science, and environmental issues. Most of the problems are multiple choice questions although there are a few short answer questions as well. I have included examples of the questions below for further insight to how students are tested.

<p>J2. Which species have been on the Earth for the shortest amount of time?</p> <ul style="list-style-type: none">A. HumansB. InsectsC. FishD. Reptiles	<p>J4. Which is an example of a chemical reaction?</p> <ul style="list-style-type: none">A. The melting of iceB. The grinding of salt crystals to powderC. The burning of woodD. The evaporation of water from a puddle
<p>J7. How are warm-blooded animals different from cold-blooded animals?</p> <ul style="list-style-type: none">A. Warm-blooded animals have a higher metabolism in warm weather.B. Warm-blooded animals are more aggressive in captivity.C. Warm-blooded animals always have a higher blood temperature.D. Warm-blooded animals normally maintain a fairly constant internal temperature at all air temperatures.E. Warm-blooded animals are found only in warm climates.	<p>J5. Which form of solar radiation causes sunburn?</p> <ul style="list-style-type: none">A. VisibleB. UltravioletC. InfraredD. X-raysE. Radio waves

The difficulty of the questions somewhat varies but remains realistic for the grade levels which are being tested. The questions are also distinctly focused on testing only the given child's scientific knowledge and not being influenced by any other biases. This means that if there is a noticeable drop in scores from the richer quintiles to poorer quintiles it isn't due to the lack of wealth in the lower quintile but instead because of a lack of education which they receive.

First I graphed the 1995 assessment (Figure 1.1). This test was administered almost immediately after the end of Apartheid. This meant that an inequality would not be abnormal

since the education system has had very little time to be reformed. The density graph of the scores below strongly supported this.

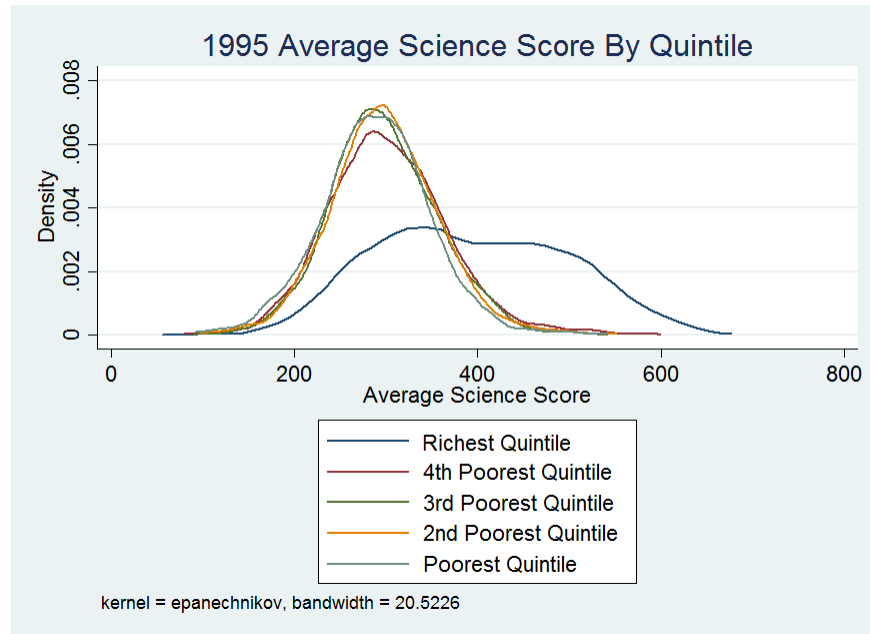


Figure 1.1

In this graph there is a distinct difference in scores between the richest quintile and the poorer 80 percent of the sample. We see that the richest 20 percent receives a more even distribution and has a large range which spans from 200 to 600. In contrast, the four poorer quintiles are very condensed and seldom surpass 400 points. This makes a lot of sense, during the Apartheid the upper class white South-Africans received many more opportunities for learning and so those who capitalized on these chances were able to far surpass the lower class black citizens who received weaker state-monitored educations. I have included the summary of the scores and variance (Figure 1.2) to further support this case.

