Understanding the Gender Divide:

STEM Secondary 3 Examination Outcomes in Rwanda

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DATA | RESEARCH | ANALYTICS

Context

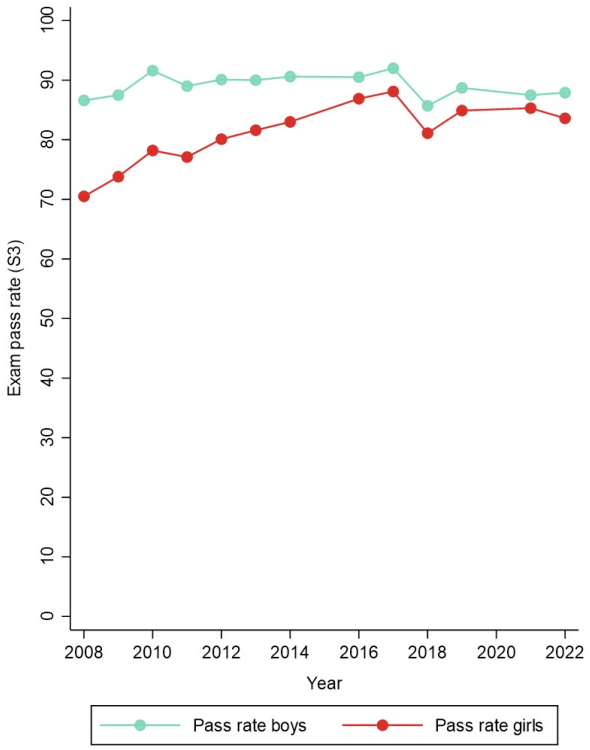
In the 2021/2022 academic year an estimated 87.9% of boys and about 83.6% of girls passed the Secondary 3 (S3) National Examinations for lower general secondary education [1].

Historically there has been a gap in the pass-rates between girls and boys at S3 level. The gap has narrowed over the years (Figure 1), from 16 percentage points (86.6% vs 70.5%) in 2008 to less than 5 percentage points since 2016. During this period, the exam pass rate for boys has remained relatively stable, while the pass rate for girls has steadily increased, plateauing after 2016.

While in relative terms boys have outperformed girls on average in the S3 national examinations, many more girls are progressing to upper secondary school.

More than 55% of students in S3, and an estimated 55.4% of exam-takers in 2022, were girls. As a result of this gap in enrolment, in 2022, 58,766 girls passed the S3 national exam, compared to 49,802 boys (15% more girls). Combined, over the past 5 years (between 2017-2022), almost 30,000 more girls than boys have graduated from lower secondary education.

Figure 1: S3 National Examinations Pass Rate, by gender, between 2008-2022



Takeaways from this paper:

- The gender gap in STEM is better explained by child-level factors compared to school-level factors
- The gender gap is wider in high-performing schools
- The higher the proportion of female teachers as part of the general secondary education teaching staff, the smaller the gap between girls and boys on STEM subjects

[1] MINEDUC, Education Statistical Yearbook, 2022

What the evidence says

How big are differences in STEM results between girls & boys?

STEM subjects contributed to the gap in exam outcomes between girls and boys, but there are differences by subject.

Across all STEM subjects, we observe that girls score lower than boys in the 2021/2022 S3 National Examination. The gap in outcomes between girls and boys is smallest in mathematics, where we estimate a difference of 1.5 percentage points in average exam scores; and is largest in biology, where the gap is close to 5 percentage points.

We observe a similar gap in STEM subjects in previous years going back to 2018 (for which we have S3 data disaggregated by subject). Although the differences in average exam scores and pass rates might appear moderate, the inequity in learning outcomes is more pronounced.

We can see this by comparing the percentage of girls and boys that achieved a "satisfactory" grade in STEM subjects (+50% correct answers). In biology, for example, an estimated 37.5% of boys scored a satisfactory grade, compared to 24.4% of girls (a gap of 13 percentage points). The corresponding gap in chemistry and physics is 10 and 9 percentage points respectively. The gap in mathematics is smaller, at an estimated 4.5 percentage points. To put these values into context, for some subjects the gap is equivalent to the gap in scores observed between urban and rural schools.

