Girls Do Better

The Pro-Female Gender Gap in Learning Outcomes in South 1995-2018

- Nic Spaull & Nwabisa Makaluza[1]

Abstract

In this paper we analyze gender gaps in educational outcomes in South Africa using four nationally-representative datasets - PIRLS, TIMSS, SACMEQ and Matric – over the period 1995-2018. We show that girls outperform boys at the mean in all subjects and all grades, including in Mathematics and Physical Science, and including in the school-leaving exam, Matric. Pro-girl gaps at the primary-school level are large and statistically significant with Grade 4 girls an entire year ahead of Grade 4 boys in reading outcomes. Similarly large differences can be found in the most recent Matric microdata (2018). We show that the received wisdom in South Africa, that males outperform females in Mathematics and Physical Science in Matric, is partly a function of higher rates of male dropout in high school, leaving a stronger cohort of males to write matric. In 2018, for every 100 females in matric there were only 80 males. If one compares an equal number of males and females in matric, girls do unequivocally better in all 13 subjects when looking at average performance. When looking at higher levels of achievement (60%+) girls do better in nine subjects and boys do better in two subjects (Mathematics and Physical Science). However, girls are still less likely to fail these two subjects when compared to their male counterparts. Given these results and the theory that human capital contributes to employment and earnings, we see the need for further research (in the South African context) for why the female advantage in education does not translate into a female advantage in the labour market. What are the general, and specific, constraints for why women experience inferior labour outcomes in the world of work.

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1. Introduction

It is now well-documented that the opportunities and life-chances of boys and girls differ in meaningful and important ways in most countries around the world. Three areas that have received considerable scholarly attention over the last 50 years are the gender differences evident in education, employment and earnings. While the first of these is the focus of the current paper, it is not entirely separate from the other two. Cross-national research shows that in almost all countries, women are less likely to be in paid employment, and when they are, are paid less on average than their male counterparts (ILO, 2017). This is also true of South Africa (Wittenberg, 2014). Yet, at the school-level in South Africa the exact opposite is true; girls are more likely to remain in school and more likely to pass all subjects than their male counterparts, as we will show. Systematically documenting the superior academic achievement of girls in South Africa is an important research endeavour since it dispels the myth that the poor outcomes women face in the labour market are somehow driven by female under-performance at school or at university.

The paper is structured in four different parts. In Section 2 we document the gender differences in education in a local and international context, as well as the gender differences in enrolment, repetition and dropout in South Africa. Section 3 documents the South African differences in learning outcomes by gender over the period 1995-2018 using data from nationally-representative surveys of Reading, Mathematics and Science, as well as population-wide data on the most recent cohort writing the school-leaving exam (Matric 2018), and Section 5 concludes.

2. Education and gender: local and international evidence

The social, economic and civic benefits of education are now widely documented in the literature. These include higher levels of subjective well-being (Melin, Fugl-Meyer, & Fugl-Meyer, 2003; Murrell & Meeks, 2001), better mental and physical health (Murrell & Meeks, 2002), improved child health (Currie, 2009), as well as improved labour productivity, higher wages and faster economic growth (Hanushek & Zhang, 2009; Heckman, Stixrud, & Urzua, 2006; McIntosh & Vignoles, 2000; Appleton, Atherton, & Bleaney, 2013; Barro & Lee, 2013). Given this plethora of benefits, any gender differences in either access to education or in learning outcomes are therefore important to interrogate and understand.

Existing literature on gender and education in South Africa

In South Africa there has been considerable attention paid to gender and education by government, researchers and civil society more generally (Wolpe, 2005; Chisholm & September, 2005; Commission for Gender Equality, 2007; Zuze & Reddy, 2014). South Africa is in the fortunate position of having reached near full-enrolment for both boys and girls. In 2017, 98% of children aged 7-17 years (11,2 million children) attended some form of educational facility and there were no statistically significant gender differences in either

access or attendance (Hall, 2018: p. 149). As a result much of the extant literature focuses on differences in learning outcomes.

A recent analysis by Zuze & Beku (2019) of gender and learning outcomes in South Africa using large-scale representative data provides a useful summary. Using similar datasets to those we analyse in this paper, they show that girls outperform boys at the primary and lower secondary level in Reading, Mathematics and Science. They also show that boys are more likely to be bullied at school and that girls are less confident about their Mathematics abilities in Grade 9, despite higher average achievement in Mathematics at this level (Zuze & Beku, 2019: 1). In a more wide-ranging study Kirkwood (2018: p.1) shows that while women are *more* likely to enrol in undergraduate degrees (61% of undergraduates are female), they are slightly *less* likely to enrol in postgraduate studies (48% of Masters students are female and 43% of Doctoral students are female) (see also Government of South Africa, 2015). The World Economic Forum's Global Gender Gap Report 2018 also documents the differences in South African graduates by degree type. It shows that females are three times less likely to get a degree in 'Engineering, Manufacturing and Construction', half as likely in 'Information and Communication Technologies' and 22% less likely in 'Natural Science, Mathematics and Statistics' (WEF, 2018: p.252). We return to this in our analysis of higher education in South Africa.

While it is true that there are no notable gender differences in initial enrolment in South Africa, there are large and significant differences in throughput, repetition and dropout. Research by Branson et al. (2014) and Fleisch & Shindler (2009) show that girls in South Africa are significantly less likely to repeat a grade or to drop out of school, something that is concentrated in the upper years of secondary school in South Africa. Lam et al. (2010: 3) show that in the Western Cape "girls move through school faster than boys, with female schooling exceeding male schooling by about one full grade among recent African cohorts who have finished schooling." Using population-wide panel data[2] for the same province, Van Wyk et al. (2017: 20) follow all grade six learners in the Western Cape (N=77,633) over the period 2007-2013. They find that males are 29% more likely to have dropped out of school by 2013 compared to their female counterparts (male dropout rate: 48%, female dropout rate: 37%).