5 quantiles of assetindex	Summary of AverageSci	
	Mean	Std. Dev.
1	371.06465	102.10353
2	301.83092	66.079454
3	298.17529	58.911995
4	298.39791	59.860885
5	289.16139	60.299655
Total	311.73183	77.414708

Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	8793710.05	4	2198427.51	431.32	0.0000
Within groups	49884116	9787	5096.97722		
Total	58677826.1	9791	5993.03708		

Figure 1.2

We can see in figure 1.2 that on average, the richer students score about 70 points higher than the underprivileged ones. We can also see from the last column in the variance analysis that there is less than a 0.0001 chance that there is not a statistical significance between one's asset quintile and academic output.

This shows that in a system a discriminatory education the poorer children will be marginalized. The more important focus of this research is whether or not this marginalization has shrunk under the ANC. Below I have included the graphs from 1999 (Figure 1.3) and 2011 (Figure 1.4) to see if the inequality has disappeared over these 15 years.

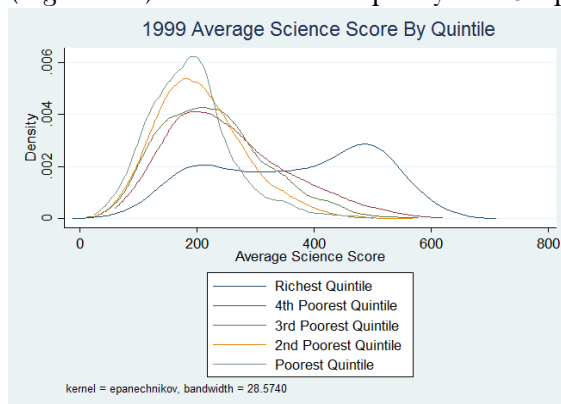


Figure 1.3

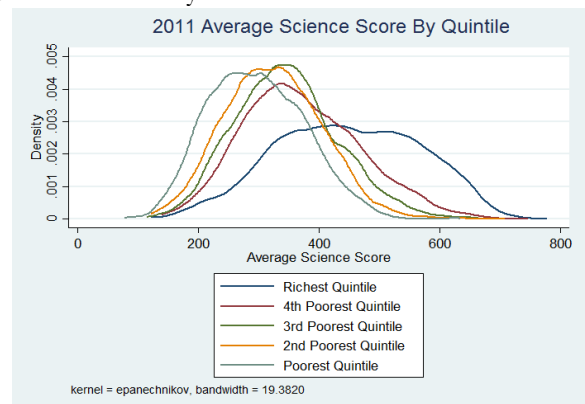


Figure 1.4

These results would be considered concerning. We see that the scores actually appear to become more polarized in 1999 and simply return to the original inequality in 2011. This shows that the post-apartheid South Africa has done very little to successfully combat the burden of their inequality.

5 quantiles of assetindex	Summary of AverageSci	
	Mean	Std. Dev.
1	359.53225	140.10423
2	252.80443	103.2555
3	227.63889	90.932985
4	207.13187	77.195429
5	188.51993	71.566868
Total	247.20841	116.40386

Figure 1.5

5 quantiles of assetindex	Summary of AverageSci	
	Mean	Std. Dev.
1	461.50487	114.38443
2	370.59227	97.367261
3	344.90978	85.647718
4	323.41356	80.874947
5	296.10522	79.368603
Total	362.03698	110.24157

Figure 1.6

Source	Analysis of Variance					Source	Analysis of Variance				
	SS	df	MS	F	Prob > F		SS	df	MS	F	Prob > F
Between groups	29487362.8	4	7371840.7	742.05	0.0000	Between groups	75555887	4	18888971.7	2182.50	0.0000
Within groups	80876229.5	8141	9934.43428			Within groups	186795304	21583	8654.74235		
Total	110363592	8145	13549.8579			Total	262351191	21587	12153.2029		

Above are the summaries of the 1999 (Figure 1.5) and 2011 (Figure 1.6) statistics. Figure 1.5 shows the means drifting even further apart and an extremely small probability that these variables are not connected. Figure 1.6 also shows that same low probability and once again we see the top wealth bracket dominating over the lower ones to a disconcerting level.

I should note that although the inequality is persistent the range of scores shifts between the different years. This is because the level at which South Africans are being taught changes in conjunction to the exams. If anything this should make these figures even more concerning because it shows how the inequality is able to persevere even as results fluctuate.