Indicator	Estimated Average Exam Score	Pass Rate (Scored more than 0 grade)	Satisfactory Rate (Scored more than grade 2)	Number of Students with satisfactory score
Biology Boys	44.5%	96.5%	37.5%	21,239
Biology Girls	39.7%	95.7%	24.3%	17,100
Biology Gap	-4.8pp	-0.8pp	-13.2pp	-4,139
Physics Boys	40.2%	93.5%	23.6%	13,329
Physics Girls	37.5%	92.4%	14.7%	10,334
Physics Gap	-2.8	-1.1pp	-8.9pp	-2,995
Maths Boys	41.5%	89.3%	33.6%	19,008
Maths Girls	40.0%	88.8%	29.1%	20,475
Maths Gap	-1.5pp	-0.5pp	-4.5pp	1,467
Chemistry Boys	40.9%	89.5%	29.9%	16,902
Chemistry Girls	36.7%	85.0%	19.9%	14,012
Chemistry Gap	-4.2pp	-4.5pp	-9.9pp	-2,890

*pp stands for percentage points difference

Understanding the STEM gender gap

Child-level factors may be the most important predictor of the gender gap

Even though we only have data at the school level, we are able to infer the importance of child-level factors in determining the size of the gender gap. We do this by comparing correlations in the gender gap across subjects within the same cohort, to the correlations in the gender gap in the same subject across different years or grades. This allows us to evaluate whether the gender gap is more consistent within schools or within cohorts of individual students.

Our results suggest that the gender gap is related to child or household factors, rather than being driven by school-level factors.

We observe that the gender gap in the S3 exam for biology, mathematics, chemistry and physics within the same school were strongly correlated in 2022. This correlation is quantified with R-squared values, which we use here to measure how much of the gender gap in one subject is explained by the gap in another. For the S3 mathematics and physics exams in 2022, the R-squared value was 37%; this same statistic was 44% for the chemistry exam and 32% for biology. These figures suggest that the gender gaps observed in one STEM subject tend to mirror those in other subjects within the same group of students.

Correlation	R-squared
Gender gap correlation between different S3 subjects in 2022	
Mathematics and Chemistry	44%
Mathematics and Physics	37%
Mathematics and Biology	32%
Gender gap correlation across years and cohorts (Mathematics)	
2021 vs 2022	3%
S3 vs S6 in 2022	1%

If school-level factors were the primary drivers of the gender gap, we would expect to see consistent gender gaps across different student cohorts and across years within the same schools. For example, if a school had a large gender gap in mathematics in 2022, we would anticipate a similar gap in 2021. Instead, we find that the gender gap in mathematics in 2022 only explains 3% of the variation in the gender gap observed in 2021.

Similarly, if school-level factors were the main driver of the gender gap, a significant gender gap in science scores in one grade (like S3) would likely be mirrored in another grade (like S6). Again, we find that this is not the case, since only 1% of the variation in the gender gap in mathematics in S6 in 2022 was explained by the gender gap in mathematics in S3 in the same year.

If individual teachers were the main issue, we would likely see weaker correlations in the gender gap across subjects which are taught by different teachers. The strong correlations we observe contradict this, suggesting that the factors influencing the gender gap go beyond the influence of teachers.

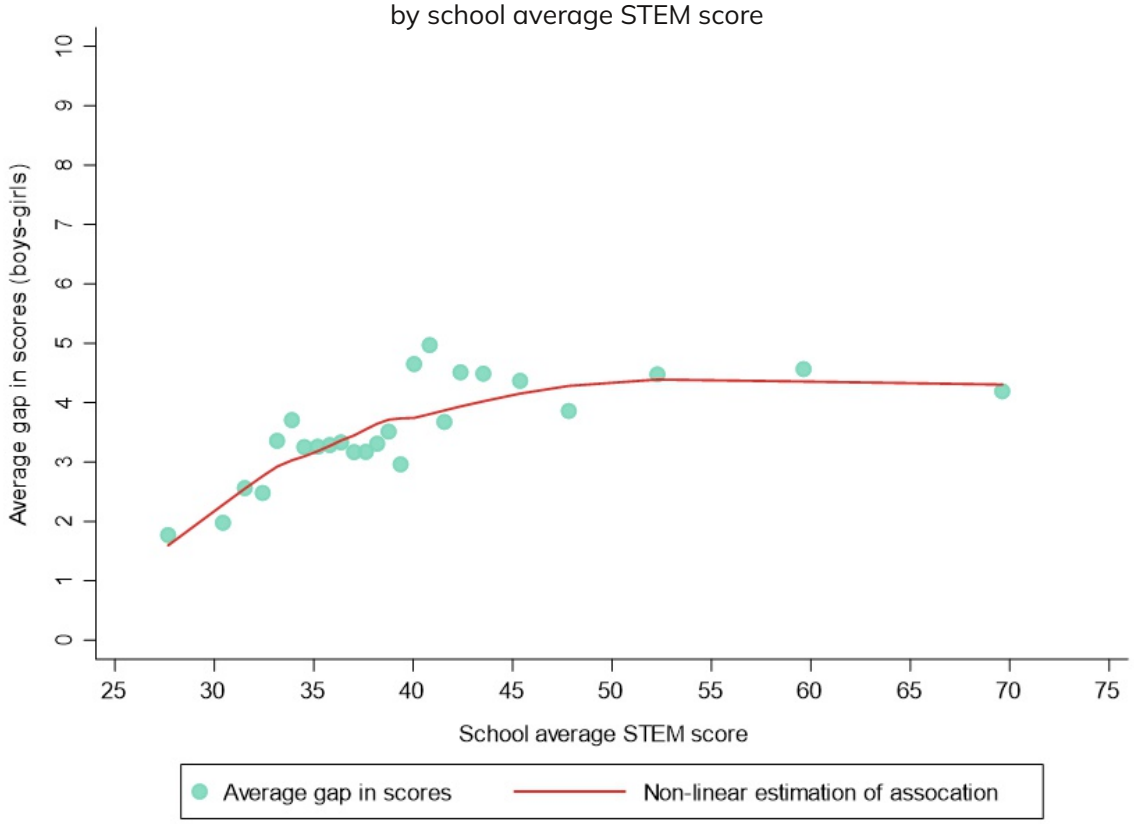
The gender gap is wider in high-performing schools

