How well do South African schools convert grade 8 achievement into matric outcomes?

STEPHEN TAYLOR, SERVAAS VAN DER BERG,VIJAY REDDY AND DEAN JANSE VAN RENSBURG

Stellenbosch Economic Working Papers: 13/11

KEYWORDS: SOUTH AFRICA, SOCIO-ECONOMIC STATUS, EDUCATION, EDUCATIONAL ACHIEVEMENT, EDUCATIONAL INEQUALITY
JEL: I20, I21, I30, O15

STEPHEN TAYLOR
DEPARTMENT OF ECONOMICS
UNIVERSITY OF STELLENBOSCH
PRIVATE BAG X1, 7602
MATIELAND, SOUTH AFRICA
E-MAIL: STEPHEN@SUN.AC.ZA

SERVAAS VAN DER BERG
DEPARTMENT OF ECONOMICS
UNIVERSITY OF STELLENBOSCH
PRIVATE BAG X1, 7602
MATIELAND, SOUTH AFRICA
E-MAIL: SVDB@SUN.AC.ZA

VIJAY REDDY
EXECUTIVE DIRECTOR
EDUCATION AND SKILLS DEVELOPMENT
HUMAN SCIENCES RESEARCH COUNCIL
PRIVATE BAG X07, 4014
DALBRIDGE, SOUTH AFRICA
E-MAIL:VREDDY@HSRC.AC.ZA

DEAN JANSE VAN RENSBURG
JUNIOR RESEARCHER
EDUCATION AND SKILLS DEVELOPMENT
HUMAN SCIENCES RESEARCH COUNCIL
PRIVATE BAG X07, 4014
DALBRIDGE, SOUTH AFRICA
E-MAIL:
DJANSEVANRENSBURG@HSRC.AC.ZA

A WORKING PAPER OF THE DEPARTMENT OF ECONOMICS AND THE
BUREAU FOR ECONOMIC RESEARCH AT THE UNIVERSITY OF STELLENBOSCH

How well do South African schools convert grade 8 achievement into matric outcomes?

STEPHEN TAYLOR, SERVAAS VAN DER BERG, VIJAY REDDY AND DEAN JANSE VAN RENSBURG

ABSTRACT

School retention in South Africa and performance in the major school-leaving matric examination are characterised by significant inequalities on the basis of race and socio-economic status. In order to know at what point in the educational trajectory policy interventions and school improvement programmes will be most effective, it is necessary to trace the development of these educational inequalities to earlier phases of schooling and before. This paper reports on findings from a unique dataset that tracks individuals who participated in TIMSS in 2002 as grade 8 students to matric in 2006 and 2007. This permits an investigation into the extent to which educational inequalities are already evident by the eighth grade, and what if anything is achieved by secondary schools to reduce them.

Several noteworthy findings emerge. The overall level of achievement, at both grade 8 and matric, differs widely across the historically different parts of the school system. There are also intriguing differences in the abilities of different parts of the system to convert grade 8 achievement into matric outcomes. What is clear is that inequalities in the cognitive ability of students at the outset of secondary school persist and that there is no observable evidence of a closing of these gaps by matric. This points to the importance of interventions prior to secondary school – at the primary school level and even at the level of early childhood development. Finally, it is also demonstrated that the decision to take mathematics in matric is characterised by a high degree of randomness within the historically black part of the school system. This points to the value of meaningful assessment practices and feedback to students, which serve as an important signal as to whether or not to choose mathematics as a matric subject.

Keywords: South Africa, Socio-economic Status, Education, Educational Achievement, Educational Inequality

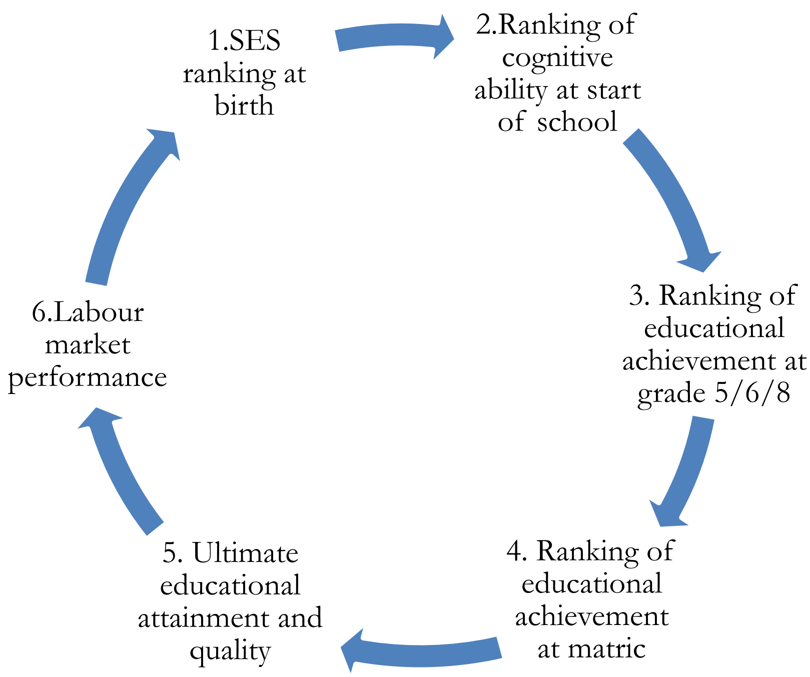
JEL codes: I20, I21, I30, O15

1. Introduction

It is well known that the outcomes of the major school-leaving examination in South Africa (the matric examination) are still characterised by substantial inequalities along racial and socio-economic lines. In 2007 less than 40% of black South Africans between the ages of 21 and 25 had attained matric. In contrast, this figure was more than 80% for white and Indian South Africans.[1] In the 2007 matric examination, one in 11 white students achieved A-aggregates whereas only one in 640 black students achieved A-aggregates. Furthermore, nearly half of those black students that did achieve A-aggregates were in historically white and Indian schools.

It is important to trace the development of these educational inequalities to earlier phases of schooling and before in order to discern the stage(s) in the educational trajectory of children that policy interventions and school improvement programmes can be expected to be most effective. Educational inequalities are established very early on in life through the impact of home background (including socio-economic status) on cognitive development, which begins virtually from birth and continues throughout an individual's education. One's educational attainment in turn affects labour market success and determines the socio-economic status of the next generation, as the so-called "earnings function" literature has shown. This idea is conveyed in Figure 1, which is a schematic diagram illustrating intergenerational mobility and the role of education therein.

Figure 1: Schematic diagram of the role of education in intergenerational mobility

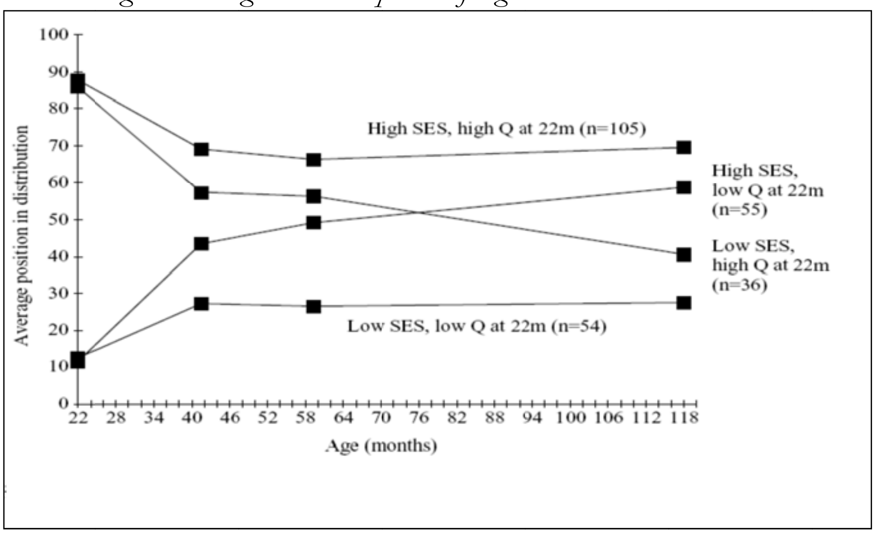


[1]Based on calculations from the Community Survey of 2007.

The figure depicts relative mobility rankings as a series of snapshots over time. In the first snapshot individuals are born into a particular position along the socio-economic ranking. The figure then shows snapshots throughout the trajectory of an individual's educational development and into the labour market. There is substantial evidence to account for the links between the various stages depicted in the schematic diagram. Several international studies have observed powerful effects of family SES on the cognitive development of children very early on in life. Feinstein (2003) has shown that even by the age of 22 months there are considerable differences between the cognitive abilities of high and low SES children. Feinstein (2003) examined the trajectories of these children using panel data with test scores at age 22 months, 42 months, 60 months and 120 months, and their ultimate educational attainment at age 26. He established that the test scores at 22 months were correlated with educational attainment at age 26, although the correlation of attainment with scores at 42 months was stronger. Feinstein (2003) observed a considerable amount of relative improvement for high SES children that achieved low scores at 22 months, especially during the phase between 22 and 42 months of age. High SES children that scored poorly at 42 months achieved only small improvements in their ranking after that. Amongst low SES children, those with low initial scores tended to remain near the bottom end of the rankings at later stages while those with high initial scores were prone to slipping down the ranking, especially during the phase between 22 and 42 months.

Figure 2 is borrowed from Feinstein's (2003) study and shows the average rank position in the distribution of children in the sample at ages 22, 42, 60 and 120 months. Four groups are tracked in the figure: high SES children with high initial scores, high SES children with low initial scores, low SES children with high initial scores and low SES children with low initial scores.

Figure 2: Cognitive development of high and low SES children

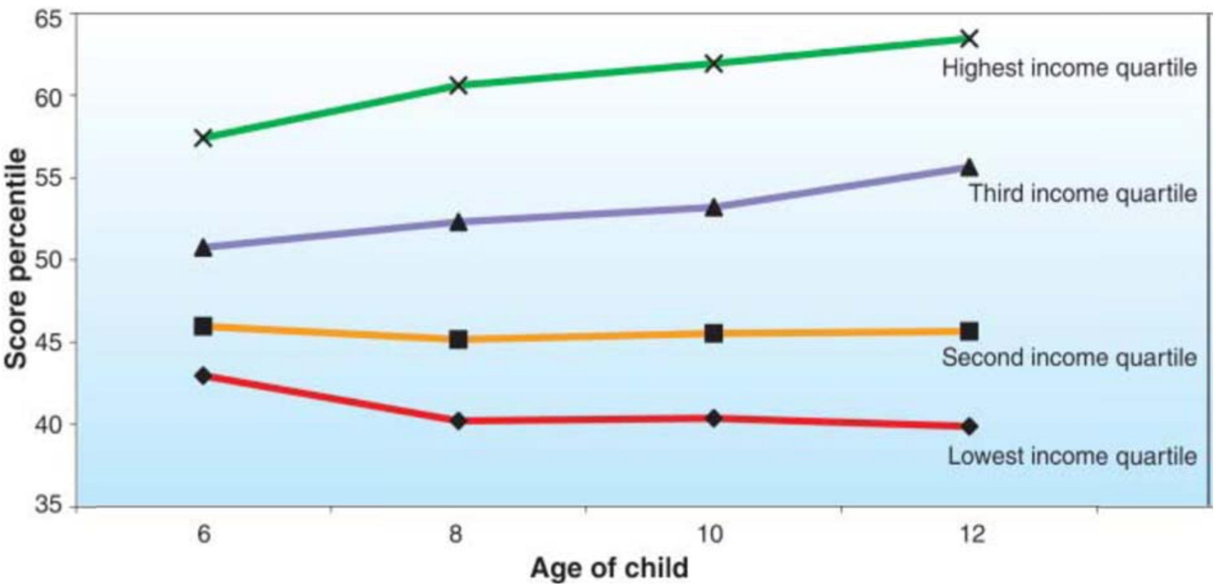


Source: Feinstein (2003: 85)

Perhaps the most disconcerting aspect of Feinstein's (2003) study was that he could find no evidence that initial inequalities were reduced by entry into the school system. The considerable degree of sorting and mobility that occurs between the age of 22 months and 42 months on the basis of SES points to the importance of educational investments made in the home and can be taken as an indication that interventions should be employed as early as possible. Heckman (2006) argues for exactly this, based on a similar piece of analysis to that of Feinstein's.

Heckman (2006: 1901) considers that although much hope is often put in schools to reduce skills gaps on the basis of SES, the motivations and abilities derived from one's family background play a far stronger role in the determination of academic performance than do traditional school inputs, which are usually the chief focus in policy debates. Heckman (2006) demonstrates this using a similar figure to the Feinstein (2003) graph shown above. Figure 3 shows the average achievement ranking (score percentile) for different income quartiles at ages 6, 8, 10 and 12. Note that the same individuals were tracked from age 6 to 12 and the income quartiles were derived from the average of family income between 6 and 10 years of age.

Figure 3: Academic achievement by SES and age



Source: Heckman (2006: 1900)

Citing the data shown above, Heckman (2006: 1901) argues that gaps in achievement are already stable by the third grade and that schools are very limited in their ability to narrow these gaps thereafter. According to Heckman, the reason for this phenomenon is the hierarchical nature of learning with early cognitive development being the foundation for all subsequent learning. As Heckman (2006: 1900) puts it, "the mastery of skills that are essential for economic success and the development of their underlying neural pathways follow hierarchical rules. Later attainments build on foundations that are laid down earlier." He points out that the track records for various forms of adult education, such as criminal rehabilitation and adult literacy, are rather dismal. In contrast, early childhood learning programmes usually enjoy particularly high returns. Heckman (2006) therefore contends that interventions amongst disadvantaged children will have greater impact at earlier ages. Moreover, from the point of view of optimising resources, he argues that most societies are over-investing in adult education and under-investing in early childhood development.