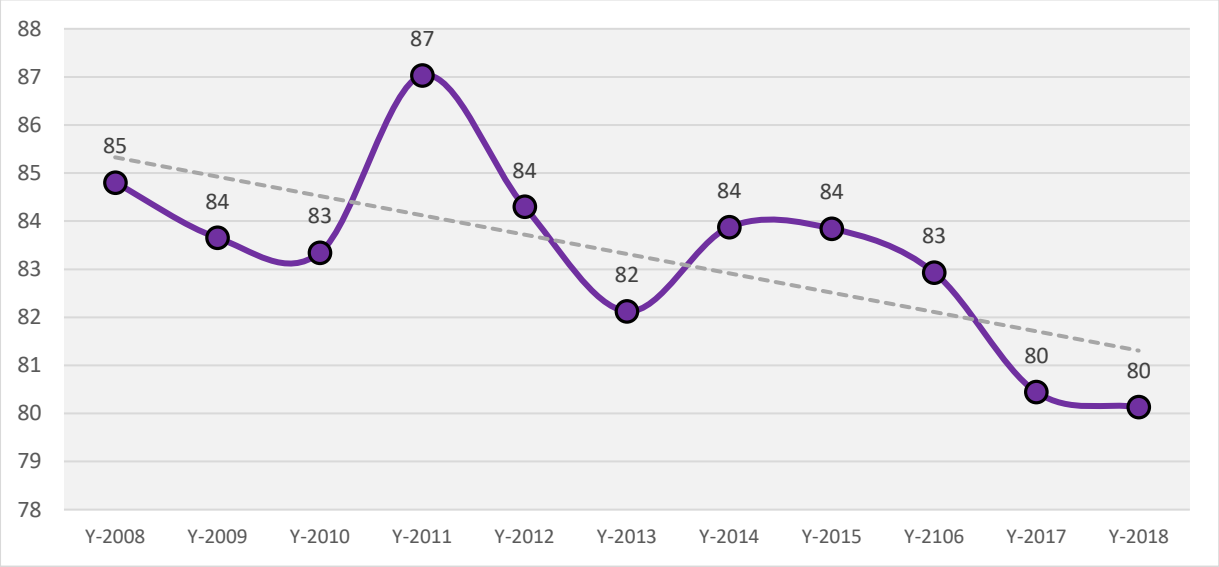
As a result of these trends, there are substantial differences in the number of males and females reaching and writing the school leaving exam, the National Senior Certificate (NSC, Grade 12), known locally as '*Matric.'* Over the last 10 years males have constituted a declining proportion of those writing matric and in 2018 for every 100 females writing matric there were only 80 males[3] (DBE, 2019a: p.50). Figure 1 below reports on publicly available information on the male:female ratio of those writing matric from 2008-2018 relative to 100

2 The same individuals are observed over multiple points in time.

3 This is looking specifically at full-time candidates taking at least seven subjects. Of the 512,735 candidates, 284,643 are female (DBE, 2019a: p.50).

females. With outliers in 2011 and 2013, the male:female ratio has been steadily declining from 85:100 in 2008 to 80:100 in 2018 (DBE, various years[4]).

Figure 1: Ratio of males to females (relative to 100 females) writing Matric 2008-2018 (own calculations using official Matric reports)



The 'under-representation' of males in matric has important implications for analysing the matric data since those who drop out are, on average, weaker students (Lambin, 1995; Lewin, 2009). Given that males drop out at higher rates than females, the resulting male cohort in matric is a more selective one than the female cohort (Perry, 2003). We address this issue later in the paper by creating an enrolment-comparable cohort which has equal numbers of male and female matriculants.

The gender gap in learning outcomes internationally

Internationally almost all organisations working in education explicitly report on gender in some shape or form (United Nations, 2015; World Bank, 2016, UNESCO, 2015; OECD, 2016). While much of this focuses on access to education in low-income countries, we choose to foreground the international literature on gender differences in learning outcomes since these are most relevant for the South African context.

International Reading Results by Gender

The main quantitative analyses of learning outcomes internationally are cross-national assessments where representative samples of children from a selected grade or age are assessed on the same test across participating countries. Both the Program for International Student Assessment (PISA) and the Progress in International Reading and Literacy Study (PIRLS) have found that on average girls always outperform boys in Reading. Of the 45 (mostly high-income) countries that participated in PIRLS 2011 at the fourth-grade level, 40 had large pro-girl differences in reading achievement, with the remaining five countries showing no

4 These figures are taken from the National Senior Certificate (NSC) Technical Report for each year, published by the Department of Basic Education.

difference by gender (Mullis et al., 2012a: p7). In all rounds of the PISA assessment, 15-year-old girls outperform 15-year-old boys in Reading; however this gap has narrowed somewhat between 2009 and 2015 (OECD, 2016: 169, 38). Similar results have been found for reading in Latin American countries at the primary school level. The SERCE[5] 2007 data show that girls significantly outperformed boys in all 17 Latin American countries at the Grade 3 level and in nine countries at the Grade 6 level (LLECE 2008 in Saito 2011). In sub-Saharan Africa, the SACMEQ data shows that nine of the 14 countries had higher average Reading scores for girls than boys, with the difference being statistically significant in five countries. Of the six countries with pro-boy Reading scores (all of which are much poorer low-income countries), the difference is only statistically significant in two countries (Zimbabwe and Tanzania) (Saito, 2011: p18).

International Mathematics and Science Differences By Gender

In the PISA 2015 Science assessment, 15-year-old boys scored marginally higher than their female counterparts (4 points), with significant pro-boy differences in only 24 of the 72 countries. The PISA 2015 Mathematics assessment showed that boys outperform girls by 8 score points on average, but that the difference is only statistically significant in 28 of the 72 countries/economies (OECD, 2016: p.196), down from 38 points in PISA 2012 (OECD, 2015:20). Of the 49 countries participating in the Trends in International Mathematics and Science Study (TIMSS) 2015 at the Grade 4 level, about half exhibit no achievement difference between boys and girls in Mathematics (23 countries) and Science (25 countries). At the Grade 8 level this rises to 26 of the 39 countries in Mathematics and 20 of the 39 countries in Science. Contrary to popular belief at the eighth-grade level for Mathematics and Science there are more countries where girls outperform boys (7 countries for Mathematics and 14 for Science) than where boys outperform girls (6 countries for Mathematics and 5 countries for Science) (Mullis et al., 2016: p15). It is worth noting that all of the above statistics are country averages. Disaggregating results shows that there is considerably more variation in boys' achievement, meaning that boys are more likely than girls to be both at the very top and the very bottom of the distribution (OECD, 2015) – something that we look at in detail in the second half of this paper. Turning to Africa, Dickerson et al. (2015: 13) uses data from SACMEQ and PASEC[6] (francophone West Africa) and show that of 19 African countries included in their sample, boys significantly outperform girls in Mathematics in 10 countries, while girls significantly outperform boys in three countries (see also Saito, 2011). These results are all correlated with income such that wealthier countries exhibit pro-girl differences and very poor countries exhibit pro-boy differences.

[5] SERCE stands for the Segundo studio regional comparative y explicativo

[6] SACMEQ stands for the Southern and Eastern African Consortium for Monitoring Educational Quality, and PASEC stands for the Programme d'Analyse des Systèmes Educatifs des Pays de la Confèrences des Ministres de l'Education des Pays Francophones.

To summarize the international evidence above, girls significantly outperform boys in Reading irrespective of assessment, grade or country. In about one third of countries boys outperform girls in Mathematics and Science although this is only true in PISA. In TIMSS there are more countries were girls outperform boys than boys outperforming girls. In Africa there are more pro-boy gaps in Mathematics but this is generally a feature of countries with very low per capita income.

3. Analysis and results

South Africa is in the fortunate position of having multiple sources of reliable data on learning outcomes, both across subjects and over time. The main sources of sample-based assessment data are the three cross-national assessments that the country takes part in; SACMEQ, PIRLS and TIMSS[7] which assess Reading, Mathematics and Science outcomes at both the primary school level (Grades 4-6) and the secondary school level (Grades 8-9) (see Howie et al., 2017; Reddy et al., 2016; and Moloi & Chetty, 2011). All three assessments are nationally representative and independently administered, with samples typically ranging from 250-400 schools per assessment. In addition to sample-based assessment data, there is also population-wide data available on matric learning outcomes. These exams[8] are conducted at approximately 6,300 secondary schools per year (DBE, 2019a: p.23). All matric subjects are assessed using nationally standardised and centrally-marked assessments.