Although school-level determinants might not be the strongest predictors, schools do play a role. The strong association between the average performance of a school and the size of the gender gap within that school indicates that school-level factors are also relevant in determining the gender gap in STEM subjects.

Boys appear to experience higher returns compared to girls. The gender gap in average exam scores increases as the average performance of schools improves. This holds true up to an average school score threshold of about 50 on the national examination, which for day schools represents schools in the 97.5th percentile. The fact that the gender gap increases in schools with better average performance in STEM subjects is somewhat counterintuitive. One might expect that higher-quality education would benefit all students equally or even help to close the gender gap by providing better support and resources to all students.

It is important to note that a slightly different picture emerges when we examine relative measures of the gender gap. For instance, looking at the percentage of students with satisfactory scores (an average in science exams of

Figure 2: Average gap in S3 STEM Subject Examination scores between girls and boys, by school average STEM score



50 or more), we find that the gender gap actually diminishes in schools with an average science score above 50 points. It's important to note, though, that such schools represent a very small minority of schools in Rwanda. The overarching trend is clear: the gender gap between girls and boys tends to increase in better-performing schools.

Pupil-to-teacher ratios are not correlated to exam scores: but the gender balance of teachers is

Surprisingly, we did not find a correlation between pupil to teacher ratios and STEM scores in the S3 examination. This suggests that the number of teachers is not the main constraint to better STEM outcomes in lower secondary education.

Girls do seem to be more disadvantaged when there are fewer teachers for each pupil. This effect is driven by the top 10-15% of schools where pupil-to-teacher ratios are very low. In schools with fewer than 20 pupils per teacher at secondary level (about 20% of schools), the average gender gap in science scores is 2.9 percentage points; this increases to an average of 3.7 percentage points in schools with 20 pupils per teacher or more.

The gender composition of teachers has a bigger effect: the higher the proportion of female teachers as part of the general secondary education teaching staff, the smaller the gap between girls and boys on STEM subjects in the S3 National Examination. The effect is small, but statistically significant.

In schools with less than 20% female teachers at secondary level, the average gender gap was 4.3 percentage points (N=243 schools); this reduces to a gap of 3.0 percentage points in schools where the proportion of female teachers is 80% or above (N=97 schools), a reduction of about 30%.