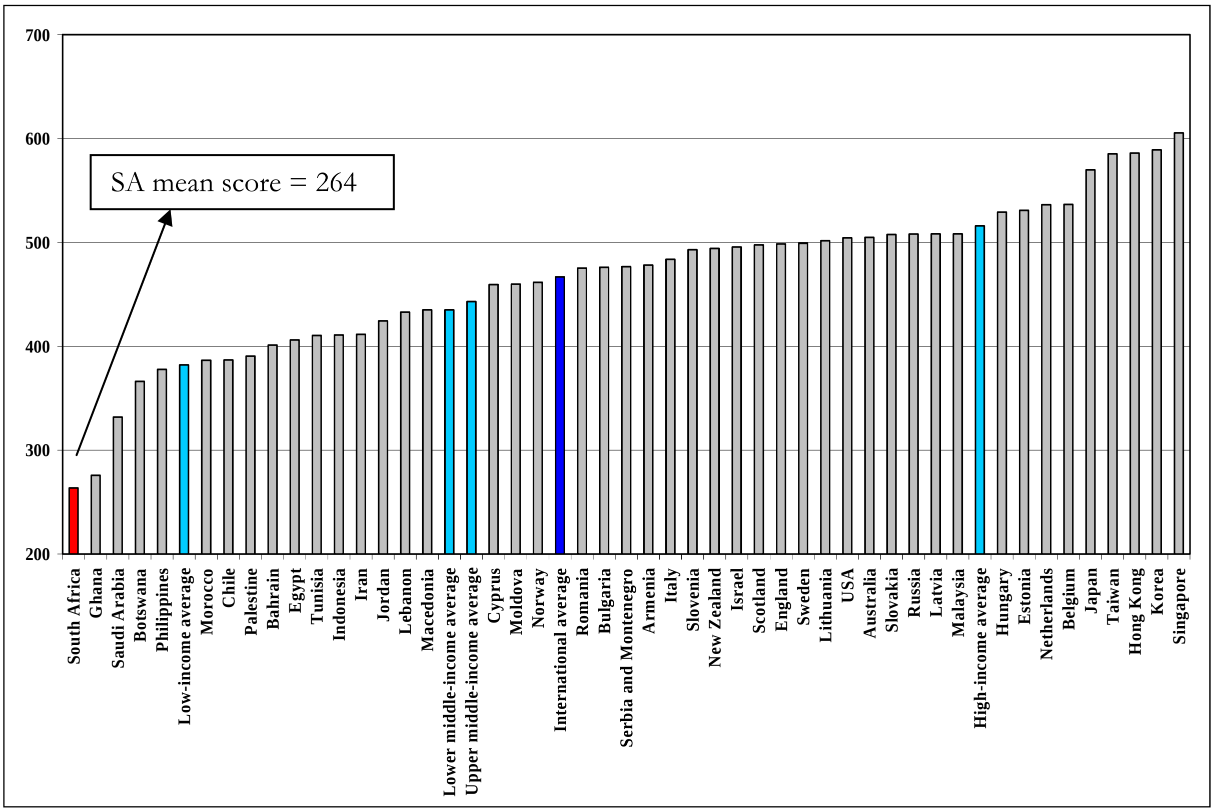
In terms of the schematic diagram in Figure 1, the research by Feinstein (2003) and Heckman (2006) demonstrates that upon entering school considerable skills gaps already exist on the basis of SES, a reality characterised by Lee and Burkham (2002) as "inequality at the starting gate." Once individuals enter the school system the hierarchical nature of learning will mean that a combination of prior learning and other factors including socio-economic status will influence cognitive development. One can think of the effect of socio-economic status on educational achievement over time as consisting of a direct effect and an indirect effect. The direct effect is the ongoing impact of differential home conditions, such as access to resources, nutrition and educational support. The indirect effect is the accumulated impact of socio-economic status on all prior educational development, which is the foundation for new learning. These effects are always operating together as individuals progress through the educational trajectory depicted in Figure 1. Encouragingly, Gustafsson (2010) has found that, for those in rural areas, attending pre-school (i.e. prior learning) had a significant positive impact on primary school learning that was independent of the effect of home background. This would suggest that early interventions targeted at children from poor backgrounds can have some positive effect.

As far as snapshot 3 in Figure 1 is concerned, there is now ample evidence concerning the performance of South African children at various stages within school. The resounding verdict emanating from recent large-scale assessments of student achievement is that South African children are performing at worryingly low levels by international comparison. The Progress in International Reading Literacy Study (PIRLS) for 2006 established that grade 5 students in South Africa demonstrate lower reading ability than grade 4 students in all 39 other participating countries. Similarly, South Africa was the bottom-performing participant in the TIMSS 2002 study, for both mathematics and science at grade 8 level.[2] Figure 4 presents the average mathematics scores for all the TIMSS 2002 participants as well as the mean scores for high income countries, upper-middle income countries, lower-middle income countries and low

[2]A total of 46 countries participated in the 2002 round of TIMSS, which tested grade 4 and grade 8 students in mathematics and science. In South Africa only grade 8 students participated. Although the International Association for the Evaluation of Educational Achievement (IEA) released the data in 2003, and it is therefore often referred to as TIMSS 2003, the fieldwork took place in 2002.

income countries, according to World Bank classifications. It should be noted that the participants in PIRLS and TIMSS were mainly developed countries although the TIMSS sample included six African countries. The SACMEQ[3] surveys of grade 6 reading and mathematics in 2000 and 2007 revealed that South African children performed just below average in comparison with those in 13 other Southern and East African countries (Van der Berg, 2008, Spaull, 2011).

Figure 4: National average scores for mathematics in TIMSS2002



Note: The TIMSS scores are scale average scores set to have an international mean of 500 and standard deviation of 100.

These surveys provide informative cross-sectional snapshots of educational achievement amongst South African children. What has been lacking until recently in South African educational data, however, is longitudinal panel data that tracks the educational achievement of the same sample of students over time. The data used in this paper is a type of constructed panel dataset, which was possible to assemble by virtue of collaboration with the Human Sciences Research Council (HSRC) who co-ordinated and managed the South African part of TIMSS. In 2002, TIMSS surveyed 8,952 grade 8 students in 255 schools throughout South Africa. Using personal details about these students retained by the HSRC, it was possible to identify 2,734 of these students in matric in 2006 or 2007 (or both in the case of repetition). The

[3]Southern and East African Consortium for Monitoring Education Quality

official matric data for these years were used for this purpose. The new combined dataset thus contains information about mathematics and science achievement at grade 8 level as well as a large range of student, home, teacher and school characteristics as collected in TIMSS 2002. It also contains information about matric subject choice, final matric result (pass category) and total marks achieved in matric English, mathematics and science for those students that were successfully identified in matric.

In addition to the unique panel nature of the dataset, it was possible to include information regarding the former education department that each school would have belonged to under apartheid.[4] It may seem inappropriate to focus on these categories. However, these historically different systems continue to perform at very different levels and under a different set of processes, as several authors recognise (e.g. Reddy, 2006;Fleisch, 2008, Van der Berg, 2008). It is therefore pertinent to reinsert these categories into an analysis of South Africa's educational achievement. It is important, for example, to consider how the impact of socio-economic status on learning might interact with this institutional dimension.

Numerous questions can now be investigated for which previously existing datasets were not suitable. It is now possible, for example, to explore patterns in matric subject choice based on previous achievement. This is especially relevant regarding the decision to take mathematics to matric. It is also possible to test how well grade 8 achievement predicts various aspects of matric performance. Or, put differently, how deterministic is cognitive ability (measured by TIMSS scores) at the start of secondary schooling for matric outcomes and ultimate educational attainment? Another issue is to investigate what factors other than grade 8 achievement significantly influence grade 12 outcomes over and above whatever effect they may already have had on the distribution of grade 8 achievement. Furthermore, one can consider how well different parts of the school system are able to convert grade 8 achievement into matric achievement. Specifically, are inequalities between the historically different parts of the school system intensified or reduced over the course of secondary schooling?

It is worth recognising the broader significance of these specific questions. The extent to which students from poor backgrounds are able to ultimately achieve educational results that stand them in good stead on the labour market will determine the capacity of the education system to contribute to social and economic transformation. This is especially relevant in the light of the

[4]Under the apartheid system there were separate education departments corresponding to the various race groups in South Africa. There were separate departments for white schools (House of Assemblies – HOA), coloured schools (House of Representatives – HOR), Indian schools (House of Delegates – HOD) and black schools (Department of Education and Training – DET) and each of the homelands had an education department. For the purposes of analysis in this paper schools formerly administered by one of the homelands are grouped together with those formerly administered by the DET.

debates provoked by the Coleman Report of 1966. This landmark American study found that school characteristics, including funding, did not play a major role in explaining inequalities in schooling outcomes. Rather, the socio-economic status of students and especially that of their school peers appeared to be the dominant factors determining educational outcomes. This finding, that "schools bring little influence to bear on a child's achievement that is independent of his background" was disturbing to educators and educationists who responded with a thorough search for significant school effects. A major contribution to the debate was made by Heyneman and Loxley (1983), who contended that the "Coleman Report conclusion" about the weakness of school effects was a generalisation based on only a few of the world's education systems, namely those in North America, Europe and Japan. This finding of weak school effects in high income countries and stronger school effects in low income countries was very influential and became known as the Heyneman-Loxley effect in the literature, although this position has in turn been challenged recently (e.g. Baker, Goesling and Letendre, 2002). On balance, enough studies have found that schools *can* make a difference to suggest that the pessimistic conclusions of the Coleman Report about the impotence of schools to reverse or reduce student inequalities were too strong, but the reality is that schools often *do not* have a substantial positive impact on the educational outcomes of poor students.

Meanwhile, an explicitly critical literature has developed that regards schools as institutions that serve to reproduce capitalist society. In Marxist theory, capitalist societies are characterised by class reproduction, which is fostered by institutions such as schooling. Carnoy (1982: 81) summarises the Marxist view: "children go to school at an early age and are systematically inculcated with skills, values, and ideology which fit into the type of economic development suited to continued capitalist control." Underpinned by variations of this view, numerous "reproduction theories" of schooling emerged during the 1970's and 1980's (e.g. Bowles and Gintis, 1976). An investigation into how successfully different parts of the South African school system convert grade 8 achievement into matric outcomes potentially holds important implications regarding the effective contribution of the school system to social and economic transformation versus mere reproduction.

There is further significance in this investigation in the light of the substantial resources that have been invested in the school system. Government spending on education, at least as far as non-personnel spending is concerned, has become increasingly targeted towards schools in less affluent communities. It is therefore important to know what effect these investments are having in terms of educational outcomes.

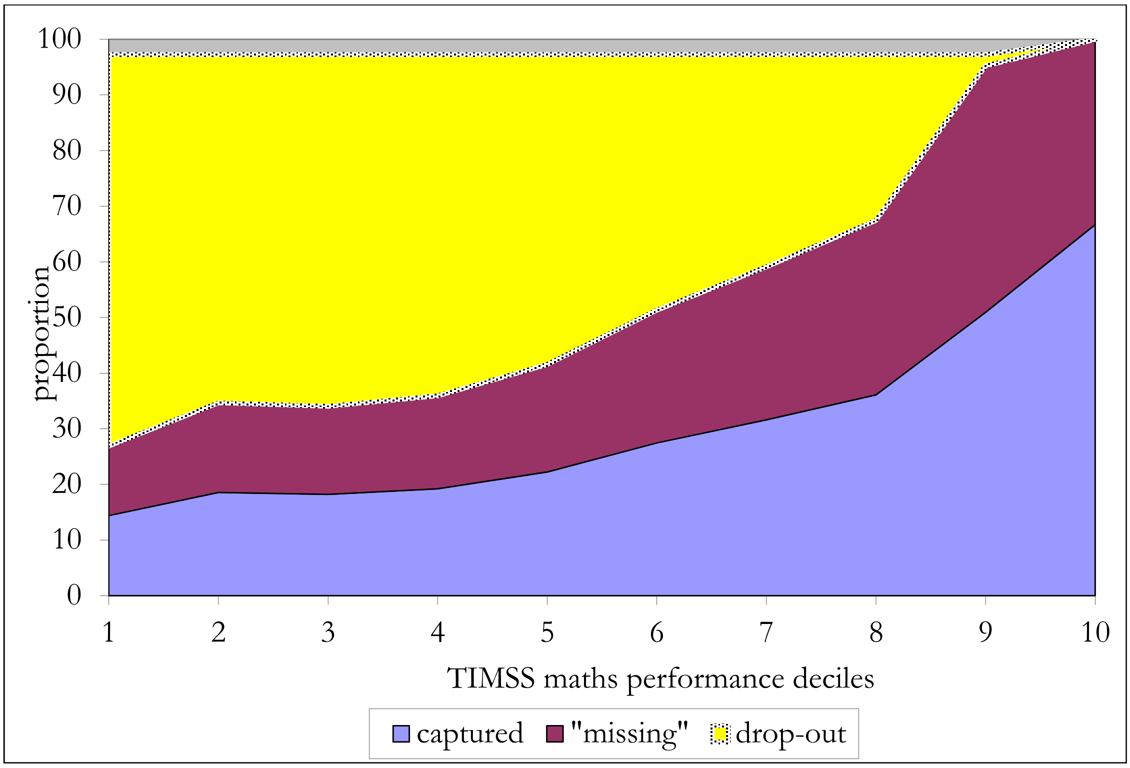
2. The "TIMSS-matric" dataset

Despite the considerable advantages of this dataset, it presents some rather challenging sample selection issues. These arise because those students who participated in TIMSS but were not identified in matric in 2006 or 2007 were not identified for one of two reasons, and it is impossible to know which reason applies. They were not identified either because they dropped out of school (or repeated more than once before matric) or because they did in fact reach matric but were not identified for reasons relating to the difficult process of identification (e.g. an error in their personal details in either the TIMSS or matric data). Although it cannot be determined which individuals dropped out and which were "missed", so to speak, it is possible to estimate the overall proportions that were "missed" and that dropped out. According to the General Household Surveys (GHS) of 2005 and 2006 approximately 42.90% of South Africans entering grade 8 drop out before reaching matric.[5] Because 30.54% of the original TIMSS sample was indeed successfully captured in matric it can be reasonably estimated that the remaining 69.46% not identified consists of 42.90% that dropped out and 26.56% that did reach matric but were "missed" in the identification process.

The proportions of the total grade 8 sample that were successfully captured in matric, that reached matric but were "missed" and that dropped out can also be estimated across varying levels of TIMSS performance. Dividing the distribution of TIMSS mathematics scores into deciles, it can be observed how many students were successfully identified in each decile. The proportion of each original TIMSS performance decile that was successfully identified in matric is depicted by the bottom area of Figure 5. As the graph indicates, the "capturing rate" increased from 14% within the lowest performing decile to 67% within the top decile.

[5]Only people between the ages of 20 and 25 were included in this calculation in order to achieve an up-to-date estimation.

Figure 5: Estimated follow through, drop out and "missed" by TIMSS performance



If it is assumed that the "missing" of individuals who did in fact follow through to matric was a random process, then the ratio of those "missed" relative to those captured in matric could be expected to be relatively stable across the distribution of TIMSS performance. This ratio is thus: 26.56% / 30.54% = 0.8697 or 86.97%. The middle area of Figure 5 is therefore given by 86.97% of those captured in each decile (the bottom area). The remaining proportion is then the estimated drop-out within each decile of TIMSS mathematics performance. The exception to this is the top performing decile where 66.7% were captured in matric. 86.97% of this is 58%, which together with the proportion captured already yields over 100%. Thus it was assumed that no drop-out occurred amongst this group of students.

Contrary to the above, there is reason to expect that some bias in the non-identification of students was at work and, therefore, that the proportion of those "missed" relative to those captured was not exactly constant across the TIMSS distribution. For example, it may have been that students at the lower end of the TIMSS distribution would have been more likely to make errors in completing personal details, or similarly that organisational inefficiency in less well-performing schools led to incomplete or inaccurate information relevant to the identification of individuals in matric. It is however unlikely that any such biases in "missing" matriculants would drastically alter the basic picture offered by Figure 5. The figure therefore remains a useful representation of the drop-out that occurs between grade 8 and matric.

The so-called capturing rate differed substantially by race. Only about a quarter of the black students that participated in TIMSS were identified in matric, whereas nearly three quarters of white students were. It is well known that the level of dropping out differs considerably across the race groups in South Africa, as the GHS estimates confirm. However, the capturing rates were not symmetrical with the expected follow through rates for each race, as Table 1 shows. In the analysis to follow, therefore, separate weights for each race were applied in order to weight up those captured in matric and weight down those not identified. The weighting procedure is outlined in Appendix A.

Table 1: Capturing rate by race

	TIMSS full sample	Captured in matric	Capturing rate	GHS follow through rate
Black	7329	1857	25.34%	55.34%
Coloured	1053	497	47.20%	53.56%
Indian	153	72	47.06%	88.08%
White	417	308	73.86%	86.65%
Total	8952	2734	30.54%	57.1%

3. Results: Predicting matric performance based on grade 8 achievement

The relationships between grade 8 achievement in mathematics (TIMSS 2002) and four different matric outcomes of interest are examined in this section. These four outcomes are whether or not students were identified in matric (an approximation of follow-through), the final matric result (pass category), participation in matric mathematics and the total scores in matric mathematics and English.