For my final section of this analysis I composed three pie charts (Figures 1.7, 1.8, 1.9) which show the wealth breakdown of the highest 20 percent of scorers. I could extrapolate from this which students are receiving the best science educations and, in turn, get a rough estimate of which brackets are receiving the highest allowance of social mobility. The results add an even more alarming edge to the already disturbing information of the density curves. We see in these pie

charts that not only do the richer students dominate the top scores but their presence has been growing since the end of Apartheid.

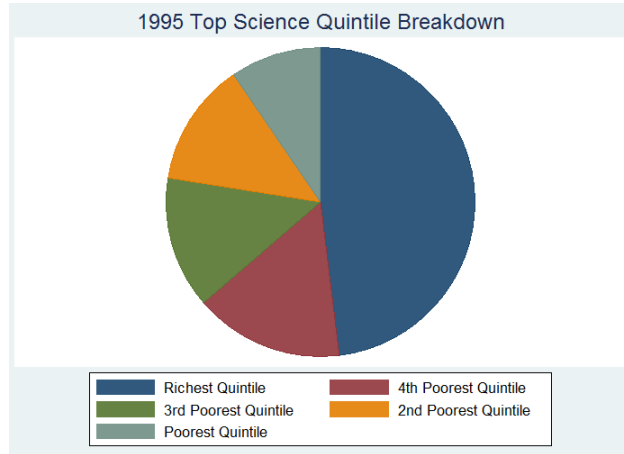


Figure 1.7

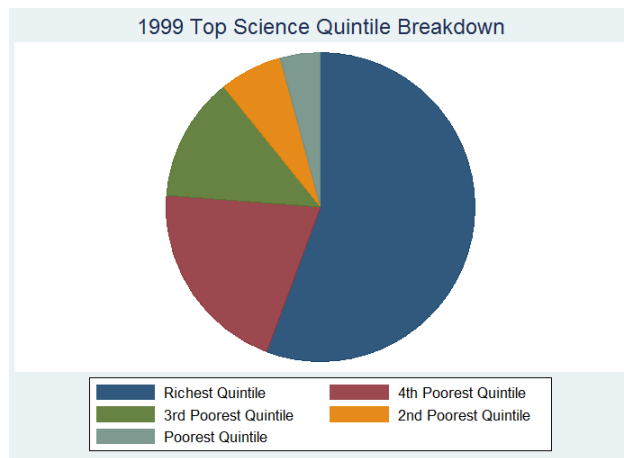


Figure 1.8

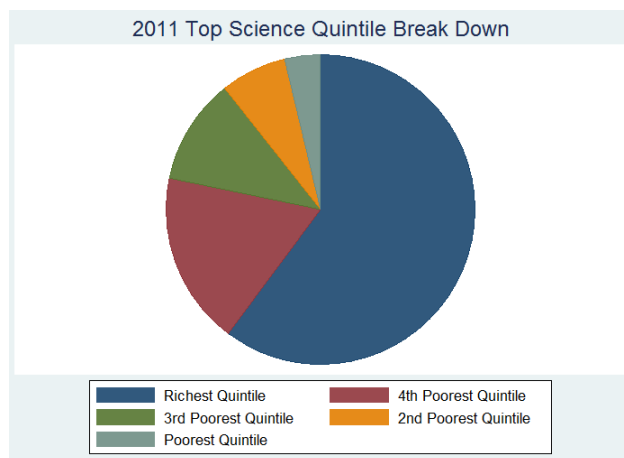


Figure 1.9

ANALYSIS OF MATH SCORES

The second section of TIMSS is the math assessment. Math testing will offer us a second perspective on the educational outputs as it relies very little on any outside knowledge and is based almost solely on what the student has learned in school. If we see the same distressing results as we saw in the science scores this will prove that the distinct gap isn't due to the actual lifestyle of a poorer student but instead due to the education they are getting in their schools. Below there are attached example questions to once again give insight into the question style.