In this paper, we analyse these three sample based assessments; **SACMEQ** (Grade 6 Reading and Mathematics; 2000 and 2007), **PIRLS** (Grade 4-5 Reading; 2006, 2011 and 2016), **TIMSS** (Grade 5 Mathematics & Grade 8-9 Mathematics and Science; 1995, 1999, 2003, 2011, 2015), as well as the most recent **Matric** data (Matric 2018[9]).

At the primary school level we find an unequivocal female advantage in average achievement in both Reading and Mathematics – across all years and in both subjects. Table 1 in Appendix A provides the breakdown of scores by assessment, year, grade and gender. Figure 2 below summarises the data reported in Table 1 illustrating the gender differences over the period 2000 to 2016. Throughout this paper gender differences are reported as 'female minus male' such that positive differences are 'pro-girl' and negative differences are 'pro-boy.' Given that different assessments use different scales to measure achievement they are often difficult to

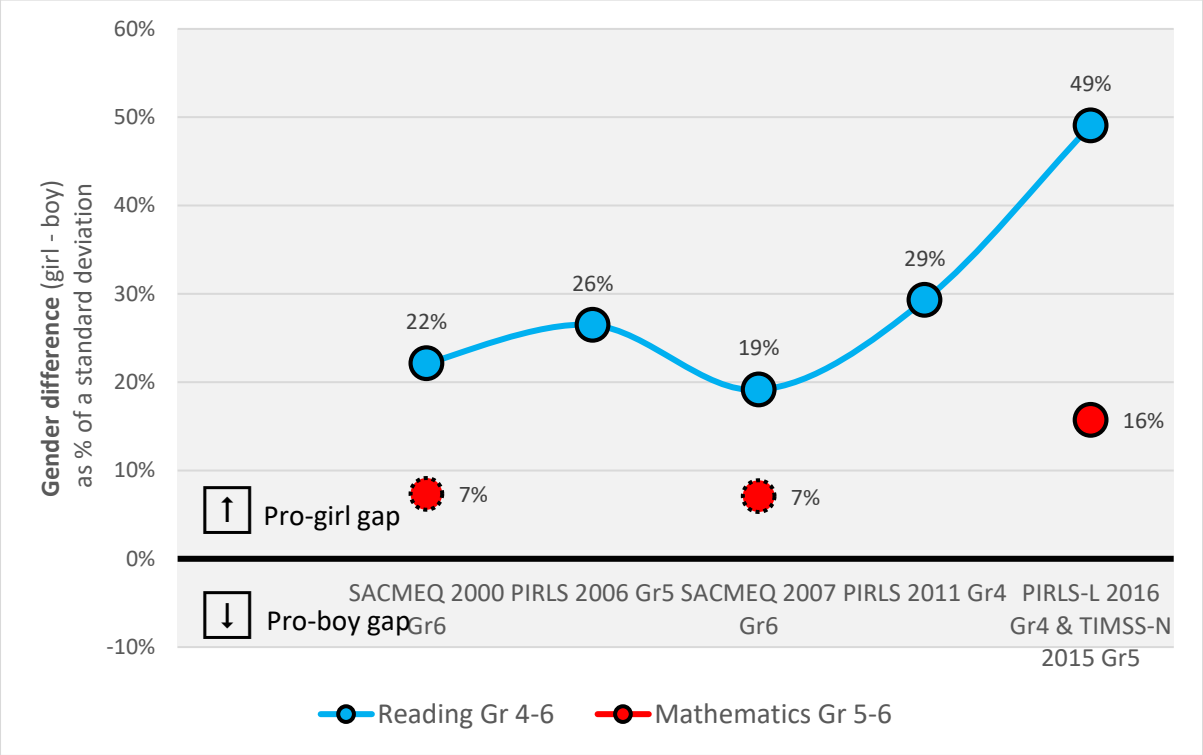
[7] SACMEQ stands for the Southern and Eastern African Consortium for Monitoring Educational Quality, PIRLS stands for the Progress in International Reading Literacy Study, and TIMSS stands for the Trends in International Mathematics and Science Study. The exact references for the full reports for each year and study can be found in Appendix A.

[8] The results we report here are the final mark allocated to a candidate for that subject in matric. That is to say it is inclusive of a continuous assessment component. The standards authority Umalusi, together with the Department have a practice of excluding continuous assessment marks if they are more than ten percentage points different to the final exam mark.

[9] The analysis of Matric 2018 is an extended analysis of a previous RESEP project analyzing this dataset for Tshikululu Social Investments for the "Maths Challenge" project.

equate or compare. As such all gender differences are expressed as a percentage of a standard deviation – a measure of the spread of the distribution.[10]

Figure 2: Primary school gender differences in mean Reading and Mathematics outcomes in SA (*Data: SACMEQ, PIRLS, TIMSS-Numeracy; 2000-2016)*
Note: Differences are expressed as a percentage of a standard deviation. Solid-circles indicate that the difference is statistically significant, dotted-circles that it is not.



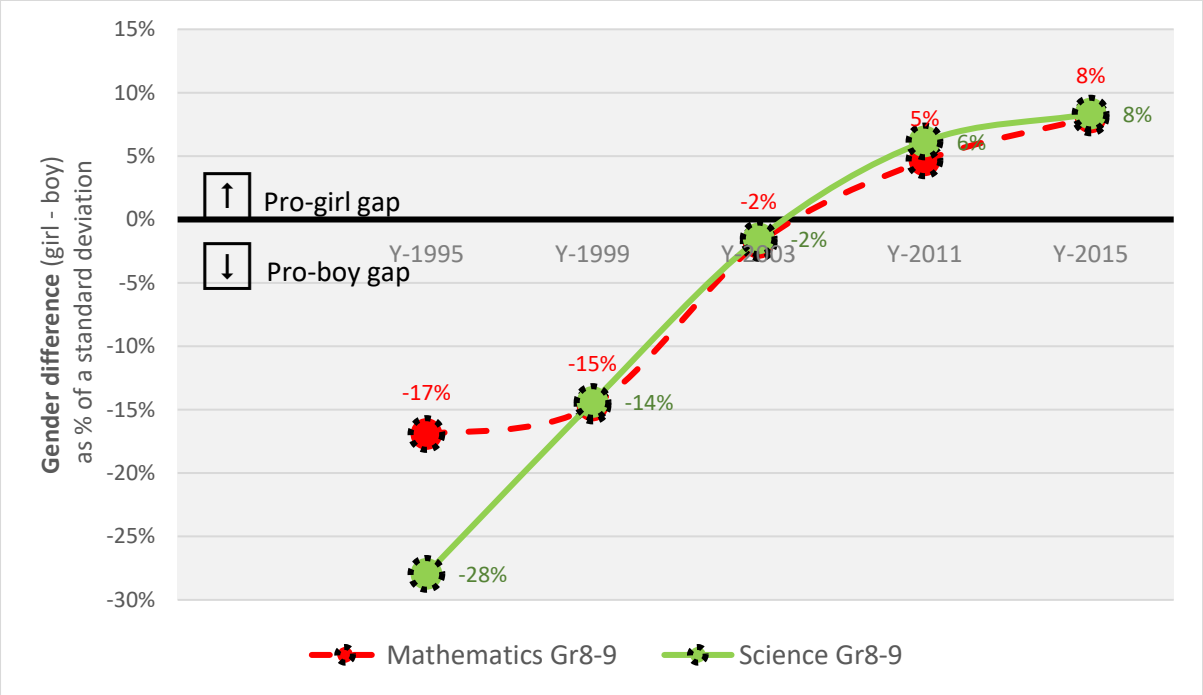
There are a number of observations worth emphasising from Figure 2. Firstly, all primary school differences in learning achievement are "pro-girl" – both in Reading and Mathematics. Secondly, the differences for Reading are all large and statistically significant, while the differences for Mathematics are positive but only statistically significant for the most recent assessment (TIMSS-Numeracy, Grade 5, 2015). Thirdly, while the pro-girl gender difference in Reading outcomes is not especially surprising given that girls learn to read faster than boys in virtually all middle and high-income countries (Mullis et al., 2012a: p7; OECD, 2015; OECD 2016: 169, 38), the extent of the difference is notable. Of the 50 countries that participated in the 2016 round of the PIRLS reading assessment (Grade 4), South Africa had the 2nd largest pro-girl gender gap behind only Saudi Arabia who had the largest pro-girl gap (Mullis et al., 2017: p. 36). To provide a more intuitive interpretation to these scores: while 28% of Grade 4 girls could read at a basic level, only 16% of Grade 4 boys could read at the same level (Howie et al., 2017: p. 76). To give a further intuitive explanation of the size of the gap, the difference