3.1) The relationship between TIMSS performance and follow-through to matric

The type of panel dataset that was created contains three categories of matric cohort, so to speak: those students who were not identified in matric, those who were identified in matric in 2006 and those who were identified in matric in 2007.[6] Table 2 reports the size of these various groups and how they had performed in TIMSS when they were in the eighth grade.

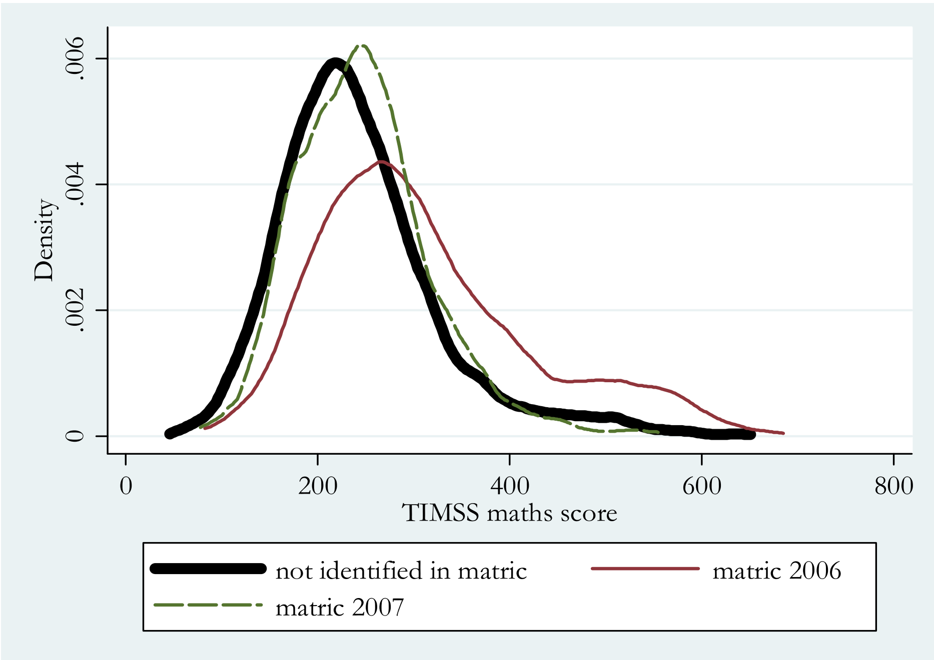
[6]There were 213 students that repeated matric and were therefore identified in both the 2006 and 2007 cohorts. According to the matric datasets, 83 of these students had in fact passed in 2006 and evidently repeated in 2007 for some reason other than failure in 2006. The 2007 performance of these 83 students was therefore omitted from the analysis and only their performance in 2006 was considered.

Table 2: TIMSS mathematics scores by identification and matric cohort

	Mean TIMSS maths score	Observations
Not identified	242.64	6218
Identified (2006 & 2007)	294.85	2734
Matric 2006	310.76	2031
Matric 2007	251.55	833
Total	263.61	8952

As one might expect, the group that reached matric without repeating (that wrote matric in 2006) had performed better on average in grade 8mathematics in 2002. Their mean score was nearly 70 points higher than that of the group not identified in matric, and nearly 60 points higher than the 2007 cohort's. It is interesting that the average TIMSS mathematics score for the 2007 matriculants was not much higher than for the group of students that were not identified in matric. Figure 6 illustrates, using kernel density curves, how similar the TIMSS performance distribution for these two groups is.

Figure 6: Kernel density of TIMSS mathematics by identification and matric year



As the figure shows, the mode of the distribution for those who wrote matric in 2006 lies to the right of the other two groups and there is also a greater concentration of relatively high TIMSS scores, indicated by the fatter right hand tail. Thus it can be said that this group had performed noticeably better than the other groups in grade 8. However, it is evident that the distribution of TIMSS scores for the matric 2007 group lies only slightly to the right of that for the group that was not tracked to matric. There are at least two possible reasons for this. It could be that there is no substantial difference between eighth graders who will end up dropping out of school prior to reaching matric and those who remain in the system until matric but take an extra year to get there. Alternatively, the distribution for those not identified could hide two underlying distributions: a distribution of mainly low TIMSS scores by students who did in reality drop out of school and a somewhat stronger distribution of scores for students who actually did reach matric but were "missed" in the identification process. Given how similar the modes and overall shape of these two distributions are, it would seem that the first of the two proposed reasons is the more dominant: there was little difference in grade 8 achievement between students who dropped out of school and students who reached matric with a delay.

There are intriguing differences in these follow-through patterns across the various former education departments, as Table 3 shows. It is striking that students in formerly coloured, Indian and white schools who wrote matric in 2007 or were not identified in matric had performed considerably better in grade 8 than students in historically black schools who wrote matric in 2006. One might suppose that this could have been due to more lenient grade progression in historically black schools. It is also interesting though that within historically black schools, the difference in TIMSS scores between students who wrote matric in 2006 and those who wrote a year later was only about 24 points on average. Within the other categories of former department, however, the difference in grade 8 achievement between the 2006 and 2007 matric cohorts was much more substantial, nearly 70 points within formerly HOA schools, for example. Taken together, these patterns may suggest that grade 8 achievement (as measured in TIMSS) was a fairly accurate sorter of ability (proxied for by the likelihood of reaching matric) within formerly HOR, HOD and HOA schools, but did not sort very cleanly within formerly DET schools.

Table 3: Mean TIMSS mathematics scores by ex-department and matric cohort

	Matric 2006	**Matric 2007**	**Not tracked**
DET (B)	256.05	231.88	219.97
	(1151)	(616)	(5042)
HOR (C)	366.11	316.89	303.12
	(361)	(126)	(713)
HOD (I)	398.59	308.40	331.48
	(121)	(35)	(150)
HOA (W)	473.29	404.22	422.84
	(398)	(56)	(313)
Total	310.76	247.68	242.64
	(2031)	(833)	(6218)

Note: Number of observations in parentheses

3.2) The relationship between grade 8 performance (TIMSS) and passing matric

Out of the original 8,952 students participating in TIMSS in 2002, 1,911 were found to pass matric in either 2006 or 2007. 197 students were tracked to matric but cannot be said to have passed or failed, due to missing data or fewer than 6 subjects being taken. This means that 21.83% of those who participated in TIMSS in 2002 were found to have passed matric by 2007. Applying the new weighting to the calculation of this rate (i.e. weighting up those captured and weighting down those not captured, separately for each race group in accordance with expected follow through rates) produced a rate of 39.6%. This "conversion rate" is an estimate of the percentage of grade 8 South African students that go on to pass matric. This estimate is remarkably close to that obtained using the Community Survey (2007) data. According to the Community Survey, 39.7% of South Africans between the ages of 22 and 29 that completed grade 7 went on to complete matric.

Table 4 shows the percentage within each matric cohort that passed matric. Unsurprisingly, those who reached matric without repeating any years were a stronger cohort as reflected by the pass rate in matric. Note that in this table individuals who repeated are counted in both cohorts and are double-counted in the total pass rate. An alternative statistic not shown in the table is a pass rate calculated as those who passed in *either* year divided by the total number of students identified in matric. With the relevant weighting, this yielded a matric pass rate of 72.2%.

Table 4: Pass rates in each matric year

Matric year	Pass rate	Observations
2006	78%	1941
2007	48%	661
Total	70%	2602

There are some noteworthy differences in pass rates across the historically different parts of the system, and these will henceforth be a major focus of analysis. Table 5 reports the "conversion rates" and pass rates for each race group and former education department. The low conversion and pass rates amongst black and coloured students and the corresponding former departments are not surprising given the historical disadvantage and ongoing low socio-economic status of these groups.

Table 5: Matric "conversion rates" and "pass rates" by race and ex-department (with new weighting)

	Race group		Ex-department	
	Conversion rate	**Pass rate**	**Conversion rate**	**Pass rate**
Black/DET	38.08%	69.97%	34.09%	65.13%
Coloured/HOR	38.54%	77.78%	36.76%	76.21%
Indian/HOD	87.98%	98.73%	74.97%	93.18%
White/HOA	84.88%	99.34%	71.31%	96.56%
Total	41.84%	74.05%	40.09%	72.21%

Note: Conversion rate = those passed/original TIMSS sample
Pass rate = those passed/total identified in matric

In order to investigate how the relationship between grade 8 achievement and passing matric differed across the former education departments a probit regression was estimated. The dependent variable took a value of 1 if a student passed matric in either 2006 or 2007, and a value of zero if a student did not pass matric or was not identified in matric. The variables included to predict passing matric were the TIMSS mathematics score in grade 8, dummy variables for each of the former departments and variables interacting former department with TIMSS mathematics score.[7] The results are reported in Table 6. Due to the interactions the coefficients are hard to interpret without plotting the estimated probabilities of passing matric graphically. Therefore this is presented in Figure 7.

Table 6: Probit regression predicting passing matric
(Dependent variable: Pass = 1; No pass observed = 0)

Explanatory variables	**Marginal effects coefficient**	**Standard error**
TIMSS maths score	0.0025**	0.00016
HOR (C)	-0.4055**	0.038
HOD (I)	0.3101*	0.136
HOA (W)	0.4094**	0.091
HOR*TIMSS maths	0.0012**	0.00038
HOD*TIMSS maths	-0.0005	0.00039
HOA*TIMSS maths	-0.0012**	0.00027
Observations	8728	
Pseudo R-squared	0.1361	

*Significant at 5% level **Significant at 1% level

[7] An asset-based index for student socio-economic status, which is explained in Appendix B, did not emerge as a significant predictor of matric pass rates or conversion rates once grade 8 achievement was controlled for and was therefore omitted from this model.

Figure 7: Predicted probabilities of passing matric by former department

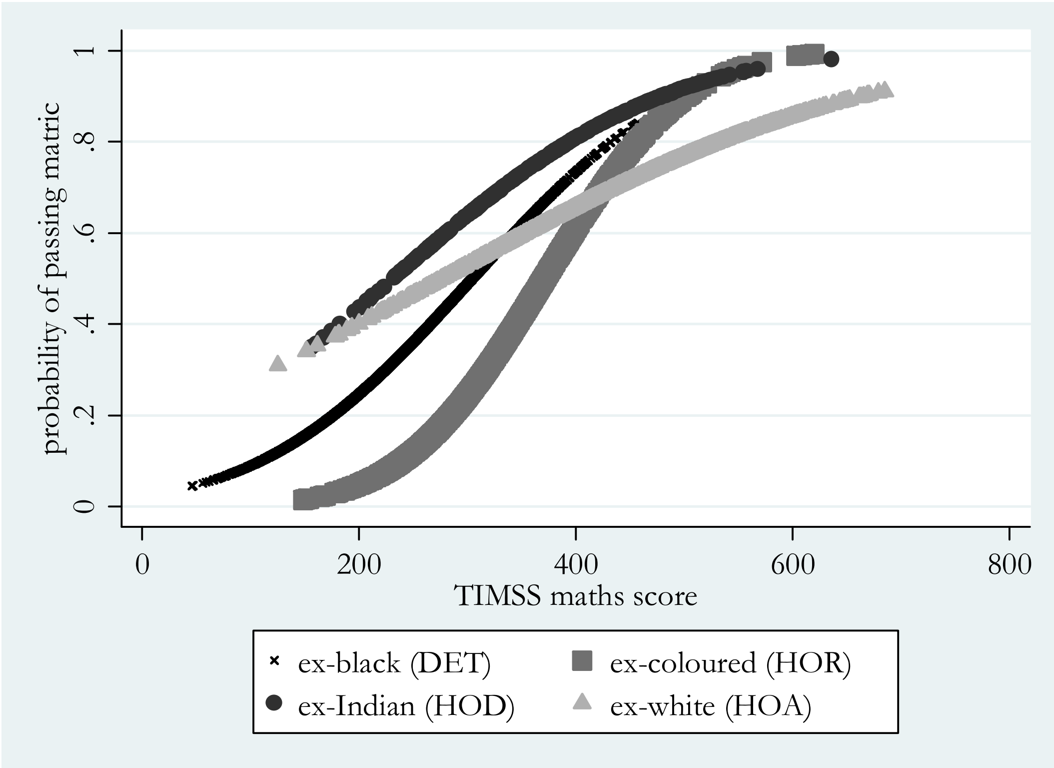


Figure 7 is a scatterplot of the predicted probabilities of passing matric across different levels of performance in grade 8. Evidently, the probability of passing matric conditional upon TIMSS performance differed across the former education departments. One might think of the differences in the probability of passing for a given level of grade 8 achievement as differences in the abilities of the respective school "systems" to convert grade 8 achievement into matric achievement. Two aspects of the figure strike one as surprising and pose challenging questions. Firstly, at the top end of the TIMSS distribution, why does there appear to be better conversion of TIMSS performance into matric passes within ex-HOR (C) schools than within ex-HOA (W) schools? Secondly, why does there seem to be better conversion within ex-DET (B) schools than within ex-HOR (C) schools at the lower end of the TIMSS distribution, which is where the bulk of students is concentrated?

There are various considerations pertaining to the first question. Firstly, the sample size for ex-HOR schools is rather small at the top of the TIMSS distribution. Only 70 students within ex-HOR schools achieved a score of over 450 in TIMSS. Of these, 54 were identified in matric. Although these are relatively low numbers of students, they were spread across 18 schools. Small sample size was therefore probably not the main reason for the differential conversion at the top end of TIMSS performance.

A second possible reason for the apparent lower conversion at the top end within ex-HOA schools has to do with the problems of matching TIMSS participants with the matric datasets. 372 students in ex-HOA schools scored over 450 in TIMSS and only 270 of these were identified in the matric datasets. It is likely that many of these non-identified individuals from ex-HOA schools did in reality reach matric but were simply not found in the matric datasets and that this was the main factor driving the apparent difference in conversion between ex-HOA and ex-HOR schools at the top end of the TIMSS distribution. It should be noted that when modelling the probability of passing matric *conditional upon reaching matric*, the estimated probability of passing converged towards one at the top end of the TIMSS distribution for students in ex-HOR and ex-HOA schools alike.[8]

A third possible reason for the apparent difference in conversion at the top end is that those few students in ex-HOR schools who did achieve high TIMSS scores may have been particularly motivated or have had especially good home support. It is unlikely that such individuals, motivated enough to reach a high level of achievement by grade 8 despite what may have been an unfavourable school environment, would have then dropped out of school or been poorly prepared for the matric exam.