<p>I1. Brad wanted to find three consecutive whole numbers that add up to 81. He wrote the equation $(n - 1) + n + (n + 1) = 81$. What does the n stand for?</p> <p>A. The least of the three whole numbers</p> <p>B. The middle whole number</p> <p>C. The greatest of the three whole numbers</p> <p>D. The difference between the least and greatest of the three whole numbers</p>	<p>J11. A quadrilateral MUST be a parallelogram if it has</p> <p>A. one pair of adjacent sides equal</p> <p>B. one pair of parallel sides</p> <p>C. a diagonal as axis of symmetry</p> <p>D. two adjacent angles equal</p> <p>E. two pairs of parallel sides</p>
<p>I4. The numbers in the sequence 2, 7, 12, 17, 22, ... increase by fives. The numbers in the sequence 3, 10, 17, 24, 31, ... increase by sevens. The number 17 occurs in both sequences. If the two sequences are continued, what is the next number that will be seen in both sequences?</p> <p>Answer: _____</p>	<p>J14. Divide: $0.004 \overline{)24.56}$</p> <p>A. 0.614</p> <p>B. 6.14</p> <p>C. 61.4</p> <p>D. 614</p> <p>E. 6140</p>

The questions contain content from units such as fractions, geometry, algebra, data representation, measurement, and proportionality. Once again, the questions are relatively reasonable for the grades which they apply to and have a fair amount of variety. I plugged in the scores from each year (figure 2.1, 2.2, 2.3) and made density graphs similar to the previous ones

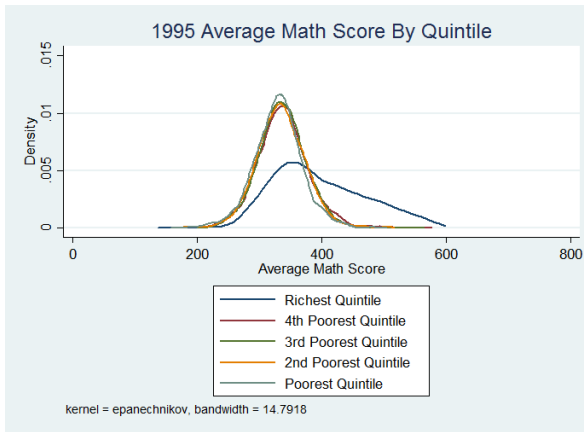


Figure 2.1

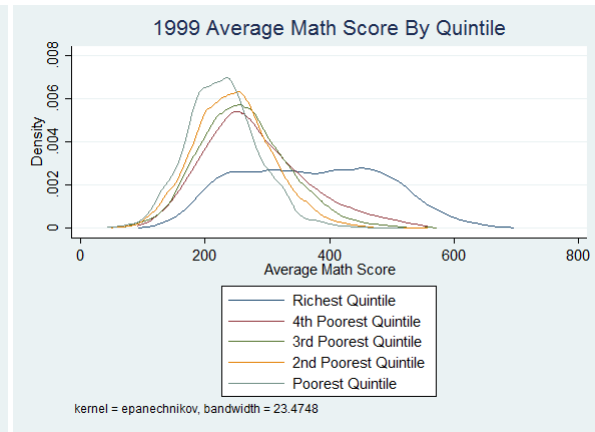


Figure 2.2

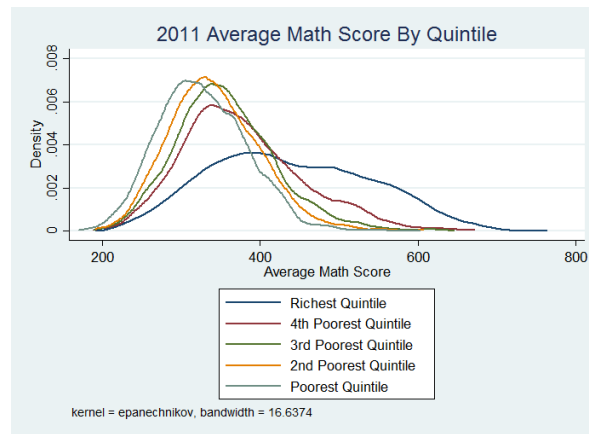


Figure 2.3

Readers should find these graphs to be as disturbing as the science ones. We can see disparity so clearly that it looks as though almost no progress has been made in mending the gap. The charts which preceded these graphs supported my thesis with the difference in means and variance once again.