[10] To provide an intuitive interpretation of a standard deviation, a 0,5 standard deviation increase is the same as moving from the 50th percentile of the distribution to the 69th percentile of the distribution (assuming the distribution is normal).

in PIRLS Literacy 2016 (Grade 4) of 49% of a standard deviation is approximately equivalent to one year of learning. That is to say that Grade 4 girls are one year 'ahead' in terms of learning outcomes relative to Grade 4 boys.

Figure 3 provides a similar analysis to Figure 2 except that it focuses on secondary schools and specifically Grade 8-9. The TIMSS study is the longest standing cross-national assessment in the country, testing Mathematics and Science and ranging from 1995-2015. Results show that while boys seemed[11] to outperform girls in both Mathematics and Science in 1995 and 1999, this difference has declined over time and in 2011 and 2015 Grade 9 girls seemed to marginally outperform Grade 9 boys in both Mathematics and Science, although the difference is not statistically significant.

Figure 3: Secondary school gender differences in mean Mathematics and Science outcomes in South Africa (*Data: TIMSS 1995-2015).*
Note: Scores expressed as a percentage of a standard deviation. Solid-circles indicate that the difference is statistically significant, dotted-circles that it is not.



The data reported in Figure 3, at least post-2003, seems to be at odds with the received wisdom in South Africa, viz. that boys do better than girls in both Mathematics and Science. There may be some truth to this claim since we are only reporting average performance,

[11] Note that none of the differences in Figure 3 are statistically significant. It is possible that this is because the assessments in 1995, 1999 and 2003 were too difficult for South African Grade 8 students, given that they were aimed at students in high-income contexts. From 2003 onwards South African Grade 9 students wrote the Grade 8 test. The 'match' between the difficulty of an assessment and the ability level of the test-takers is one of the attributes contributing to the reliability and validity of the results.

when it may be that boys do better than girls at other parts of the distribution. There is some international evidence for this. The PISA Mathematics test of 15 year olds shows that the pro-boy Mathematics gap is twice as large at the 90th percentile (20 score points) as it is at the mean (11 score points) (OECD, 2015: p.30). The same report shows that 10 countries have pro-girl differences at the mean but pro-boy differences at the 90th percentile. The same study found that six out of ten students in the lowest performance category in reading, mathematics and science were boys (OECD, 2015: p.13). In sum, boys are typically over-represented in both the lowest and highest performance categories. Unfortunately, South African sample-based studies of Mathematics achievement (like TIMSS) have exceedingly few students achieving in the higher categories – only 1% of Grade 9 learners in South Africa reached the TIMSS Advanced Benchmark category - making gender comparisons dubious from a sample-size perspective. However, using population-based data it is possible to disaggregate performance even at high-levels of achievement. To do that we turn to the Matric 2018 microdata.

Gender differences in learning outcomes in Matric 2018

The school-leaving or 'matric' exam is the only 'high-stakes'[12] exam in the South African schooling system and remains important for two reasons. Firstly, passing matric is associated with slightly higher probabilities of finding employment (Hofmeyr et al., 2013) and higher wages, compared to those without matric. It is worth noting that this premium is modest and may be declining over time[13]. Secondly, it is important as a necessary condition for university entrance. The largest improvement in labour market prospects (both for employment and earnings) is for those who have a post-matric or tertiary qualification (Van der Berg & Van Broekhuizen, 2012; Branson et al. 2013).

Before it is possible to compare the achievement of males and females in matric one must address the issue of differential dropout by gender and the concomitant sample selection processes underlying who makes it to matric. In 2018 there were 342,553 females and 282,180 males who were full-time matric candidates (i.e. there were 21,4% more females than males). This is despite the fact that there are almost equal numbers of males and females at birth (StatsSA, 2018). There is a large body of South African research illustrating that dropout is primarily a function of falling behind academically and also strongly associated with grade repetition (Branson et al., 2013; Van Wyk et al., 2017). As a result, if there are roughly equal numbers of boys and girls starting school, but fewer males reaching matric, this is because there are more weaker-performing males dropping out compared to their weaker-

[12] It is also the only externally set and externally assessed national examination at the time of writing.

[13] For youth aged 18-24 years, those with matric have a narrow unemployment rate that is three percentage points lower than those without matric (looking at 1995-2011 using the October Household Survey 1995-1999, Labour Force Survey 2000-2007, and the Quarterly Labour Force Survey 2008-2011 (Spaull, 2013: p.38).

performing female counterparts[14]. Put differently, weaker-performing females are more likely to remain in the school system and write matric compared to weaker performing males. Because we do not measure the performance of those who have dropped out of school, only those who remain, comparing the performance levels of 'all' males and 'all' females using matric data disadvantages females. Note that this is not true when comparing PIRLS Literacy (Grade 4) or TIMSS Numeracy (Grade 5) since almost all boys and girls are still in school. If one is trying to determine if males perform better than females, or vice versa, it is important to find a comparable group.

To address this issue we do gender comparisons for two groups of students: (1) all learners writing matric in 2018 (ignoring the fact that there are more females), and (2) a comparable group with equal numbers of males and females writing matric in 2018. The second 'comparable' group is created by calculating the total number of males in Matric 2018 (282,180) and then finding the same number of females to compare them to. Given that dropout is primarily driven by weaker achievement we order the distribution of achievement by test scores from weakest to strongest and exclude the weakest 60,373 female learners until there are 282,180 males and 282,180 females. One can think of these as the 'best' performing 282,180 learners of their gender. We replicate the same approach for all subjects. If there are more females than males we reduce the number of females until we get to equal enrolment by gender. For example, there are 64% more female candidates (56,054) taking Accounting than there are male candidates (34,286). To create the comparable group, we look at the highest achieving 34,286 males in Accounting and compare them to the 34,286 highest achieving females in Accounting (Table 1). We report on 13 of the highest enrolment subjects in matric, which are also those considered priority subjects by many universities and prerequisites for high-status professions such as medicine and engineering (Table 1).