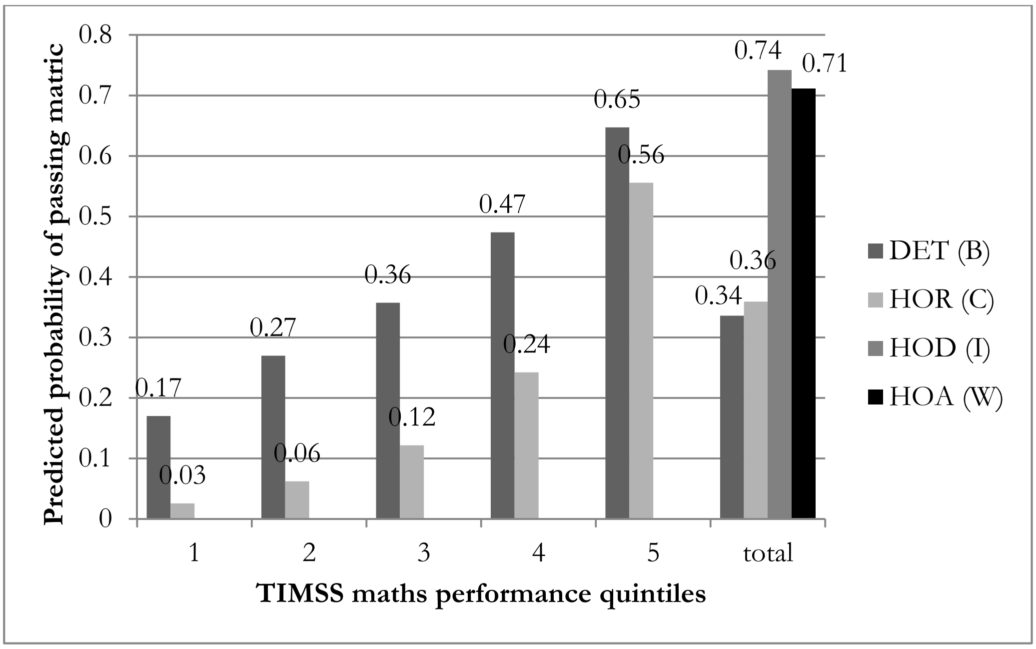
A fourth possible explanation for the apparent differences between historically white and coloured schools in conversion at the top end of the distribution relates to what can loosely be termed "coaching for assessment". Effective "coaching" would no doubt involve frequent exposure to good quality assessment accompanied by meaningful feedback to students in order for them to understand what is expected of them. If, in grade 8, students in historically coloured schools had been less well coached for assessment than those in historically white schools, then the TIMSS scores may underestimate the true ability of students within ex-HOR schools. It is unlikely that an equally large disparity in the level of "coaching for assessment" would persist at the matric level due to the traditional importance of the matric exam in South Africa. Consequently, students in historically coloured schools would have performed nearer to their true ability in matric than in TIMSS. Therefore, the estimated probability of passing for a given TIMSS score might be more appropriately associated with a score somewhat to the right (in Figure 7) of the registered TIMSS score. For example, the ability of an ex-HOR student that scored 450 in TIMSS may have been better reflected by a score of 500. This might account for the gap between ex-HOR and ex-HOA schools at the top end of the TIMSS distribution.

[8] This probit model and the accompanying scatterplot depicting the predicted probabilities of passing matric is presented in Appendix C.

The second curiosity raised by Figure 7 is the apparently better conversion of grade 8 achievement into matric passes within ex-DET schools than within ex-HOR schools across the lower and middle parts of the TIMSS distribution. When considering Figure 7, it is important to keep in mind where the bulk of the students are concentrated. The median TIMSS score for students in ex-DET schools was 228 and for students in ex-HOR schools was 318, indicating that TIMSS scores for the latter group were concentrated at considerably higher levels. Nevertheless, despite the overall higher level of achievement within ex-HOR schools, it would appear that for a given TIMSS score the probability of passing matric was higher for students in ex-DET schools. This gap in the probability of passing held for the majority of the distribution of TIMSS scores and narrowed towards the higher end.

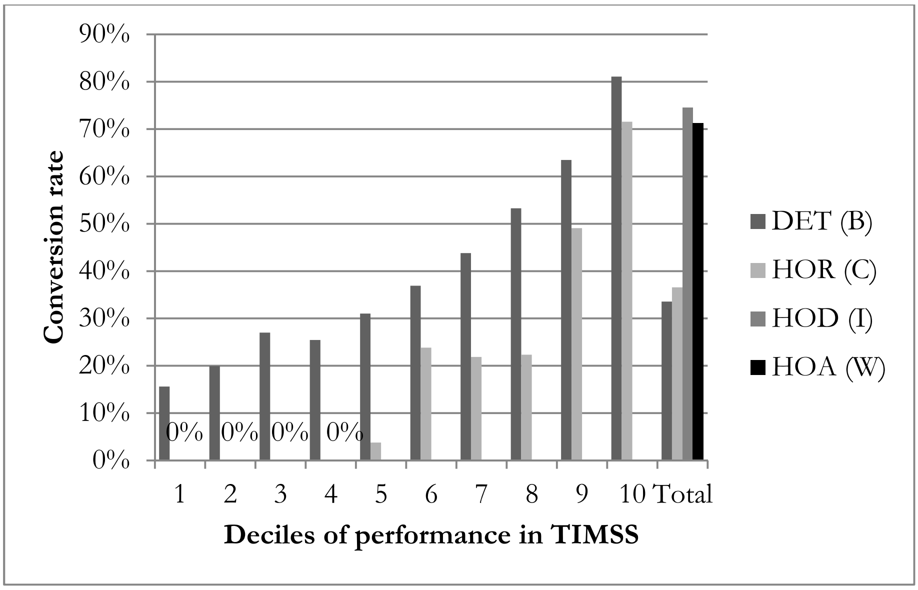
Figures 8 and 9 present the apparent differences in conversion between historically black and coloured schools using bar charts. Figure 8shows the average probability of passing matric(as estimated by the probit model in Table 6) for each quintile of performance in TIMSS mathematics and by former department. Figure 8 therefore shows the same results as does Figure 7 but in a different way. The focus here is on comparing historically black and coloured schools at each quintile of TIMSS performance. Therefore, the probabilities of passing for each quintile for historically white and Indian schools are not depicted, although for comparison the total average probabilities of passing for these groups are shown. Figure 9 shows the simple conversion rates[9] within each decile of TIMSS performance and by former department.

Figure 8: Probability of passing matric by TIMSS performance and former department



[9]Conversion rate = number passed / original TIMSS sample

Figure 9: Conversion rates by TIMSS performance and former department



Figures 8 and 9 reveal that although in each quintile (decile) of TIMSS performance the probability of passing (pass rate) was greater for students in ex-DET schools than for those in ex-HOR schools, yet the overall probability of passing (pass rate) was higher within ex-HOR schools. This ostensible anomaly arises because the bulk of ex-HOR students were located in the upper quintiles (deciles) of TIMSS performance. Note that out of the 77 students in formerly HOR schools in the bottom four deciles only five were identified in matric, and not one of the five passed, which accounts for the zero pass rates for ex-HOR schools within the bottom four deciles. In contrast, approximately 20% of students in ex-DET schools in the bottom four deciles of TIMSS achievement went on to pass matric. This may indicate that TIMSS was more effective at discriminating between students of varying ability within ex-HOR schools than it was within ex-DET schools.

If the apparently better conversion of grade 8 achievement into matric passes within historically black schools could be shown to be more than merely apparent, this finding could be interpreted as somewhat redemptive for ex-DET schools, at least at the secondary school level: despite a very low overall level of performance, this group of schools is better at realising matric passes than ex-HOR schools given the level of grade 8 achievement with which they have to work. Conversely, the apparent difference in conversion may be capturing a negative process within ex-HOR schools rather than a positive process within ex-DET schools. One factor which may underlie poor conversion within ex-HOR schools is the high rate of drop-out that is known to occur amongst coloured students. Nyanda *et al* (2007: 52) demonstrate that the enrolment rate for coloured youth drops sharply around the ages of 15 and 16, and that this pattern is peculiar to this population group. Despite low levels of performance there is a higher rate of retention amongst black youth of high school age. Although this feature of coloured schooling may feed into the lower conversion within ex-HOR schools evident in Figure 7, it does not seem to be the whole story. When estimating a probit model predicting the probability of passing matric *conditional upon reaching matric* a similar pattern emerges: at given levels of TIMSS performance, students in ex-DET schools have a higher probability of passing than students in ex-HOR schools, across most of the distribution.[10]

A second hypothesis for why ex-DET schools appeared to convert grade 8 achievement into matric passes better than ex-HOR schools is that students in ex-DET schools had systematically underperformed in TIMSS, but were able to perform nearer to their true ability in matric. One reason to expect this relates to the fact that TIMSS testing was administered in English or Afrikaans. Consequently, many black students probably were at a language disadvantage whereas the majority of coloured students would have been tested in their mother tongue. The extent of this language effect may well have diminished somewhat by matric, as black students may have become more accustomed to learning and being examined in English. Table 7 confirms that students in historically black schools spoke the language of the TIMSS test less frequently on average than those in historically coloured schools. Only 7.4% of students in ex-DET schools reportedly always spoke the language of the test at home. For students in ex-HOR schools this figure was 61.9%. This language disadvantage may well have contributed to a systematic underperformance amongst students in ex-DET schools in TIMSS.

Table 7: Frequency of speaking the language of the TIMSS test by former department

	DET (B)	HOR (C)	HOD (I)	HOA (W)	Total
Always	7.4%	61.9%	40.7%	54.8%	18.4%
Almost always	7.0%	11.6%	14.2%	23.5%	9.3%
Sometimes	66.5%	23.7%	42.8%	19.6%	57.0%
Never	19.1%	2.9%	2.4%	2.2%	15.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

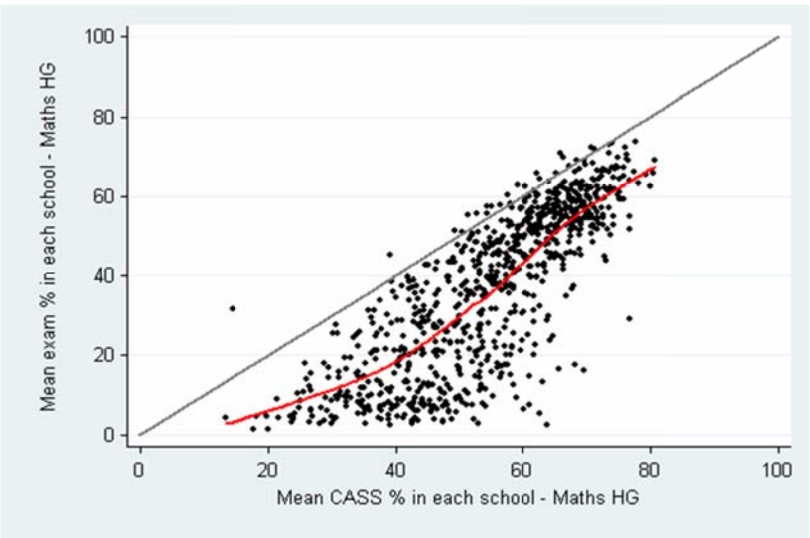
Another reason to expect systematic underperformance of ex-DET students in TIMSS is that grade 8 students in this part of the system may have been poorly coached for assessment. If students had not routinely been exposed to assessment accompanied by meaningful feedback it is understandable that their performance in a test such as the TIMSS mathematics test would have underestimated their true ability. Recent research has shown that assessment in many of South Africa's schools is weak and provides a rather inaccurate signal to students. Lam,

[10] This probit model and the accompanying scatterplot depicting the predicted probabilities of passing matric is presented in Appendix C.

Ardington and Leibbrandt (2008) argue that grade progression amongst black students can be described as something of a lottery. The authors assume that grade progression reflects both the true ability of students and a stochastic element linked to factors like the student form on the day of an exam and inconsistent assessment by teachers. They find that this stochastic component is particularly large amongst black students, implying that in the schools they attend grade progression is weakly linked to actual learning or ability. Lam et al (2008: 39) conclude that the ability to assess learning accurately is a critical aspect of school quality that is lacking in many of the schools that black students attend.

Van der Berg and Shepherd (2010) have demonstrated that considerable discrepancies exist between continuous assessment scores, which are determined by schools independently, and matric examination results, which are nationally comparable. Two types of problems with continuous assessment marks are examined by Van der Berg and Shepherd. Firstly, in many schools continuous assessment marks were weakly correlated with matric scores. This means that students received an unreliable signal of their relative performance compared with their classmates. Secondly, there is the problem of assessment leniency. In many schools, especially low performing schools, continuous assessment marks were considerably higher than matric marks. This is described well by Figure 10, which is reproduced from the report of Van der Berg and Shepherd. Each dot in the scatterplot represents one school consisting of at least 15 students. The figure shows that in schools that achieved low average mathematics Higher Grade (HG) marks in the matric examination the continuous assessment marks tended to be considerably inflated. Students in schools below the trend line cannot have had an accurate expectation of how well they would perform in the matric examination.

Figure 10: Continuous assessment marks and matric mathematics HG 2005 and lowess regression trend line



Source: Van der Berg and Shepherd (2010: 10)

It is reasonable to expect that low quality assessment practices would be more common and severe at the grade 8 level than at grade 12, where schools are focused on grooming students for the matric exam. In ex-DET schools, a scarcity of effective teachers often leads to a concentration of the better teachers in grade 12 due to the high-stakes nature of the matric examination. This may result in particularly weak assessment practices in the lower grades. This would all result in underperformance in TIMSS by students in ex-DET schools.

To summarise, the fact that there appears to be better conversion of grade 8 achievement into matric passes in ex-DET schools may be less of an indication that more learning occurred in ex-DET high schools than in ex-HOR high schools, and more a reflection of a systematic underperformance in TIMSS amongst students in ex-DET schools caused by some mix of the following factors: a language disadvantage in TIMSS, poor exam writing skill and weak assessment practices prevalent in the historically black part of the school system.

3.3) The relationship between TIMSS performance and participation in matric mathematics

Just over 61% of the sample that was identified in matric took mathematics on either the standard or higher grade. There were interesting differences between the former education departments in mathematics participation. Table 8 reports the numbers taking mathematics on the standard grade (SG) and higher grade (HG) by former department. Not surprisingly, the proportion of students taking mathematics at the higher grade was greatest within formerly white and Indian schools. Other interesting features of the table include the high proportion of students in ex-DET schools (58.52%) that took mathematics SG, and the high proportion of students in ex-HOR schools (59.34%) that did not take matric mathematics at all.

Table 8: Participation in matric mathematics by former department

	DET (B)	**HOR (C)**	**HOD (I)**	**HOA (W)**	**Total**
No maths	610	289	60	150	1109
	(34.52)	(59.34)	(38.46)	(33.04)	(38.72)
SG	1034	174	65	178	1451
	(58.52)	(35.73)	(41.67)	(39.21)	(50.66)
HG	123	24	31	126	304
	(6.96)	(4.93)	(19.87)	(27.75)	(10.61)
Total	1767	487	156	454	2864
	(100)	(100)	(100)	(100)	(100)

Note: Column percentages in parentheses

To investigate these patterns somewhat further, a probit regression model was estimated, predicting the probability of taking mathematics in matric conditional upon grade 8 performance in TIMSS. The dependent variable took a value of 1 if a student took mathematics in matric and zero if a student did not take mathematics or was not identified in matric. The explanatory variables included the TIMSS mathematics score in grade 8, dummy variables for each of the former departments and variables interacting former department with TIMSS mathematics score. There is a selection issue to deal with because in order for an observation to potentially participate in matric mathematics that student must first have been identified in matric. Therefore a Heckman 2-step probit was estimated in which the main equation modelled participation in mathematics and the selection equation modelled whether a student was identified in matric or not. The selection equation accounted for whether the school was located in an urban, semi-urban or rural area, the severity of student absenteeism in the school, student socio-economic status, parental education and student age. It was felt that these factors were more likely to affect drop-out from school than the decision to participate in matric mathematics. The *Rho* value was significantly different from zero indicating that a selection process was at work and thus justifying the 2-step procedure. The results are reported in Table 9. Again, the coefficients are hard to interpret without plotting the estimated probabilities of taking mathematics on a graph. This is presented in Figure 11.