Figure 3: Estimated average STEM scores in S3 exams, by pupil-teacher-ratio

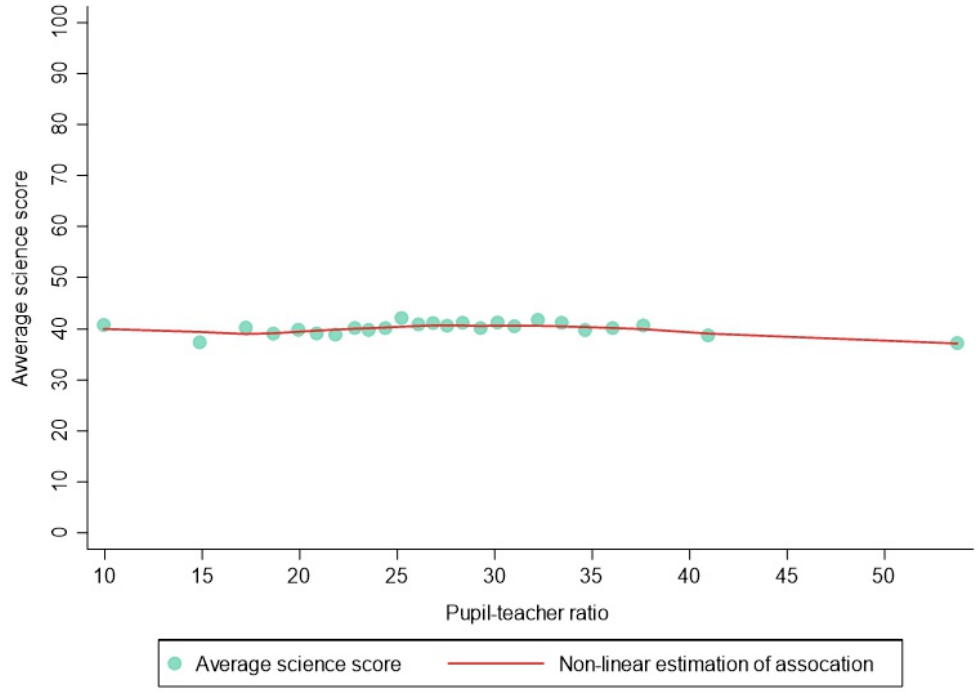
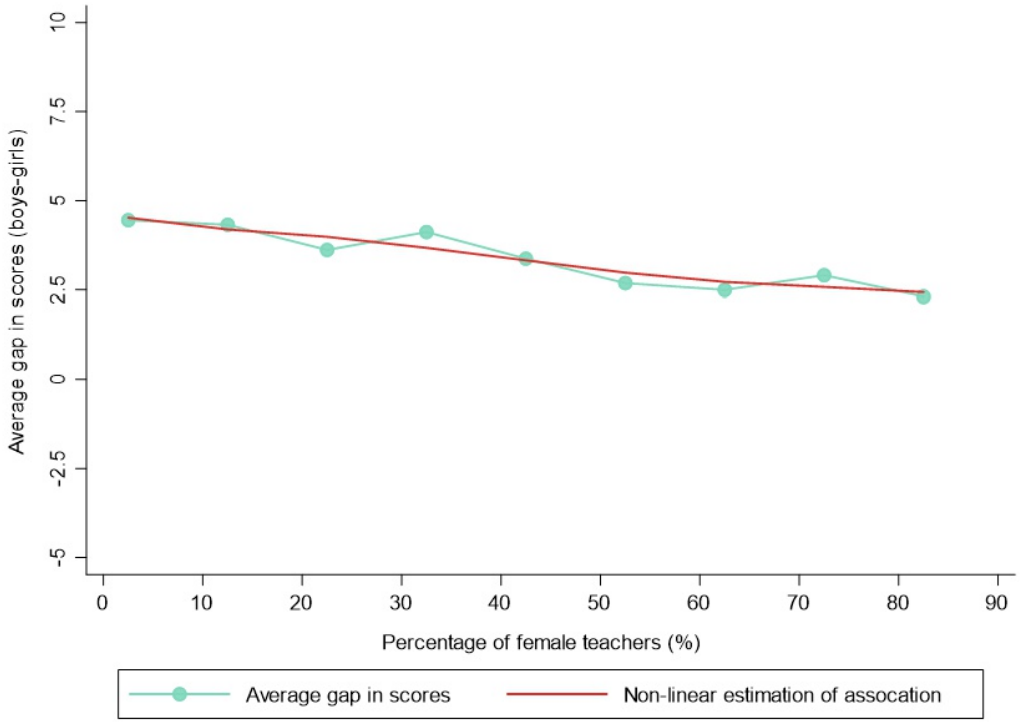


Figure 4: Average gap in estimated STEM S3 Examination scores between boys and girls, by proportion of female teachers



Two ideas for further research

The proportion of female teachers seems to be linked to average school scores.

This is not a causal association, but rather a reflection of the allocation mechanism of teachers to schools. Female teachers, on average, tend to be allocated to lower performing schools. It would be interesting to explore how this contributes to the growing gender gap in higher performing schools.

The proportion of female teachers has a different effect on male and female students.