Table 1: Matric 2018 enrolment by gender

Matric subject	# Male candidates	# Female candidates	Total # of candidates	# More females than males	% More females writing
Computer Applications Technology	17 451	17 757	35 208	306	1,8%
History	72 212	82 453	154 665	10 241	14,2%
Geography	124 914	144 892	269 806	19 978	16,0%
Mathematics Literacy	133 804	160 662	294 466	26 858	20,1%
English First Additional Language	226 693	272 497	499 190	45 804	20.2%
Life Orientation	280 127	338 906	619 033	58 779	21,0%
Physical Science	76 088	96 323	172 411	20 235	26,6%
English Home Language	47 028	59 620	106 648	12 592	26.8%

[14] Other reasons for higher male drop-out rates may include higher job search prospects or enrolments into TVET institutions. Although these options are not investigated in the paper, the question of why males are more likely to drop out poses an interesting question for further research.

Mathematics	100 713	133 216	233 929	32 503	32,3%
Life Science	131 669	178 491	310 160	46 822	35,6%
Business Studies	80 427	111 879	192 306	31 452	39,1%
Economics	47 805	67 471	115 276	19 666	41,1%
Accounting	34 286	56 054	90 340	21 768	63,5%
Total writing matric	**296 284**	**356 657**	**652 941**	**60 373**	**20,4%**

Figure 4a and 4b shows the difference in the average matric exam scores between female and male learners across the 13 subjects (4a is non-comparable and 4b is comparable). A positive value represents a higher average score for female learners. For example, Figure 4a shows that if one looks at all those writing matric in 2018 (i.e. non-comparable) then female learners achieved an average score that was 3.6 percentage points higher than male leaners in English Home Language (HL). Likewise, a negative value of -5 percentage points in Mathematics means that male learners scored 5 percentage points higher at the mean in this subject.

Figure 4a: Difference in mean scores of females relative to males for the **Non-Comparable Group** (full Matric 2018 cohort) expressed in percentage points.

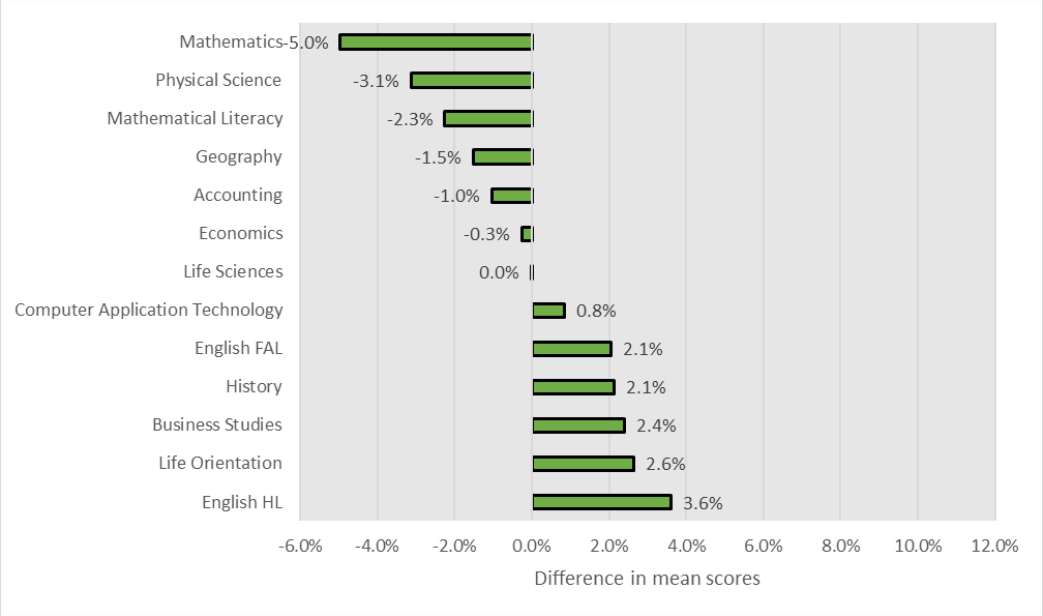
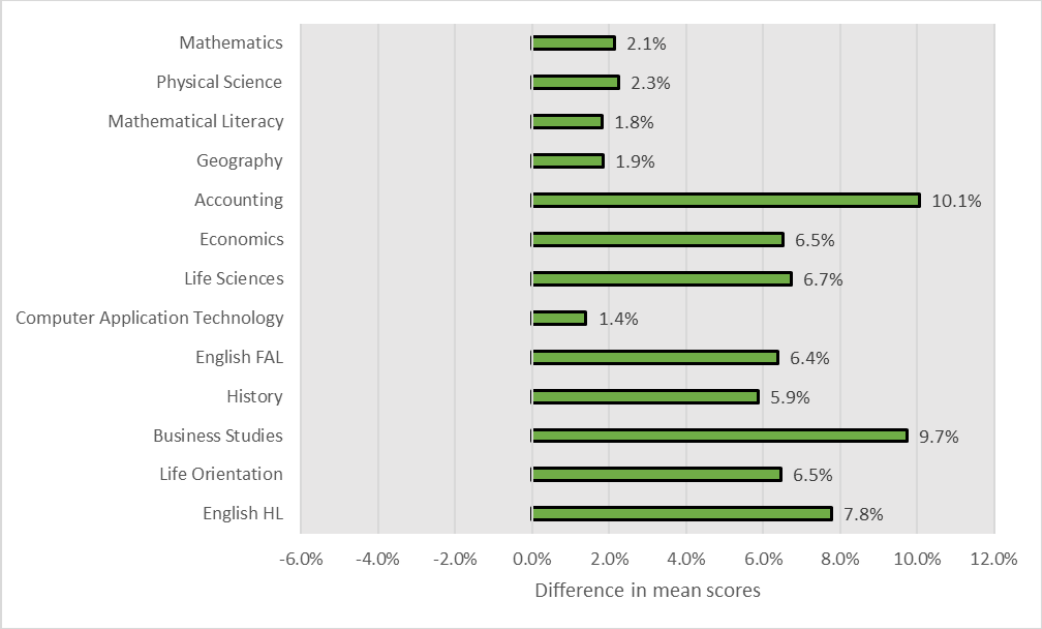


Figure 4b: Difference in mean scores of females relative to males for the **Comparable Group** (Matric 2018 cohort with equal numbers by gender) expressed in percentage points.