Figure 11: Predicted probability of taking mathematics in matric by former department (based on Table 9)

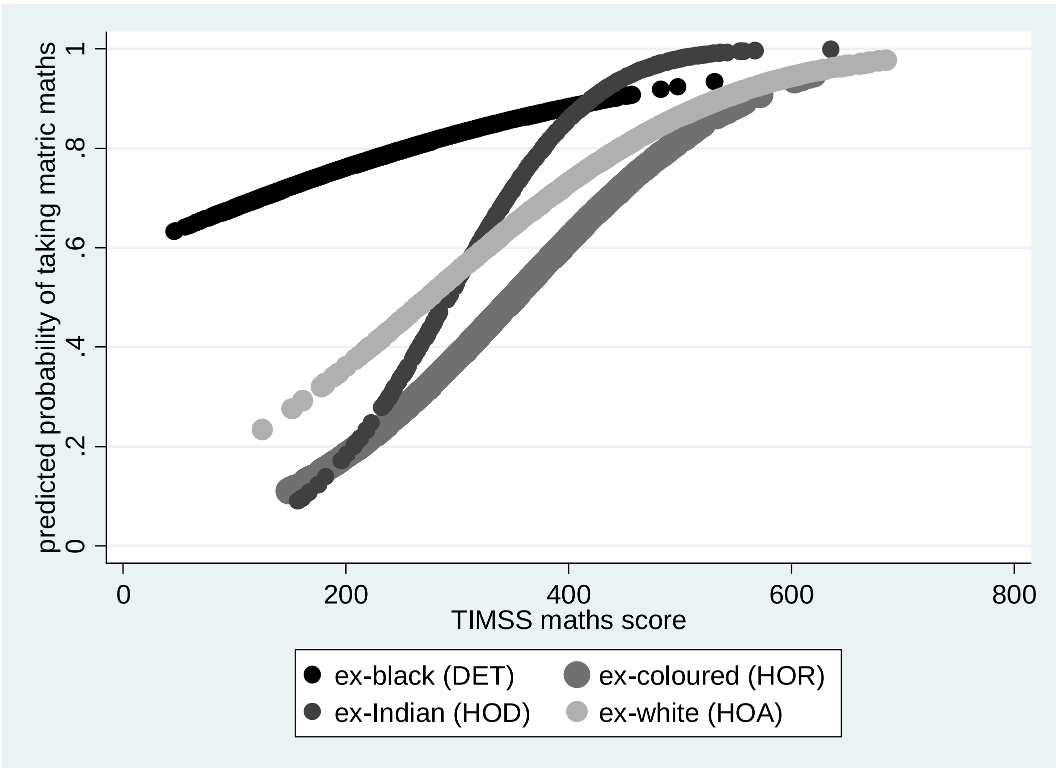


Table 9: Heckman 2-step probit regression predicting participation in matric mathematics

(Dependent variable: mathematics SG or HG = 1; No mathematics in matric = 0)

Explanatory variables	Coefficient	Robust standard error
Main Equation: Participation in mathematics		
TIMSS maths score	-2.344**	0.478
HOR (C)	-3.116**	0.591
HOD (I)	-1.561**	0.405
HOA (W)	0.002**	0.001
HOR*TIMSS maths	0.004**	0.001
HOD*TIMSS maths	0.007**	0.002
HOA*TIMSS maths	-0.000065**	0.0003
Constant	0.229	0.156
Selection Equation: Identification in matric		
Urban	0.284**	0.070
Semi-urban	0.156**	0.060
Rurality unspecified	0.298**	0.111
Absenteeism moderate	-0.124**	0.045
Absenteeism severe	0.000	0.097
Absenteeism very severe	-1.306**	0.176
Absenteeism unspecified	-0.307**	0.103
Student SES	0.044*	0.020
Parent education0	-0.126	0.069
Parent education1	-0.162**	0.049
Parent education3	0.018	0.063
Parent education unspecified	-0.288**	0.047
Student age	-0.270**	0.016
Constant	4.148**	0.250
Rho	-0.696	
Wald test: Probability: Rho = 0	0.000	
Observations	8723	
Censored observations	5910	
Uncensored observations	2813	

*Significant at 5% level **Significant at 1% level

When comparing the probabilities of taking mathematics for ex-DET schools and ex-HOR schools a similar picture emerges to that which came out when comparing the probabilities of passing matric for these two groups. At given levels of grade 8 performance, students in ex-DET schools had a greater probability of taking mathematics in matric than students in the rest of the school system, especially than those in ex-HOR schools. The difference is considerable: across most of the distribution the difference in the probability of taking mathematics was between 20 and 50 percentage points.

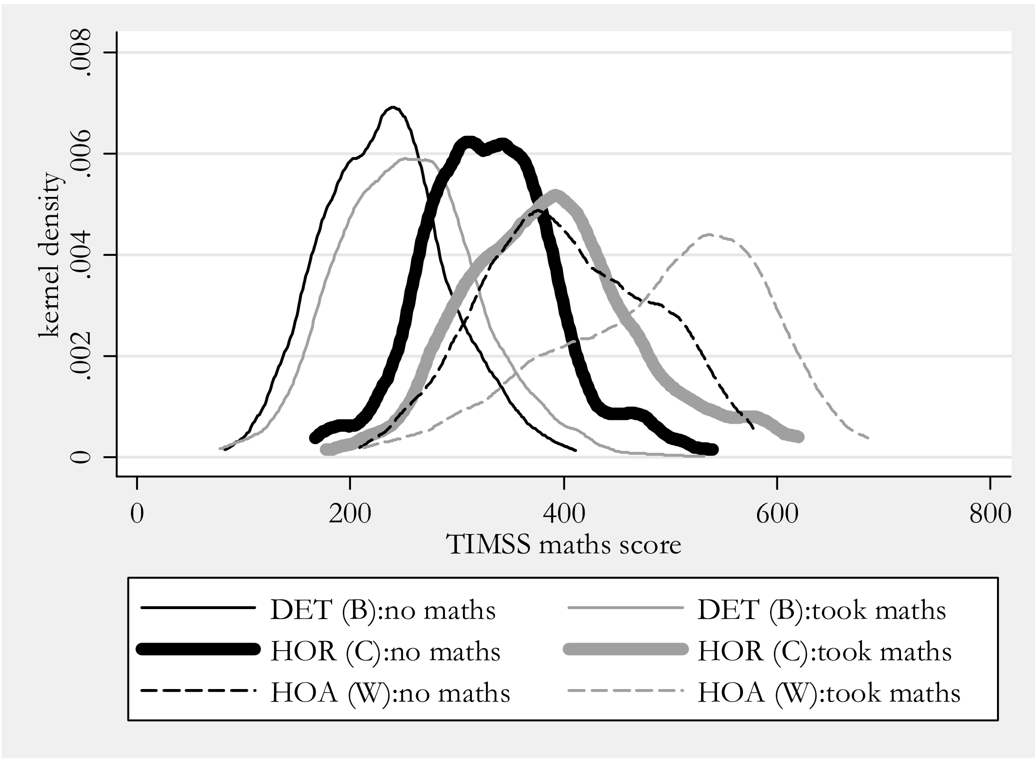
The same explanations that were considered with respect to the differential probabilities of passing matric could apply to these differences in the probability of taking mathematics in matric. Figure 11, considered in isolation, is consistent with the supposition that ex-DET schools were better than the rest at taking medium to low performing grade 8 students and producing suitable matric mathematics candidates. However, this seems implausible given what is known about the general level of efficiency in this section of the school system. Alternatively, the pattern could be attributable to systematic underperformance in TIMSS amongst students in ex-DET schools. This would mean that these students registered a probability of taking mathematics associated with a mathematical ability tantamount to 20 or 40 points (for argument's sake) higher than their achieved TIMSS scores. Even so, a systematic underperformance in TIMSS can surely not account for the very wide gap in the probability of taking mathematics between ex-DET schools and the other groups.

It is likely that ex-DET schools differed in important ways from the others in terms of the processes that fed into the decision to take mathematics to matric. The factors involved in this decision making process might include, amongst others, prevalent attitudes toward mathematics, understanding of the standard required for matric, parental influences, the quality of guidance regarding subject choices available to students, or the precision with which schools are able to assess the mathematics ability of their students and hence the quality of information available to students, parents and teachers upon which to base subject choice decisions. Whatever the relevant factors, Figure 11would suggest that some students in ex-DET schools who would have been best advised not to choose mathematics for matric were allowed or encouraged to do so or, conversely, that students in other schools were overly discouraged from taking mathematics. Out of a potential 300 marks in the case of standard grade mathematics and 400 for higher grade, the average total mathematics mark for ex-HOR students was 114.23 and for ex-DET students was 83.96. The respective mode scores were even lower due to top-end observations raising the mean. These statistics are not impressive for either group of schools. The greater likelihood therefore is that too many students in ex-DET schools took mathematics rather than that too few students in ex-HOR schools chose this subject.

The relative flatness of the line for ex-DET schools in Figure 11 lends further weight to the argument that the decision to take mathematics in this group of schools was probably based on weak information regarding the ability of students. In these schools changes in mathematics ability did not strongly affect the probability of taking mathematics to matric. In contrast, the lines for the other three groups of schools were relatively steep, indicating that weak mathematics students were far less likely to take mathematics than strong students.

Figure 12 shows this same pattern using kernel density curves. For historically white and coloured schools, there was a considerable difference between the TIMSS performance of those who ultimately took matric mathematics and those who did not. The distribution of TIMSS performance for ex-DET students who took mathematics was, however, very similar to that for those not taking mathematics. This implies that in ex-DET schools, the decision whether or not to take mathematics to matric was largely random and was not strongly determined by actual mathematics competence earlier in high school. Simple probit regressions for each former department predicting participation in matric mathematics only on the basis of TIMSS mathematics achievement confirmed this.[11] In the model for ex-DET schools, very little of the variation in taking mathematics was explained by the TIMSS mathematics score, as indicated by the pseudo R-squared statistic. In contrast, a substantially greater proportion of the variation in taking matric mathematics could be explained by TIMSS performance in the models for ex-HOR schools, for ex-HOA schools and for ex-HOD schools. By comparison then, the decision to take mathematics to matric appeared to have a large random component in historically black schools. This supports the hypothesis that imprecise assessment and consequently low quality of guidance regarding subject choices may have led some students in historically black schools to take mathematics when they would have been better advised not to, and perhaps vice versa.

Figure 12: Kernel density curves of TIMSS performance by former department and participation in matric maths

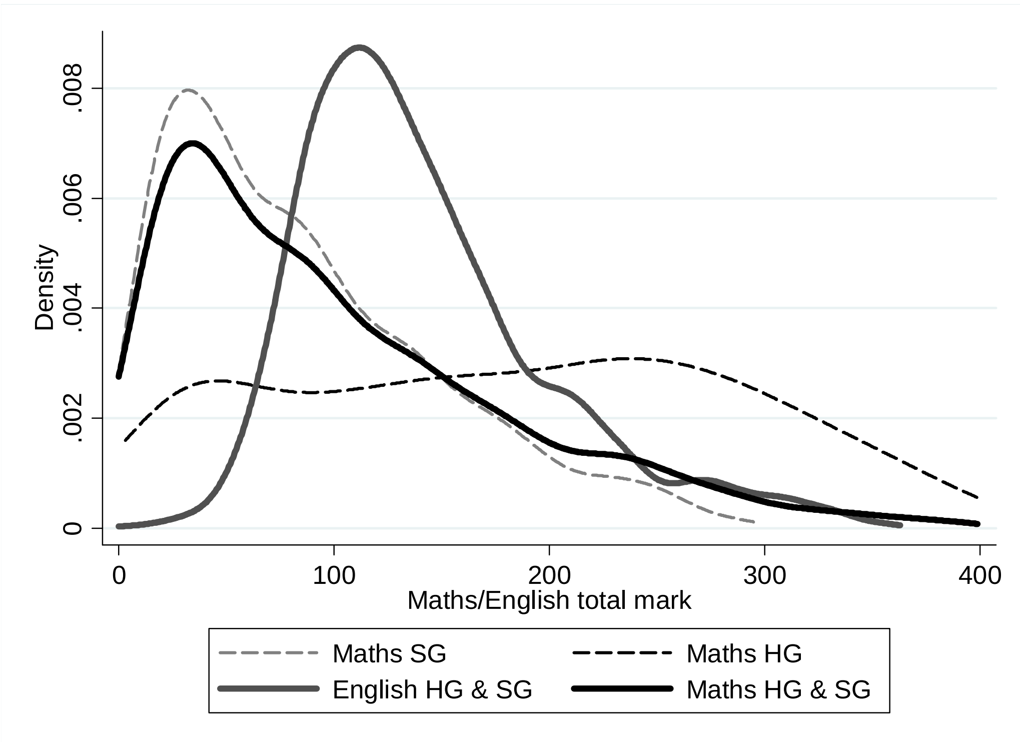


[11] The regression results as well as the numbers of students taking mathematics and not taking mathematics in matric for each former department are presented in Appendix D.

3.4) The relationship between TIMSS performance and matric mathematics and English performance

The distributions of performance in matric mathematics and English are displayed using kernel density curves in Figure 13. For both subjects the maximum possible mark is 300 marks in the case of standard grade and 400 for higher grade. For the sake of the analysis in this section, scores of those doing standard grade and higher grade were treated as one distribution, based on the assumption that 240 out of 300 for standard grade, for instance, is roughly equivalent (in terms of the underlying competency it reflects) to 240 out of 400 on the higher grade. For interest's sake, kernel densities for mathematics standard grade and higher grade are also separately shown in Figure 13. It should be noted there were only 304 cases of participation in mathematics higher grade, while there were 1382 cases for standard grade. It is concerning how far left the modes of these two distributions lie, especially in the case of mathematics. This strengthens the notion that a considerable number of students (mainly in historically black schools) took mathematics despite not having a suitable foundation for doing so.

Figure 13: Kernel density curves of matric mathematics and English performance



The scatterplots and lowess smoothing lines in Figures 14 and 15 provide a visual indication of the association between grade 8 achievement in TIMSS and matric achievement in mathematics and English, respectively. Lowess regressions are a locally weighted form of non-parametric regression, which allows the shape of the curve to be determined by the data rather than by a linear or quadratic model specification. Interestingly, the association between TIMSS mathematics achievement and matric English achievement was stronger than that between TIMSS mathematics and matric mathematics. This is partly evident in the visibly better fit in Figure 15 than in Figure 14 and was confirmed by correlation coefficients. The correlation between TIMSS mathematics and matric English was 0.78 compared with 0.62 for that between TIMSS mathematics and matric mathematics. With this in mind it was decided to use the total mark achieved in matric English as the dependent variable for most of the subsequent analysis. Another consideration affecting this decision was that the sample of students that took English was larger than that which took mathematics.