5 quantiles of assetindex	Summary of AverageMath	
	Mean	Std. Dev.
1	382.00179	71.819724
2	337.77206	42.654428
3	336.36152	38.182846
4	334.48917	39.806928
5	329.29666	38.891247
Total	343.98778	51.725911

Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	3619656.53	4	904914.133	392.28	0.0000
Within groups	22576848.6	9787	2306.82012		
Total	26196505.1	9791	2675.56992		

Figure 2.4

5 quantiles of assetindex	Summary of AverageMath	
	Mean	Std. Dev.
1	366.38125	115.72103
2	280.40777	83.892692
3	263.60422	72.162326
4	245.98786	63.585229
5	228.51624	58.741282
Total	277.0476	94.488821

Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	18740173.6	4	4685043.39	706.58	0.0000
Within groups	53979505.4	8141	6630.5743		
Total	72719678.9	8145	8928.13738		

Figure 2.5

5 quantiles of assetindex	Summary of AverageMath	
	Mean	Std. Dev.
1	450.57318	98.438429
2	376.50152	76.090092
3	356.25617	63.62511
4	342.33173	57.877969
5	326.93494	56.097996
Total	372.72847	85.826463

Source	Analysis of Variance			F	Prob > F
	SS	df	MS		
Between groups	44188056.7	4	11047014.2	2076.43	0.0000
Within groups	114825707	21583	5320.19214		
Total	159013764	21587	7366.18167		

Figure 2.6

One significant aspect of these scores, in contrast to the science ones, is the smaller standard deviations in each of the years. We find that math scores are a lot more standardized throughout the country and can probably extrapolate that this has to do with a more standardized curriculum. In some respects, this should make our graphs even more alarming. Even in subjects with nationalized concrete curriculum we see upper class families receiving the best educations and producing the strongest outputs.

One could make the argument that one determinant of your wealth quintile are helpful resources for math such as calculators or computers. Although this concern exists, at the time of the test none of these resources were accessible and the students were able to reap as little benefit from them as possible. The only possible manner in which a determinant of quintile created an unfair advantage is if the child had gained prior knowledge from their personal use of these items.

For the final piece of my analysis I created pie charts (figure 2.7, 2.8, 2.9) once again to map the economic status of the highest scorers. We see the same thing as in the charts of science scores. The upper class has a growing presence as the highest outputs. This is in direct contrast with the beliefs of the ANC and once again shows the lack of progress in closing the disparity.