When looking at the Non-Comparable Group (Figure 4a) boys outperform girls at the mean in 6 of the 13 subjects and girls outperform boys in the other 6 (no difference in Life Science). However, if one compares an equal number of boys and girls in matric (the Comparable Group, Figure 4b) then girls outperform boys at the mean in all subjects, including Mathematics and Physical Science (note this is at the mean). Many of these differences are large. In 8 of the 13 subjects girls score 5 percentage points higher on average than boys. Even in Mathematics and Physical Science, when one is now comparing equal numbers of boys and girls, there is no evidence that boys perform better than girls at the mean. This is something that is not widely known in South Africa. For example, in the official government report on Matric 2018 the Department of Basic Education compares the total number of boys and girls passing Mathematics and Physical Science and concludes that "in both subjects males performed better than females" (DBE, 2018: p.58) – without acknowledging the sample selection processes (higher male dropout) that has led to a stronger male cohort in matric.

Turning to languages, the average female learner taking English Home Language[15] (HL) performs 7.8 percentage points higher at the mean than the average male taking the same subject when there are comparable numbers of male and female matriculants (Figure 4b). In all likelihood, this is a continuation of the pro-girl differences in Reading seen earlier in primary school. Large differences in Accounting, Business Studies, Economics and Life Sciences are perhaps to be expected since these are also the subjects with the largest pro-female differences in the numbers writing these exams. To compare males and females in these subjects we are required to drop large numbers of lower-performing females to get equal numbers of males and females.

[15] We also calculate the differences for the other 10 official languages. Looking at the non-comparable group the difference ranges from 3.2 - 4.2 percentage points, and for the comparable group it ranges from 5.2 – 7.7 percentage points.

What the above graphs illustrate is the importance of accounting for differential dropout by gender when trying to ascertain whether boys do better than girls and in which subjects. When comparing equal numbers of boys and girls in matric, girls do better at the mean in *all* subjects, in some instances by very large margins (7-10 percentage points).

Given previous research indicating that boys tend to perform better at higher levels (and worse at lower levels) of the Mathematics distribution, we now turn our attention to the distributional properties of this gender gap. By disaggregating Matric achievement by performance decile, subject and gender (Table 2a & 2b), it becomes possible to determine if and where males do better than females in each subject. The cells in Table 2a and 2b report the percentage difference in the number of females relative to males in each performance category where blue is pro-boy and red is pro-girl. Table 2A is the non-comparable group (more girls than boys) while 2b is the comparable group (equal numbers of boys and girls). For example, if one looks at Physical Science in Table 2A there are 31% more boys than girls in the category 90-100% and 43% more females in the 0-30% category. (Note that 0-30% is a failing mark and being over-represented in this category is worse than being under-represented in it.)

Table 2a: Percentage difference in the number of females relative to males in each Matric 2018 performance score category (Non-Comparable Group). (Eg: there are 31% less females than males in the 90-100% performance category in Physical Science)

Non-Comparable	0- 30%	30- 40%	40%- 50%	50- 60%	60- 70%	70- 80%	80- 90%	90- 100%
Physical Science	43%	47%	31%	13%	-3%	-10%	-20%	-31%
Mathematics	69%	39%	14%	-4%	-12%	-17%	-23%	-44%
Accounting	63%	82%	73%	63%	50%	37%	26%	29%
Mathematical Literacy	48%	24%	8%	0%	-2%	-1%	8%	8%
Geography	36%	18%	7%	3%	3%	1%	5%	13%
Economics	44%	42%	41%	40%	38%	33%	23%	19%
Life Sciences	36%	36%	36%	35%	33%	33%	39%	48%
Computer Appl. Tech.	0%	-3%	-1%	0%	10%	15%	36%	3%
Business Studies	22%	36%	44%	61%	77%	93%	121%	95%
History	-1%	8%	7%	9%	18%	39%	86%	146%
Life Orientation	-18%	-13%	-5%	7%	26%	51%	83%	116%
English FAL	-20%	-6%	3%	28%	64%	93%	159%	208%
English HL	-43%	-22%	-2%	26%	66%	107%	127%	195%

Table 2b: Percentage difference in the number of females relative to males in each Matric 2018 performance score category (Comparable Group). (Eg: there are 31% less females than males in the 90-100% performance category in Physical Science)

Comparable Group	0- 30%	30- 40%	40%- 50%	50- 60%	60- 70%	70- 80%	80- 90%	90- 100%
Physical Science	-60%	47%	31%	13%	-3%	-10%	-20%	-31%
Mathematics	-18%	39%	14%	-4%	-12%	-17%	-23%	-44%
Accounting		4%	73%	63%	50%	37%	26%	29%
Mathematical Literacy	-30%	24%	8%	0%	-2%	-1%	8%	8%
Geography	-28%	18%	7%	3%	3%	1%	5%	12%
Economics		37%	41%	40%	38%	33%	23%	19%
Life Sciences		27%	36%	34%	33%	33%	38%	47%
Computer Appl. Tech.	-22%	-3%	-1%	0%	10%	15%	37%	3%
Business Studies	-78%	36%	44%	61%	77%	92%	122%	95%
History		-9%	7%	9%	18%	39%	86%	145%
Life Orientation				4%	26%	51%	83%	115%
English FAL			-1%	28%	64%	93%	159%	208%
English HL			-61%	27%	66%	106%	127%	190%

There are a number of points that are worth noting from Table 2a and 2b. Firstly, if one does not account for the higher number of weaker-performing females still enrolled in matric then, unsurprisingly, there are larger numbers of females in the failing category (0-30%) in eight of the 13 subjects (Table 2a). However, if one only compares equal numbers of male and female

learners per subject (Table 2b) then there are less females in the failing category of all subjects. Where the cell is dark blue and there is no percentage this is because there were no females in that category (i.e. they have been dropped from the sample to make equal numbers of males and females).

The Matric 2018 data support the international finding that boys do better than girls at the top of the Mathematics distribution and worse than girls in Mathematics at the bottom of the distribution (OECD, 2015). To be specific, once one looks at performance of 60% or higher in either Mathematics or Physical Science, there are less females than there are males[16], including when one is using a comparable group of boys and girls (Table 2B). There are also 18% less females failing Mathematics than males failing Mathematics when looking at the comparable group. When looking at comparable numbers of boys and girls, girls outperform boys at the mean while boys outperform girls from the 60th percentile upwards, both in Mathematics and Physical Science. In all other subjects girls outperform boys at all levels of the distribution. The only exception to this is in Mathematics Literacy and Geography where girls and boys perform equally well between the 50th and 80th percentiles.

Although superior male academic achievement is only really evident at the top of the Mathematics and Science distributions, this is an important finding since many Science Technology Engineering and Mathematics (STEM) fields of study require 60% or more in Mathematics as a pre-requisite for university entrance. Notwithstanding the above, these differences cannot possibly explain the extremely large differences in university degree choice. Among those in Matric 2018 who received 60% or higher in Mathematics (28,152 students), 45% were female and 55% were male. Among those who received 60% or higher in Physical Science (30,369 students), 47% were female and 53% were male. Relative to differences in labour market outcomes between men and women, these gender differences in matric performance - even at the top of the distribution - are relatively small (See, Mosomi this volume).