Figure 14: Scatterplot of TIMSS mathematics against matric mathematics and lowess smoothing line

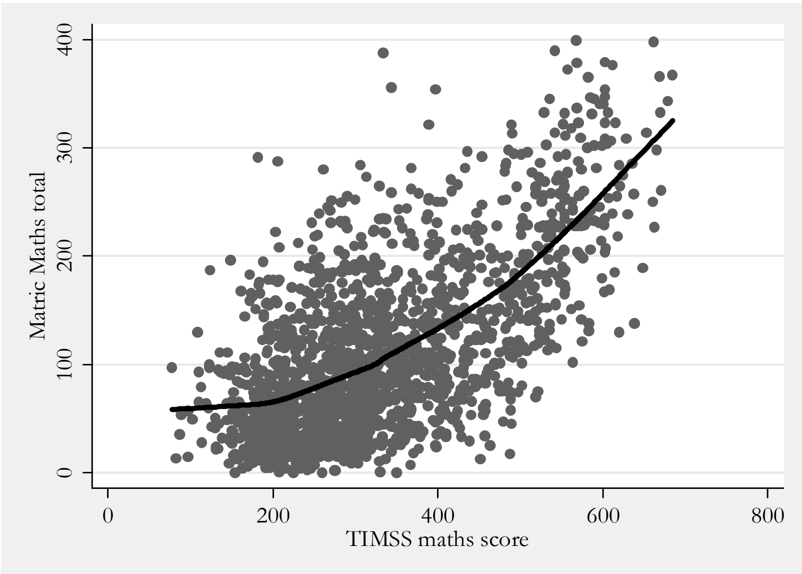


Figure 15: Scatterplot of TIMSS mathematics against matric English and lowess smoothing line

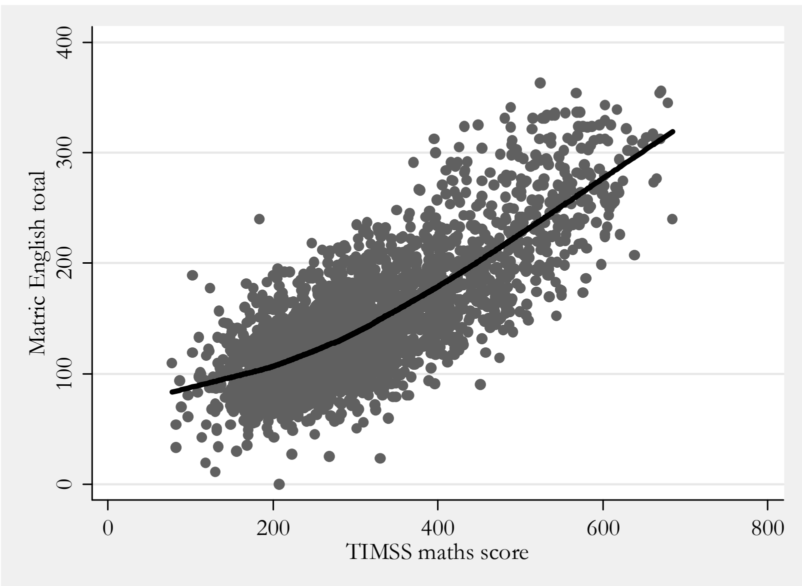


Table 10 reports the results from an OLS regression model predicting English total mark in matric by TIMSS mathematics score and its square, former education department and interactions between TIMSS performance and former department. For the sake of interpretation, the predicted English marks for each ex-department are plotted in Figure 16. At given levels of TIMSS achievement, students in historically white and Indian schools performed better in matric English than students in historically black and coloured schools. As was the case when looking at the probabilities of passing matric and the probabilities of taking mathematics in matric by former department, historically black schools appeared to convert TIMSS achievement into matric English achievement better than historically coloured schools, although in this case the difference was not statistically significant. It is likely that the superior conversion of grade 8 performance into matric performance within historically white and Indian schools relative to ex-DET schools captures a substantive difference in the relative efficiency at which these two systems operate. However, the apparent advantage in terms of conversion that ex-DET schools held over historically coloured schools is probably due to the hypotheses regarding systematic underperformance in TIMSS in historically black schools, as presented earlier.

Figure 16: Predicted English performance by TIMSS achievement and ex-department

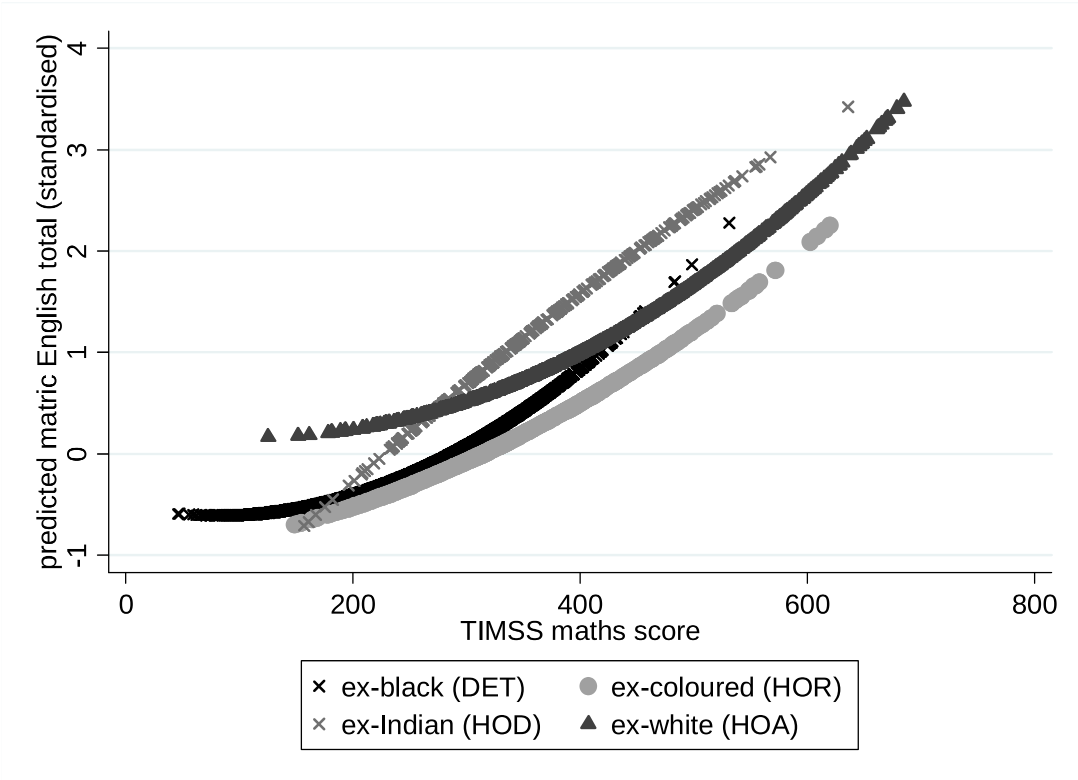


Table 10: OLS regression predicting English performance in matric

Explanatory variables	Coefficient	Robust standard error
Main Equation: English total score (standardised: mean = 0, stddev = 1)		
TIMSS maths score (std)	-0.357	0.314
TIMSS score squared	-1.297**	0.660
HOR (C)	0.802	0.544
HOD (I)	-0.091*	0.125
HOA (W)	0.255	0.207
HOR*TIMSS maths	1.142	0.403
HOD*TIMSS maths	-0.041**	0.283
HOA*TIMSS maths	0.129	0.027
HOR*TIMSS squared	-0.068~	0.035
HOD*TIMSS squared	-0.160**	0.059
HOA*TIMSS squared	-0.036	0.040
Constant	-0.591**	0.139
Selection Equation: Identification in matric		
Urban	0.259**	0.067
Semi-urban	0.214**	0.057
Rurality unspecified	0.318**	0.101
Absenteeism moderate	-0.243**	0.040
Absenteeism severe	-0.357**	0.099
Absenteeism very severe	-1.171**	0.167
Absenteeism unspecified	-0.305**	0.096
Parent education0	-0.029	0.066
Parent education1	-0.082~	0.049
Parent education3	0.026	0.065
Parent education unspecified	-0.210**	0.045
Student age	-0.310**	0.015
Student SES	0.060**	0.020
Constant	4.552**	0.239
Rho	-0.694**	0.032
Wald test: Probability: Rho = 0	0.000	
Observations	9082	
Censored observations	6424	
Uncensored observations	2658	

~ Significant at 10% level *Significant at 5% level **Significant at 1% level

Note: In an attempt to control for the selection of students into matric a Heckman 2-step procedure was followed. The selection equation was statistically significant, indicated by the statistical significance of *Rho*.

Further evidence of the underperformance hypothesis and randomness of assessment in ex-DET schools was obtained by estimating separate OLS regression models (simply predicting matric English mark by TIMSS mathematics score) for ex-DET schools and for the rest of the sample. Just over 51% of the variance in English achievement was explained by the model for all "non-DET" schools whereas only about 29% of the variance was explained by the model for ex-DET schools. This is evidence of a large stochastic component in the ex-DET model, indicating that in this group of schools grade 8 assessment was characterised by a considerable amount of randomness.

The notion of systematic underperformance is alternatively described by Figure 17, in which separate lowess regressions of matric English total against TIMSS mathematics scores for each former department are presented. In the figure, both TIMSS mathematics scores and matric English marks have been standardised to have a mean of zero and standard deviation of one. Above the mean TIMSS score, in each former department a one standard deviation increase in grade 8 achievement is associated with about a one standard deviation increase in matric English achievement, as indicated by the fact that the slopes are roughly parallel to the 45 degree line. However, below the mean TIMSS score – where the bulk of the students were located in ex-DET schools – the slopes deviate above the 45 degree line. This is exactly to be expected if candidates in ex-DET schools did in fact systematically underperform in grade 8. The very low grade 8 achievement of such candidates is thus an underestimation of their true ability, which is more accurately reflected in their matric English performance.

This increasingly familiar pattern also arises when looking at the relationship between matric mathematics marks and TIMSS performance. In Figure 18 the TIMSS scores of those tracked to matric have been divided into deciles. The bars represent 95% confidence intervals around the mean matric mathematics score for students in ex-DET schools and in ex-HOR schools within each decile of TIMSS performance. Note that no confidence intervals are displayed for ex-HOR schools in the bottom four deciles because there was only one ex-HOR observation in the bottom four deciles. In the upper six deciles, the mean matric mathematics score was higher within ex-DET schools, with the exception of the sixth decile. This corresponds with the pattern that has consistently emerged in this paper, that although students in historically coloured schools obtained a higher average level of performance than those in historically black schools, given levels of grade 8 achievement were associated with higher matric performance for students in historically black schools. Again, the most plausible explanation for this seems to be that of a systematic underperformance in TIMSS amongst students in historically black schools.

Figure 17: Lowess regressions by former department

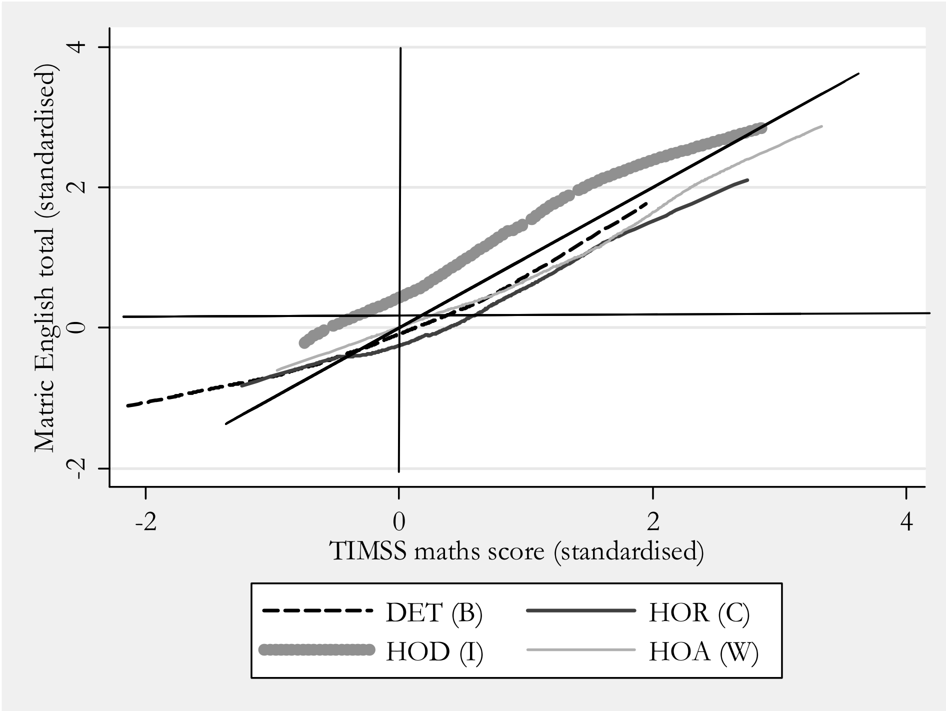
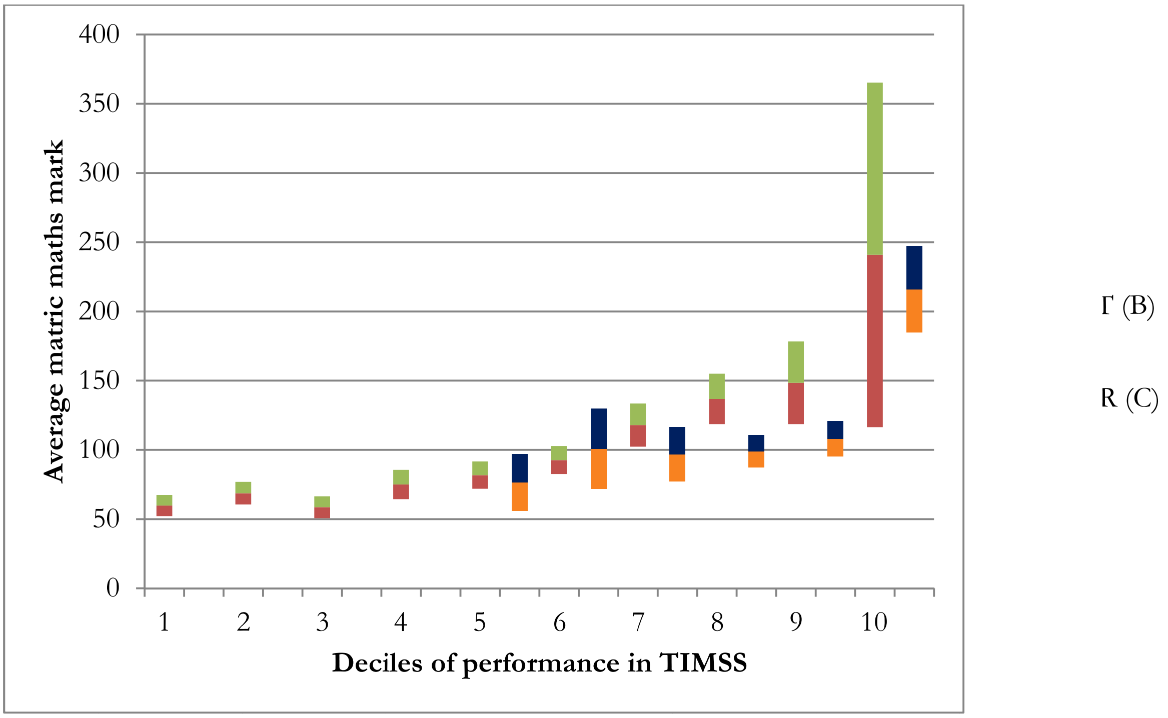


Figure 18: Mean matric mathematics mark and 95% confidence intervals by deciles of performance in TIMSS and former department



4. The influence of socio-economic status and implications for social mobility

Educational achievement in South Africa is known to vary widely across the socio-economic spectrum. Taylor and Yu (2009), for example, demonstrated this using the socio-economic gradient technique. A socio-economic gradient is a graphical representation of a regression relationship between socio-economic status and an outcome of interest, which in the present context is educational achievement. Applying the same technique to the "TIMSS-matric" dataset here produced the linear SES gradients depicted in Figure 19. The gradients for TIMSS mathematics, matric mathematics and matric English were plotted using the estimates from Regressions [1], [2] and [3] in Table 11.

The gradients for TIMSS mathematics and matric English are perhaps most suitable for comparison because the sample of observations is similar, whereas the matric mathematics group was a higher ability sub-sample. For these two gradients a one standard deviation change in SES was associated with a change in predicted achievement of just over half a standard deviation, an effect similar in size to the estimate obtained by Taylor and Yu (2009) using the PIRLS study, which tested reading amongst grade 5 South African students. This means that by grade 8 there are already considerable differences in educational achievement by SES, and that the extent of this effect is similar by matric.