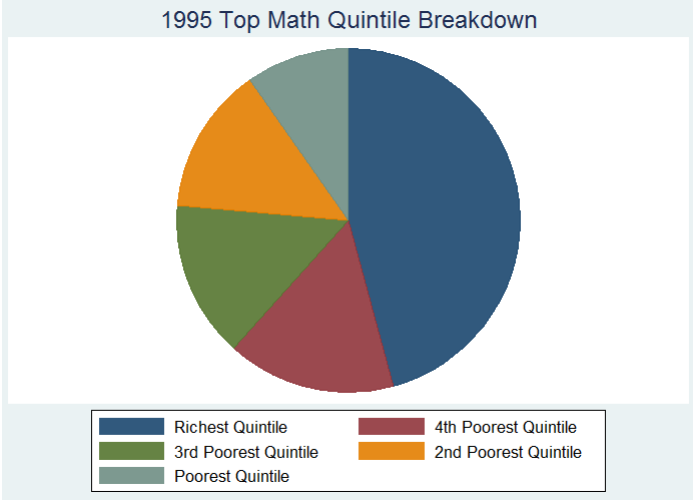


Figure 2.7

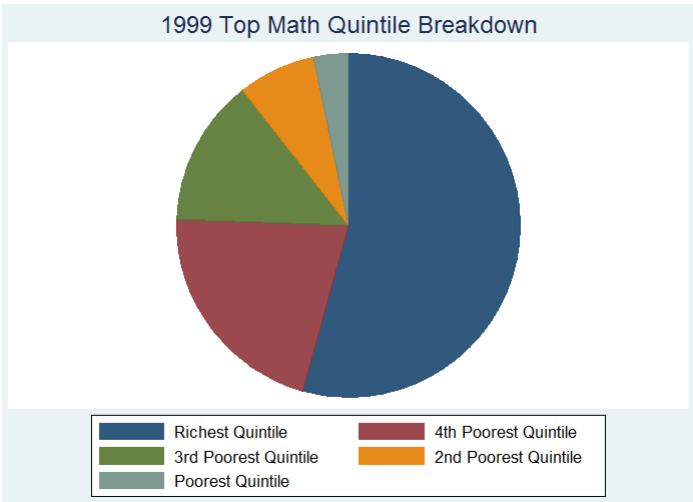


Figure 2.8

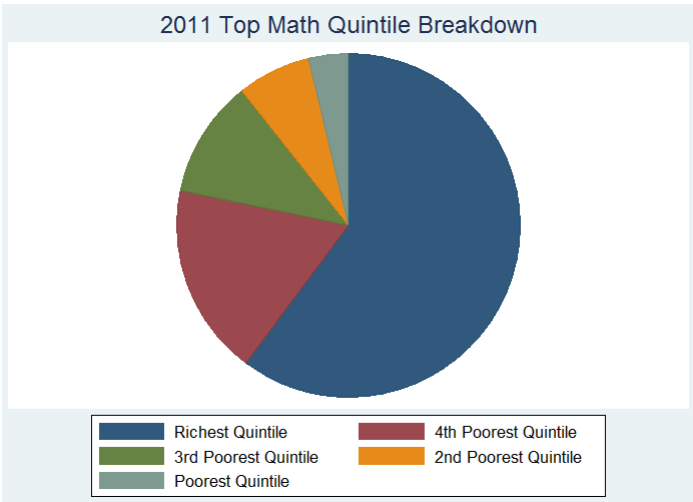


Figure 2.9

CONCLUSION

We have seen little to no change in the inequality regardless of the shift in national focus. If this rate of change remains low we can assume that South Africa's development will be hindered and the social inequality will be perpetuated. This situation should be one of the nation's top priorities and a constant concern of the government. So what is allowing the inequality to exist so prominently?

Many say the answer lies in teachers. Approximately 80% of 6th and 7th grade math teachers were trained to a lower level than the grade they teach (Spaul). The education system definitely can't be doing its job effectively with this statistic being true. One must wonder how it is possible for education to be evenly distributed if such a scarcity in mentorship exists. If teachers were better educated we could more easily break from the apartheid legacy and provide strong public educational backgrounds to South Africans regardless of wealth.

I think that the most policy oriented change that the government could implement would be the increased funding of teacher colleges. Such a change would allow for a more skilled teacher pool that could set off a chain reaction and better equip the whole workforce.

It should be noted that currently it is difficult for South Africa to focus so heavily on a single issue. The country faces many problems ranging from its HIV epidemic to political corruption. This means that even if education reform were to solve a great number of these issues, it is difficult to apply reforms in the first place. South Africa still has a long road before it can reach universal quality education, but with a couple well placed changes great progress can be made.

Bibliography

Bhorat, H., Hirsch, A., Kanbur, R., & Ncube, M. (Eds.). (2014). *The Oxford Companion to the Economics of South Africa*. Oxford University Press.

Bhorat, H. (2004). "Labour Market Challenges In The Post-Apartheid South Africa." *South African Journal of Economics*, 72(5), 940-977.

Bhorat, H. (2004). Changing class: Education and social change in post-apartheid South Africa (pp. 267-292). L. Chisholm (Ed.). London: Zed Books.

Branson, N., Garlick, J., Lam, D., & Leibbrandt, M. (2012). "Education and Inequality: The South African Case." Working paper.

Branson, N., Kekana, D., & Lam, D. (2013). *Educational expenditure in South Africa: Evidence from the National Income Dynamics Study*.

Christie, P. (2008). Opening *the doors of learning: Changing schools in South Africa* (pp. 1-235). Johannesburg: Heinemann.

Fiske, E. B., & Ladd, H. F. (2004). *Elusive equity: Education reform in post-apartheid South Africa*. Brookings Institution Press.

Leibbrandt, M., Woolard, I., Finn, A., & Argent, J. (2010). Trends in South African income distribution and poverty since the fall of apartheid.

Mincer, J. (1958). "Investment in human capital and personal income distribution." *The journal of political economy*, 281-302.

Spaull, N. (2013). "Poverty & privilege: Primary school inequality in South Africa." *International Journal of Educational Development*, 33(5), 436-447.

Spaull, N., & Kotze, J. (2015). "Starting Behind and Staying Behind in South Africa: The case of insurmountable learning deficits in mathematics." *International Journal of Educational Development*, 41, 13-24.

Spaull, N., & Taylor, S. (2014). Combining Educational Access and Educational Quality into a Single Statistic. *Development Policy Research Unit Policy Brief*, (14/31).

Wilkinson, R. G., & Pickett, K. (2011). *The Spirit Level*. Tantor Media, Incorporated.

Venkat, H., & Spaull, N. (2015). "What do we know about primary teachers' mathematical content knowledge in South Africa? An analysis of SACMEQ 2007." *International Journal of Educational Development*, 41, 121-130.