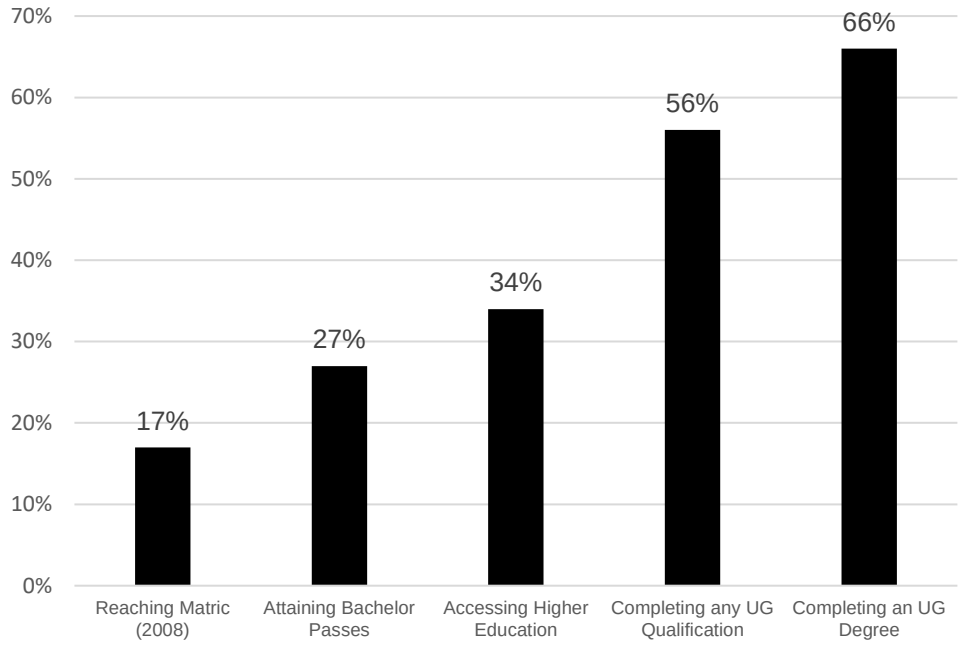
Gender differences in learning outcomes in higher education

Although it is not the focus of this paper, it is worth highlighting that the generally superior performance of females in primary and secondary schools is not eroded when moving to higher education. In earlier work on the transition from matric to higher education (Van Broekhuizen & Spaull, 2018) we found indisputable evidence of a large female advantage that continues to grow at each hurdle of the higher education process in South Africa. In that paper, we used population-wide panel data to follow every South African student from the 2008 matric cohort as they enter into and progress through university, following them for six years (n=112,402). The analysis revealed that relative to their male counterparts 27% more females qualified for university, 34% more enrolled in university, 56% more completed any

[16] In Appendix B we report the exact number of males and females in each category.

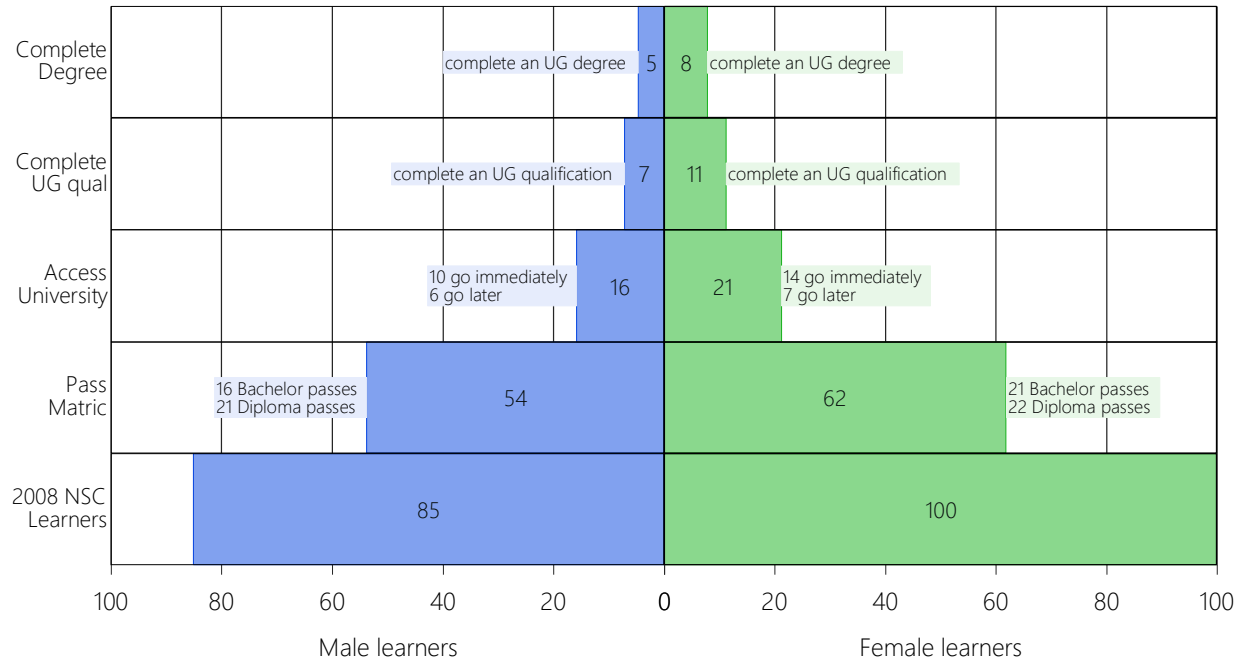
undergraduate qualification and 66% more attained a bachelor's degree. This despite there being roughly equal numbers of boys and girls at the start of school (Figure 5).

Figure 5: The percentage more females than males from the 2008 NSC Cohort (N=112,402) attaining higher education outcomes (2009-2014) (Van Broekhuizen & Spaull, 2017: p.4)



This higher education female advantage remains after controlling for school-level performance, and exists for all subgroups of race, age, socioeconomic status, and province of origin. Analysis of 19 different fields of study showed that females are significantly more likely to get a degree in 12 of the 19 fields (often by substantial margins), and they are significantly less likely to get a degree in five of the 19 fields (Engineering, Computer Sciences, Architectural Sciences, Mathematical Sciences, and Agricultural Sciences). However, this is primarily because females do not access these traditionally 'male' programs rather than due to lower completion rates. Even if one compares male and female high school students with the same matric scores, males are 72% more likely to access Engineering the year after matric as compared to females. The findings on university dropout echo those of earlier studies finding pro-female results at school; irrespective of field of study, race, age, socioeconomic status or location, females are always and everywhere 20% less likely to drop out of university than their male counterparts, including in traditionally 'male' fields like Engineering and Computer Science. It is clear that superior female academic achievement at school is consolidated and compounded at university; of 100 females in matric, 11 will go on to complete an undergraduate qualification compared to only seven males (Figure 5).

Figure 5: National higher education outcomes by gender (2008 NSC Cohort)



4. Conclusion

The aim of the present study was to document the gender differences in educational outcomes in South Africa using large-scale representative data on educational achievement. The sample-based studies were from 1995, 1999, 2000, 2003, 2006, 2007, 2011, 2015, and 2016 and showed that girls do no worse than boys in Reading, Mathematics and Science at the Grades 4, 5, 6 and 9 levels. While all gaps are pro-girl gaps, only those at the primary school level are large and statistically significant. In order to analyse the distributional properties of the gender gap we also analysed the latest school leaving exam data, Matric 2018, reporting on the 13 highest enrolment subjects.