Since we do not have individual level data on either students or teachers it is difficult to make firm conclusions with the data we have available. However, further research on how the gender of the teacher differentially affects the STEM score of girls and boys could yield interesting insights.

Additional observations about gender gap, by school category

We do not find statistically significant differences in the gender gap in science subjects between government aided, private, and public schools.

We also do not find significant difference in the gender gap in science subjects between urban & rural schools.

We do see that the average gender gap in science is higher in boarding schools (mean=4.057) compared to day schools (mean=3.448). This difference is statistically significant.

School type	N	Mean gender gap in science	Std. Dev.	Min	Max
Day Schools	1543	3.448	4.324	-18.304	21.953
Boarding Schools	226	4.057	4.04	-12.404	13.799

The difference in the mean gender gap between day and boarding schools is statistically significant (p=0.046)

School location	N	Mean gender gap in science	Std. Dev.	Min	Max
Rural schools	1533	3.559	4.356	-18.304	21.953
Urban schools	235	3.326	3.853	-12.404	15.223

The difference in mean the gender gap in science between rural and urban schools is not statistically significant (p=0.439)

School status	N	Mean gender gap in science	Std. Dev.	Min	Max
Government Aided	1002	3.590	4.258	-18.304	21.953
Private	104	3.615	4.187	-9.577	12.625
Public	662	3.421	4.363	-14.549	18.969

The difference in the mean gender gap in science between government aided and private schools is not statistically significant (p=0.955). The difference in the mean gender gap in science between government aided and public is not statistically significant (p=0.4324). The difference in the mean gender gap in science between public and private schools is not statistically significant (p=0.672).

Discussion

The reduction in the gender gap in examination pass rates stands as a clear indicator of Rwanda's commitment to gender parity and equity in education. The last 15 years have seen an impressive narrowing of the gap and an increase in the transition of girls to general secondary education. Girls now account for over 55% of the student population in Secondary 3. However, the disparity between the high enrollment rates of girls and their relative performance in STEM exams underscores the fact that deeper, systemic issues need to be addressed to ensure that the benefits of education are equitably realized.

The disparity in performance between girls and boys varies across different STEM subjects. Mathematics stands out as a subject where girls excel, compared to biology, physics, and chemistry. This makes mathematics a potential lever for change, a foundational strength that might bridge gaps in other STEM areas. A deeper understanding of why girls perform better in mathematics and how this can be translated to other subjects could yield useful insights.

The observation that the gender gap widens in higher-performing schools raises questions about the differential impacts of educational quality on boys and girls. It suggests that improvements in school performance are not translating into equal benefits. Understanding why girls do not benefit equally from better school performance is key to tackling the gender gap in STEM.

One contributing factor to the gender gap is the gender composition of STEM teachers. An estimated 36% of teachers in general secondary education are female, according to data from the Education Management Information System; this percentage is lower for STEM subjects. This imbalance in the gender composition grows as school performance increases. The percentage of female secondary teachers in the top quintile of schools in terms of performance in the national exams is 28%, compared to 38% in the bottom quintile. The correlation between the proportion of female teachers and the gender gap in STEM underscores the need for more female role models and mentors in STEM education.

The evidence points toward out-of-school elements, such as child or household-specific factors, as primary contributors to the observed gender gap in STEM learning outcomes. The lack of a uniform gender gap across various cohorts within the same school indicates that school-level factors might not be the predominant issue. Rather, the consistency of the gender gap within individual cohorts but across different STEM subjects suggests that the gap is more likely influenced by the unique circumstances and environments of the students themselves, rather than by the schools they attend. This means that the link between socio-economic factors and the gap in learning outcomes between boys and girls in STEM needs to be better understood.

Data sources and limitations

In this study, we used data from two primary sources: the School Data Management System (SDMS) provided by the Ministry of Education (MINEDUC), and examination data for the years 2017-2022 from the National Examination and School Inspection Authority (NESA). The SDMS data offers contextual information about schools, including the number of teachers, pupils, type of school, and location. The NESA data provides examination scores, disaggregated by gender at the school level. To calculate the average science gap, we first estimated the average scores for boys and girls across various subjects and then averaged these scores. By using unique identifiers, we successfully merged the school-level data from SDMS with the examination data from NESA, enabling a comprehensive analysis of the gender gap in STEM education outcomes in Rwanda.

The key limitation of this analysis is that we are only considering school-level exam data and basic school-level characteristics (type of school, number of students and teachers, gender composition of students and teachers, average school performance in the national examinations). We are not looking at individual-, household- or disaggregated school-level data, which limits the completeness of the insights we can provide.

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