Table 11: OLS regression models

Dependent variable	[1] TIMSS maths	[2] Matric maths	[3] Matric English	[4] Matric maths	[5] Matric maths	[6] Matric English	[7] Matric English
Explanatory variables							
SES	0.558 (42.44)**	0.328 (11.95)**	0.511 (24.24)**		-0.087 (3.06)**		0.075 (4.28)**
TIMSS maths				0.516 (27.09)**	0.563 (22.63)**	0.701 (50.08)**	0.660 (38.86)**
constant	-0.017 (1.49)	-0.156 (5.76)**	-0.169 (8.71)**	-0.309 (13.20)**	-0.310 (13.22)**	-0.301 (20.40)**	-0.301 (20.57)**
R-squared	0.2941	0.1144	0.2701	0.3847	0.3906	0.6112	0.6213
Observations	8851	1670	2626	1683	1670	2658	2626

*Significant at the 5% level **Significant at the 1% level
Absolute values of t-statistics in parentheses

Figure 19: Linear SES gradients

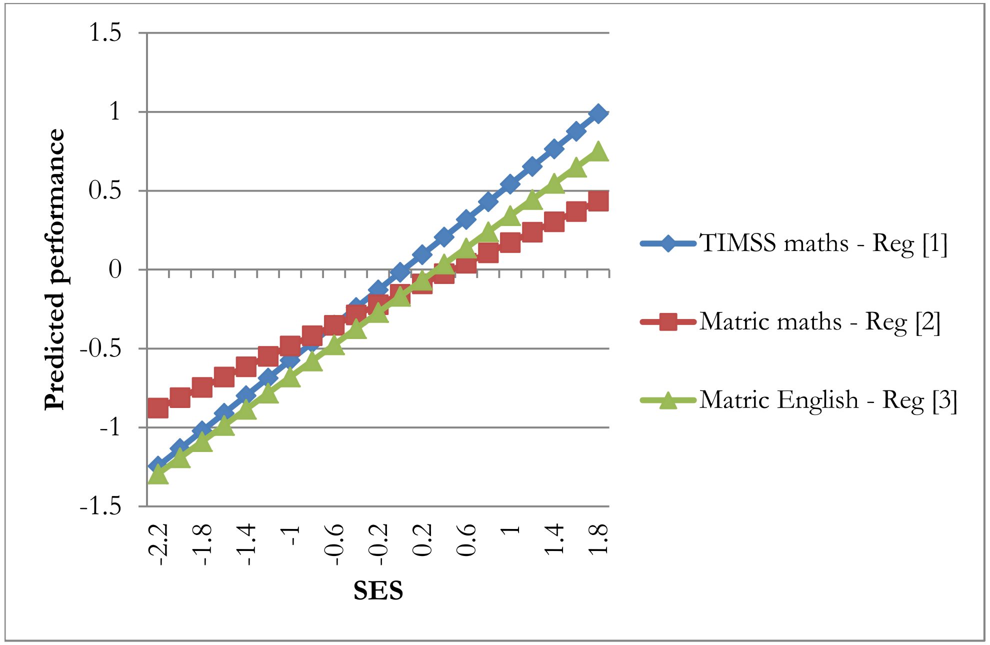
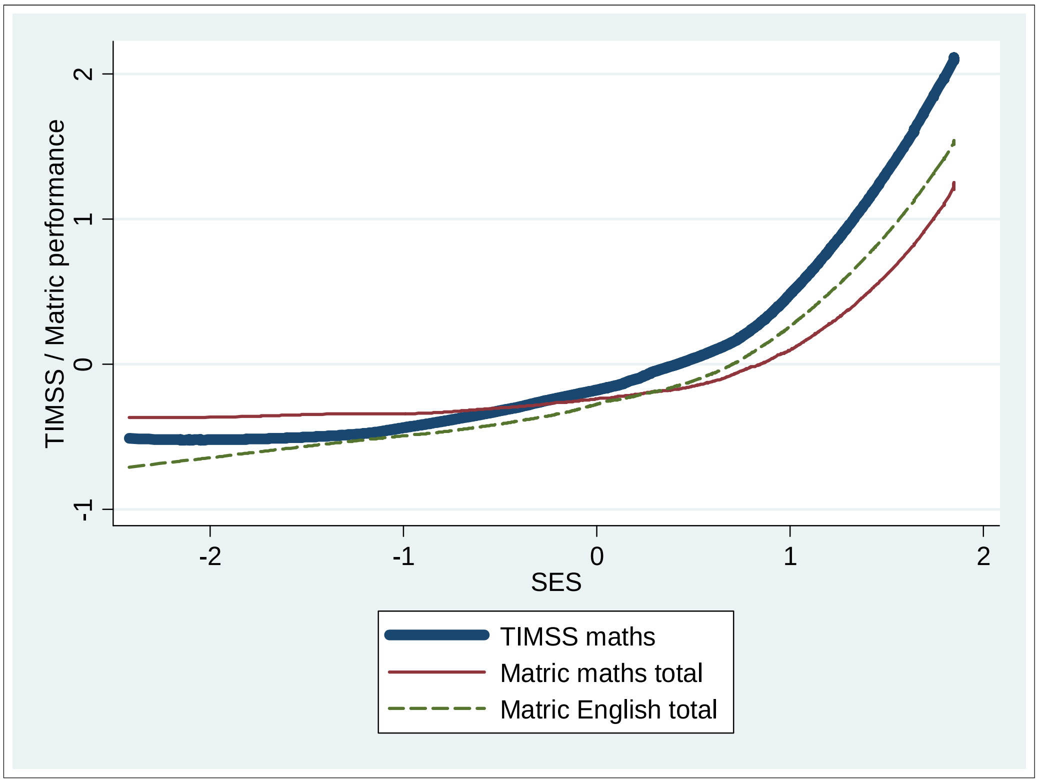


Figure 20 presents socio-economic gradients based on lowess regressions, thus allowing the shape of the curve to be determined by the data rather than by a linear or quadratic model specification. The relationship between SES and achievement, both at grade 8 and matric, is essentially flat at low and medium levels of SES, while at high levels of SES the curves become steeper. This is consistent with other studies that have found the relationship between SES and educational achievement in South Africa to be non-linear and convex (Van der Berg, 2008, Taylor and Yu, 2009). As in Figure 19, the gradients for grade 8 and matric were very close to each other, indicating that the effect of SES had to a large extent already been established by the eighth grade. Using data from the National School Effectiveness Study (NSES), Taylor (2010) produced similar lowess-type socio-economic gradients for grade 3 literacy achievement (in 2007) and for grade 4 literacy achievement (the same panel of students one year later). This confirms that the basic shape of the lowess gradient that is seen in Figure 20 was evident by the third grade, and was effectively the same at grade 4, although at a slightly higher level of overall cognitive ability due to the additional year of learning.

Figure 20: Lowess-type gradients for grade 8 achievement and matric achievement



The contention that the most important effects of SES were already laid down by the eighth grade is supported by a comparison of the estimated effects of SES in models [1], [2] and [3] with those in models [5] and [7] of Table 11. The first three models indicate that SES is a strong predictor of achievement in both grade 8 and matric. Models [4] and [6] show that grade 8 achievement too is a strong predictor of matric achievement. However, when including both SES and grade 8 achievement as predictors of matric achievement, the effect of SES seems relatively unimportant. In model [5] the coefficient on SES is actually small and negative, which would suggest that no important relationship exists. Moreover, the explanatory power of model [5], including both grade 8 achievement and SES, was only marginally greater than that of model [4], which did not include SES. This suggests that the effect of SES was already contained in the distribution of grade 8 achievement, and that little further sorting on the basis of SES occurred in secondary school.

Models [6] and [7] can be similarly interpreted. Approximately 61% of the variation in matric English achievement was explained by TIMSS mathematics scores, while including SES increased the proportion of variance explained to about 62%, a trivial addition to the explanatory power of the model. Therefore, the combination of regression models in Table 11 indicates that the effect of SES on educational achievement was already established by grade 8. This result could perhaps be interpreted in an optimistic vein: at least achievement gaps do not appear to further widen between grade 8 and matric. On the other hand, with such large disparities already evident at grade 8 it can be concluded that interventions at the secondary school level are too late. Earlier interventions are required to prevent such a substantial learning deficit amongst low SES students at the start of high school.

Thinking in terms of the schematic diagram of the role of education in social and economic mobility (Figure 1), one way to consider the extent to which mobility is possible is to examine the number of students from poor backgrounds that do ultimately achieve educational results that stand them in good stead on the labour market. Figure 21 shows the proportion of students in the poorest and richest quintiles in the TIMSS sample that went on to pass matric, score above 50% in matric English and score above 50% in matric mathematics. Approximately 28% of the poorest quintile reached matric and passed in either 2006 or 2007, whereas approximately 58% of the richest quintile achieved this. Slightly less than 8% of the poorest quintile reached matric and scored above 50% for matric English, while only about 3% achieved more than 50% in matric mathematics. This indicates that very few students from poor backgrounds ultimately realise the level of educational outcomes that are necessary to give them a meaningful opportunity to escape poverty.

Figure 21: Proportions achieving various matric performance thresholds by grade 8 SES quintile

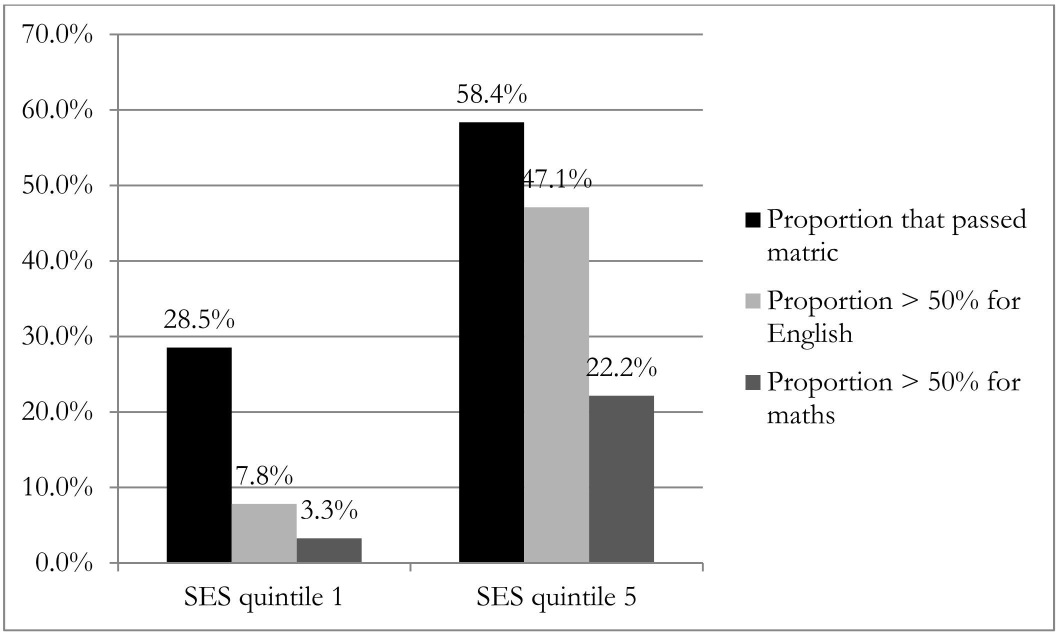
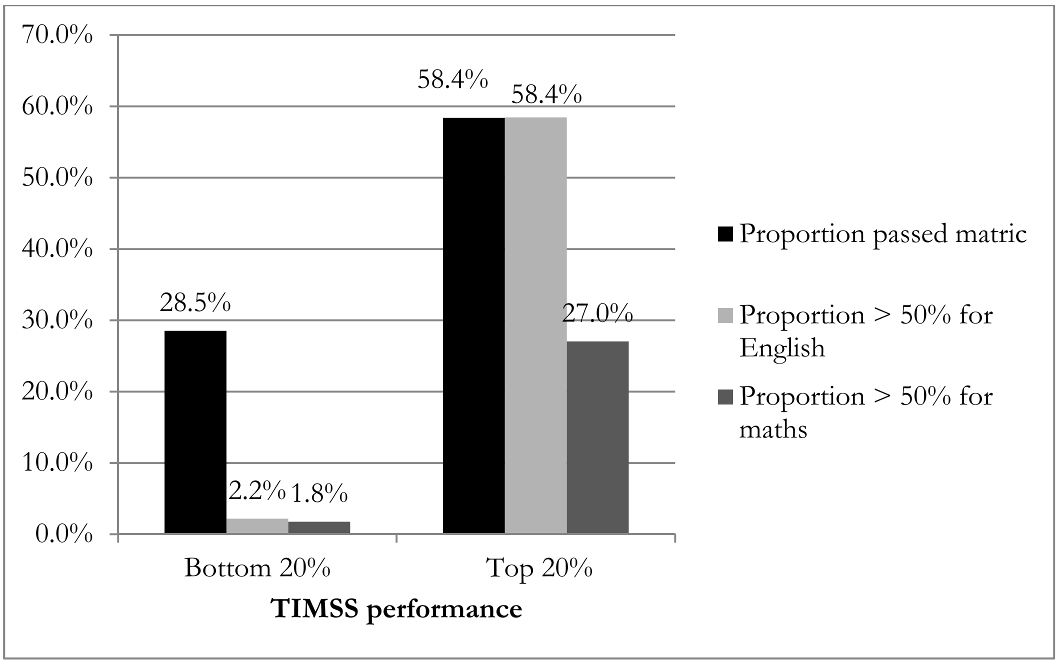


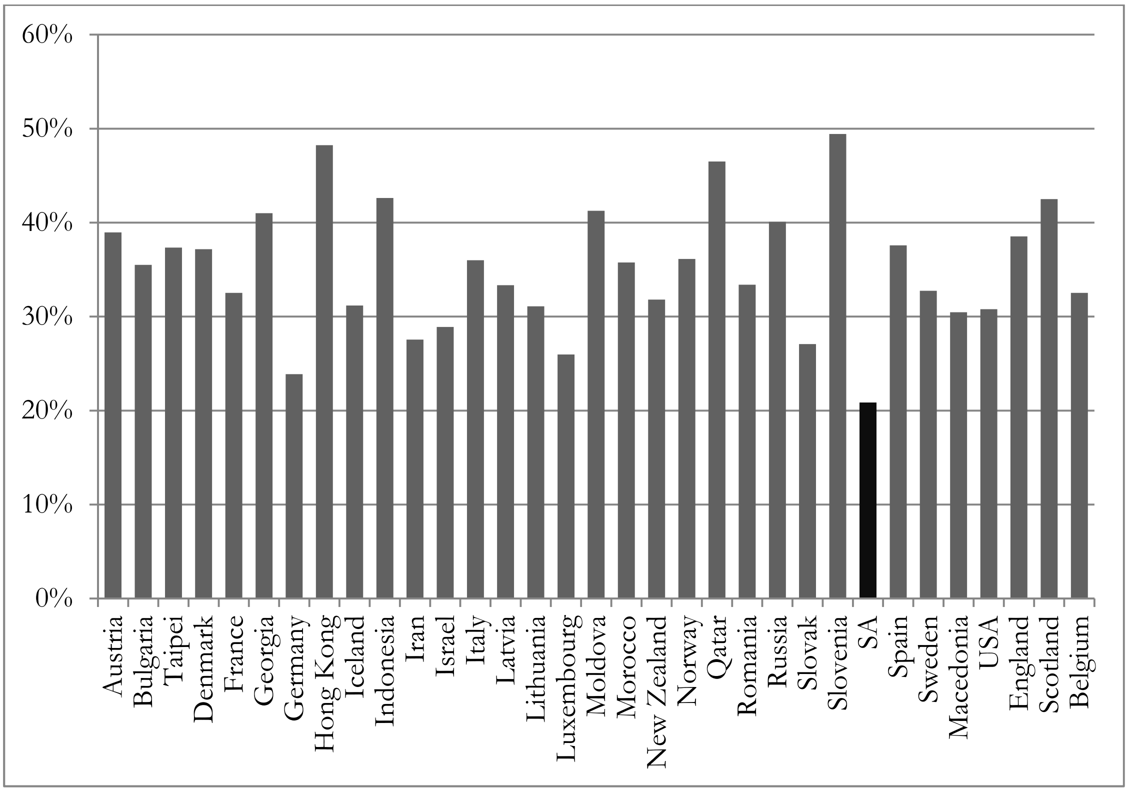
Figure 22 presents the same statistics but for the top and bottom quintiles of *performers* in TIMSS. Although just less than 30% of the bottom performers in TIMSS ultimately passed matric, a very small proportion of this group achieved relatively high marks in matric English and mathematics. Slightly over 2% achieved more than 50% in English and just less than 2% achieved 50% or more for mathematics. This indicates that low achievers in grade 8 are highly unlikely to ultimately realise high levels of achievement in matric.