Before comparing the achievement of boys and girls in matric we argued that it is important to find comparable samples of each gender. This is especially the case in South Africa given the high male dropout rates in high-school, and that earlier research has shown that the primary cause of dropout is weak academic achievement (Branson et al., 2013; Van Wyk et al., 2017). To address this, we created comparable cohorts of boys and girls (equal numbers of the highest achieving boys and girls), both for Matric as a whole, and for each of the 13 subjects. When comparing an equal number of males and females on mean performance in matric, females outperform males in all subjects, including in Mathematics and Physical Science, contrary to popular belief. We do find that at higher levels of achievement, the 60th percentile and upwards, boys outperform girls but only in two subjects (Mathematics and Physical Science). Yet boys are also more likely to fail Mathematics and Physical Science, i.e. score less than 30%, when compared to their female counterparts. Clearly South Africa adheres to the international findings that boys are over-represented in both the top and the

bottom of the performance distribution (OECD, 2015), and therefore that the gender gap in learning outcomes is largest in the tails of the distribution.

Given these results and the theory that human capital contributes to employment and earnings, we see the need for further research (in the South African context) for why the female advantage in education does not translate into a female advantage in the labour market. What are the general, and specific, constraints for why women experience inferior labour outcomes in the world of work.

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Appendix A: Gender differences in cross-national assessments 1995-2016 (**B**lue is pro-**b**oy; **G**reen is pro-**g**irl)

Survey	Year	Subject & grade	Boys	SE	Girls	SE	Diff.	Diff. as %SD	SE of the diff.	Stat. sig.?	SD	Source & page number
TIMSS	1995	Math Gr8	360	*6,3*	349	*4,1*	-11	-17%	*7,5*	N	65	Beaton et al, 1996; p34
		Sci Gr8	337	*9,5*	315	*6*	-22	-28%	*11,2*	N	78,71559633	
	1999	Math Gr8	283	*7,4*	267	*7,5*	-16	-15%	*10,5*	N	109	Reddy 2006 p54
		Sci Gr8	253	*7,7*	234	*9,2*	-19	-14%	*12,0*	N	132	O'Martin et al. 2000 p50
	2003	Math Gr8	264	*6,4*	262	*6,2*	-2	-2%	*8,9*	N	107	Reddy 2006 p54
		Sci Gr8	244	*7,7*	242	*7,2*	-2	-2%	*10,5*	N	132	O'Martin et al. 2004 p51
	2011	Math Gr9	350	*3,4*	354	*3*	4	5%	*4,5*	N	86	Mullis et al 2012b p71
		Sci Gr9	328	*4,5*	335	*4,1*	7	6%	*6,1*	N	114	Mullis et al 2012b p.69
	2015	Math Gr9	369	*4,6*	376	*5,3*	7	8%	*7,0*	N	87	Mullis et al., 2015
		Sci Gr9	353	*5,5*	362	*6,7*	9	8%	*8,7*	N	108	
TIMSS-Numeracy	2015	Math Gr5	368	*4,4*	384	*3,8*	16	16%	*5,8*	Y	102	Reddy et al., 2016; p6
SACMEQ	2000	Read Gr6	478	*7,9*	505	*10,1*	27	22%	*12,8*	Y	122	Moloi & Chetty, 2011: p51; Own calculations.
		Math Gr6	482	*6,7*	490	*8*	8	7%	*10,4*	N	109	
	2007	Read Gr6	484	*4,7*	506	*4,8*	22	19%	*6,7*	Y	115	
		Math Gr6	491	*4,1*	498	*3,9*	7	7%	*5,7*	N	99	
PIRLS	2006	Read Gr4	235	*5*	271	*5*	36		*7,1*	Y		Howie et al 2006, p20; Mullis et al 2007
	2006	Read Gr5	283	*5,5*	319	*6,3*	36	26%	*8,4*	Y	136	
prePIRLS	2011	Read Gr4	446	*4,2*	475	*3,9*	29	29%	*5,7*	Y	99	Howie et al, 2012; p28; Mullis et al, 2012a
PIRLS-Literacy	2016	Read Gr4	295	*5,1*	347	*4*	52	49%	*6,5*	Y	106	

Appendix B: Breakdown of the Matric 2018 **performance categories by subject and** gender

Subject and Gender		Performance Categories								
		0 - 30%	**30 - 40%**	**40 - 50%**	**50 - 60%**	**60 -70%**	**70 - 80%**	**80 - 90%**	**90 -100%**	**Total**
Non-comparable Group										
Mathematics	Female	62 896	27 255	19 208	11 047	6 422	3 886	1 958	470	133 142
	Male	37 240	19 658	16 908	11 475	7 289	4 694	2 544	843	100 651
	Sub-total	100 136	46 913	36 116	22 522	13 711	8 580	4 502	1 313	233 793
Physical Science	Female	27 973	24 393	18 405	11 197	6 683	4 096	2 525	1 001	96 273
	Male	19 504	16 567	14 061	9 892	6 866	4 563	3 149	1 448	76 050
	Sub-total	47 477	40 960	32 466	21 089	13 549	8 659	5 674	2 449	172 323
Accounting	Female	16 163	13 181	10 317	6 553	4 192	2 743	1 959	931	56 039
	Male	9 938	7 257	5 967	4 027	2 802	2 008	1 552	724	34 275
	Sub-total	26 101	20 438	16 284	10 580	6 994	4 751	3 511	1 655	90 314
Life Sciences	Female	43 903	42 557	36 703	25 954	15 927	8 991	3 847	513	178 395
	Male	32 264	31 233	26 989	19 300	11 964	6 739	2 778	348	131 615
	Sub-total	76 167	73 790	63 692	45 254	27 891	15 730	6 625	861	310 010
Comparable Group										
Mathematics	Female	30 399	27 255	19 208	11 047	6 422	3 886	1 958	470	100 645
	Male	37 240	19 658	16 908	11 475	7 289	4 694	2 544	843	100 651
	Sub-total	67 639	46 913	36 116	22 522	13 711	8 580	4 502	1 313	201 296
Physical Science	Female	7 740	24 393	18 405	11 197	6 683	4 096	2 525	1 001	76 040
	Male	19 504	16 567	14 061	9 892	6 866	4 563	3 149	1 448	76 050
	Sub-total	27 244	40 960	32 466	21 089	13 549	8 659	5 674	2 449	152 090
Accounting	Female	0	7 577	10 317	6 553	4 192	2 743	1 959	931	34 272
	Male	9 938	7 257	5 967	4 027	2 802	2 008	1 552	724	34 275
	Sub-total	9 938	14 834	16 284	10 580	6 994	4 751	3 511	1 655	68 547
Life Sciences	Female	0	39 646	36 703	25 954	15 927	8 991	3 847	513	131 581
	Male	32 264	31 233	26 989	19 300	11 964	6 739	2 778	348	131 615
	Sub-total	32 264	70 879	63 692	45 254	27 891	15 730	6 625	861	263 196