Figure 22: Proportions achieving various matric performance thresholds by grade 8 performance quintile



The PIRLS2006 dataset offers some perspective about the prospects for mobility according to these indicators in South Africa compared with other countries. Figure 23 shows the proportion of the poorest quintile of students within each country in PIRLS scoring above the national average of their country.[12] Note that South Africa achieved the lowest national average in PIRLS 2006. In most countries between 30% and 40% of the poorest quintile scored above the national average. The figure confirms that South Africa had the lowest proportion scoring above the national average. This implies that in South Africa, poor students have the least chance of performing well relative to other children in their country.

Figure 23: Proportions of poorest quintile scoring above the national average in PIRLS



12 Several participants in PIRLSwere not included in Figure 23 due to insufficient information required to derive the index for socio-economic status in these countries.

Conclusion

This paper has confirmed that educational achievement varies widely with socio-economic status in South Africa. This has already been well documented elsewhere. Where this paper extends what is known about the relationship between socio-economic status and educational achievement is by scrutinising how this relationship plays out over time, in particular through analysis of a unique panel-like dataset.

It would appear that the substantial educational inequalities that are well publicised at the matric level are evident as early as grade 3. The foundations of these inequalities are thus laid down very early on in the educational trajectory of individuals. At least there is no observable widening of educational achievement gaps during secondary school, although the level at which poor students are performing is so low that one would really hope to see some catch-up during secondary school. Unfortunately there is no evidence of this either. The persistence of these educational performance gaps throughout the school trajectory supports the view of learning as a hierarchical process: that new knowledge is always built on earlier foundations. The findings presented here therefore point to the importance of intervening as early as possible to support those groups who are vulnerable to developing educational deficiencies that will hold them back for the remainder of their school careers. If increased social mobility is to be achieved in South Africa, interventions prior to high school will be necessary: at the primary school level and even at the level of early childhood development.

This is not to say that what happens at the secondary school level does not make a difference. Apart from the well known disparities in the overall level of performance between the historically different parts of the school system, this paper has also highlighted interesting differences in the ability of these groups of schools to convert given levels of achievement in grade 8 into performance outcomes at the matric level. An initially surprising, and yet consistent pattern, was that students at given levels of grade 8 achievement performed better in matric if they were in historically black schools than if they were in historically coloured schools. To some extent this may be a reflection of under-utilisation of the human capital that historically coloured schools demonstrated in grade 8, or conversely, of the success of educational interventions within historically black high schools. A preferred explanation is that factors such as writing TIMSS in a language other than home language, unfamiliarity and low stakes nature of the TIMSS assessment compared with matric which is high stakes with many exemplars of what constitutes the assessment, exposure to weak assessment practices and poor exam writing technique may have contributed to a systematic underestimation of the capabilities of students in historically black schools in TIMSS. If this was the case, these students may have been able to perform at a level nearer to their true ability in matric, thus creating the impression of greater improvement since grade 8. Mounting evidence from other studies indicates that weak and random assessment practices indeed characterise many of South Africa's low-performing schools.

Patterns in matric mathematics participation were also consistent with the hypothesis of weak assessment practices in historically black schools. In these schools, there was very little difference in the average performance in TIMSS between students who took mathematics in matric and those who did not. The very low level of mathematics performance in both TIMSS and matric of these students would suggest that they had a rather inflated perception of their mathematics ability. Inaccurate and lenient assessment would have contributed to such an inflated idea. This suggestive evidence complements other recent research that has highlighted weak assessment practices in parts of South Africa's school system. Assessment practice has thus emerged as a prominent and significant aspect of school quality in this paper, despite the fact that an investigation of this issue was not explicitly intended when the analysis was embarked upon.

The exercise of following the performance of students from the eighth grade to matric has thus led to a raised appreciation of two issues in particular: the importance of early interventions to reduce educational inequality in South Africa, and the importance of meaningful assessment practices in schools.

List of References

Bowles, S. and Gintis, H. 1976. *Schooling in Capitalist America.* New York: Basic Books.

Carnoy, M. 1982. "Education, Economy and the State." in *Cultural and Economic Reproduction in Education.* Edited by M.W. Apple. London: Routledge and Keegan Paul.

Coleman, J.S., Campbell, E.Q., Hobson, C.J., McPartland, J., Mood, A.M., Weinfeld, F.D., and R.L. York. 1966. *Equality of educational opportunity*. Washington, DC: US Government Printing Office.

Feinstein, L. 2003. "Inequality in the early cognitive development of British children in the 1970 cohort." *Economica.* 70: 73-97.

Fleisch, B. 2008. *Primary Education in Crisis: Why South African schoolchildren underachieve in reading and mathematics.* Juta.

Heckman, J.J. 2006. "Skill formation and the economics of investing in disadvantaged children." *Science.* 312: 1900-1902.

Heyneman, S.P. and W. Loxley. 1983. "The Effect of Primary-School Quality on Academic Achievement Across Twenty-nine High-and-Low-Income Countries." *The American Journal of Sociology*. 8: 1162-1194.

Lam, D., Ardington, C., and M. Leibbrandt. 2008. "Schooling as a Lottery: Racial Differences in School Advancement in Urban South Africa." University of Michigan, Institute for Social Research. Population Studies Center Research Report 08-632.

Lee, V. E. and D.T. Burkham. 2002. *Inequality at the Starting Gate: Social Background Differences in Achievement as Children Begin School.* Washington, D.C.: Economic Policy Institute.

Nyanda, G., Arrow, J., Howie, S., Mabizela, S., Patel, F., Simkins, C, and S. Van der Berg. 2007. *Ministerial committee on learner retention in the South African schooling system.* Draft report.

Reddy, V. 2006. *Mathematics and Science Achievement at South African Schools in TIMSS 2003*. Cape Town: HSRC Press.

Spaull, N. 2011. "A preliminary analysis of SACMEQ III South Africa." Stellenbosch Economic Working Papers No. 11/11.

Taylor, S.G.S. 2010. "The performance of South African Schools: Implications for Economic Development." Unpublished PhD Thesis, University of Stellenbosch. December 2010.

Taylor, S.G.S and D. Yu. 2009. "The importance of socio-economic status in determining educational achievement in South Africa." Stellenbosch Economic Working Papers No. 01/09.

Van der Berg, S.2008. "How effective are poor schools? Poverty and educational outcomes in South Africa." *Studies in Educational Evaluation.* 34: 145-154.

Van der Berg, S. and D. Shepherd. 2010. "Signalling performance: Continuous assessment and matriculation examination marks in South African schools." Stellenbosch Economic Working Papers No. 28/10.

Appendix A: The calculation of appropriate weights for "TIMSS-matric" panel dataset

Those captured in matric were weighted up by the inverse of the proportion of the capturing rate relative to the GHS follow through rate, for each race.

Table A.1: Weighting calculations (For those captured)

	TIMSS capturing rate (T%)	GHS follow through rate (GHS%)	P=T%/GHS%	Weight=1/P
Black	25.34%	55.34%	0.457896	2.1839
Coloured	47.20%	53.56%	0.881309	1.134676
Indian	47.06%	88.08%	0.534304	1.871594
White	73.86%	86.65%	0.852405	1.173151

The overall weight provided by TIMSS is called "totwgt'. Therefore, for those captured the appropriate weighting system based on the above table was decided on as follows:

$$W_{Africans} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate} \right)^{-1} * totwgt = \left(\frac{25.34}{55.34} \right)^{-1} = \frac{1}{0.46} * totwgt = 2.18 * totwgt$$

$$W_{Coloureds} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate} \right)^{-1} * totwgt = \left(\frac{47.20}{53.56} \right)^{-1} * totwgt = \frac{1}{0.88} * totwgt = 1.13 * totwgt$$

$$W_{Indians} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate} \right)^{-1} * totwgt = \left(\frac{47.06}{88.08} \right)^{-1} * totwgt = \frac{1}{0.53} * totwgt = 1.87 * totwgt$$

$$W_{Whites} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate} \right)^{-1} * totwgt = \left(\frac{73.86}{86.65} \right)^{-1} * totwgt = \frac{1}{0.85} * totwgt = 1.17 * totwgt$$

Similarly, those not captured were weighted down by the inverse of the proportion of the "not captured rate" relative to the GHS dropout rate, for each race. Again, this was multiplied by "totwgt".

Table A.2: Weighting calculations (For those not captured)

	TIMSS not captured (T%)	GHS dropout rate (GHS%)	P=T%/GHS%	Weight=1/P
Black	74.66%	44.66%	1.67174	0.59818
Coloured	52.80%	46.44%	1.13695	0.87955
Indian	52.94%	11.92%	4.44128	0.22516
White	26.14%	13.35%	1.95805	0.51071

Appendix B: Description of variables used in multivariate analysis

The index for socio-economic status (SES) was derived using the 16 questions in TIMSS regarding the presence of various household items. These 16 items are the following:

Calculator
Computer
Study desk/table
Dictionary
Electricity
Tap water
Warm water
Radio
TV
VCR
Tape recorder
CD player
Own room
Bicycle
Flush toilet
Motor car

Principal Components Analysis was applied to these 16 items in order to determine the appropriate weight each item should have in the overall SES index. The index was then standardised to have a mean of zero and a standard deviation of one.

Table A.3: Description of variables used in multivariate regression models

Urban	Dummy: School is located in an urban area
Semi-urban	Dummy: School is located in a semi-urban area
Rural	Dummy: School is located in an rural area
Rurality unspecified	Dummy: location of school unspecified
Absenteeism no problem	Dummy: Absenteeism is not a problem according to principal
Absenteeism moderate	Dummy: Absenteeism is a moderate problem according to principal
Absenteeism severe	Dummy: Absenteeism is a severe problem according to principal
Absenteeism very severe	Dummy: Absenteeism is a very severe problem according to principal
Absenteeism unspecified	Dummy: Absenteeism was not specified by principal
Student SES	SES index as explained above
Parent education0	Highest parent education: no schooling or incomplete primary
Parent education1	Highest parent education: primary or incomplete secondary school
Parent education2	Highest parent education: matric
Parent education3	Highest parent education: degree
Parent education unspecified	Highest parent education: no response
Student age	Age of student in 2002 (grade 8)

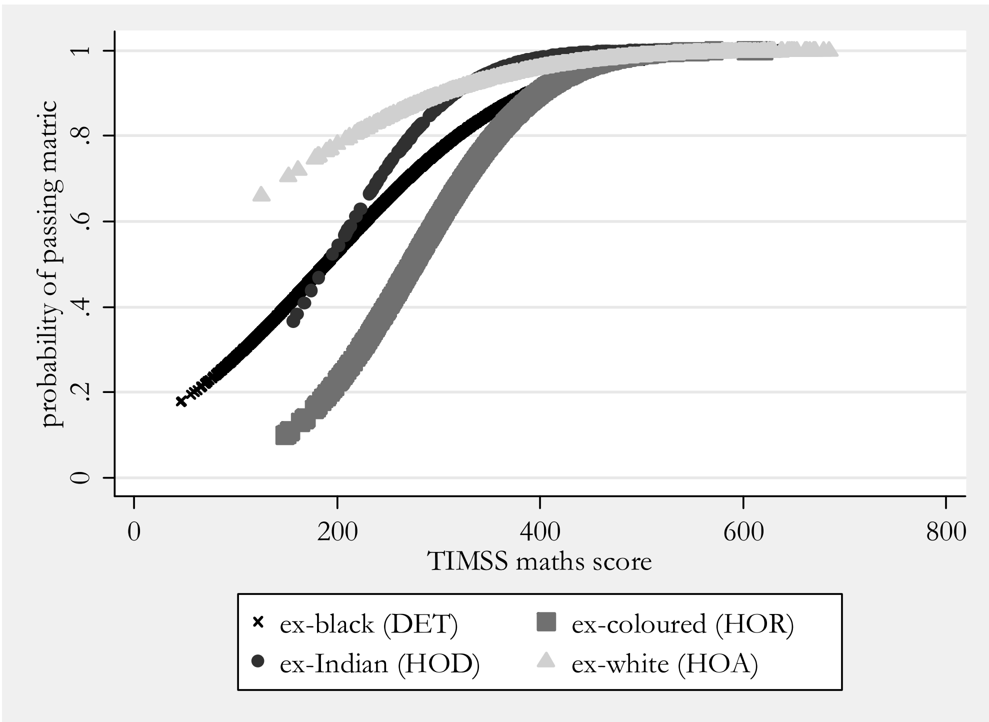
Appendix C: The probability of passing matric conditional upon reaching matric

Table A.4:Probit regression predicting passing matric
(Dependent variable: Pass = 1; No pass = 0)

Explanatory variables	Marginal effects coefficient	Standard error
TIMSS maths score	0.00173**	0.00018
HOR (C)	-0.55535**	0.19702
HOD (I)	0.23500	0.30161
HOA (W)	0.19768	0.09280
HOR*TIMSS maths	0.00100*	0.00047
HOD*TIMSS maths	-0.00010	0.00063
HOA*TIMSS maths	-0.00044	0.00047
Observations	2509	
Pseudo R-squared	0.1864	

*Significant at 5% level **Significant at 1% level

Figure A.5: Predicted probabilities of passing matric conditional upon reaching matric



Appendix D: Participation in matric mathematics by former department

Table A6: Numbers participating in matric mathematics by former department

	DET (B)	HOR (C)	HOD (I)	HOA (W)	Total
Did not take maths	610	289	60	150	1109
Took maths	1157	198	96	304	1755
Total	1767	487	156	454	2864

Table A.7:Probit regression predicting taking maths in matric
(Dependent variable: took maths SG or HG = 1; Identified in matric but did not take maths = 0)

	DET (B)	HOR (C)	HOD (I)	HOA (W)
TIMSS maths score	0.00366**	0.00931**	0.01202**	0.00758**
	(0.00050)	(0.00100)	(0.00187)	(0.00078)
Constant	-0.51368**	-3.61391**	-4.12231**	-3.00166**
Pseudo R-squared	0.0248	0.1594	0.3007	0.1979
N	1767	487	156	454

*Significant at 5% level **Significant at 1% level
Note: Standard errors in parentheses