Understanding the gender gap in learning outcomes in primary education: evidence from PASEC results

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Abstract: Ensuring that girls and boys all benefit from equitable learning outcomes is important for equity in the labour market and economic growth. Using PASEC 2014 data, the current paper attempts to better understand the gender gaps in learning outcomes. Overall, while girls achieve better outcomes in reading, boys generally outperform girls in mathematics. Applying the Oaxaca-Blinder decomposition technique, the gender gap is decomposed into two components: the contribution of the gender itself and the contribution of factors other than the gender. The results show that improving school facilities and increasing the number of female teachers can strongly contribute to closing the gender gap in mathematics and can help improve girls' and boys' achievements in reading.

Keywords: education; learning outcomes; gender; developing countries.

JEL codes: O15, I25.

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1 Introduction

Improving education access and quality have been at the core of many development policies, especially in Sub-Saharan Africa. Better education is associated with stronger economic growth (Psacharopoulos and Woodhall, 1985; Hanushek and Wößmann, 2007, 2008; Aghion et al., 2009; Pegkas, 2014) and sustained social development (Adams and Adams, 1968; Türkkahraman, 2012). Therefore, over the last decades, with support from development partners, many countries within the Sub-Saharan Africa region have taken steps to boost access to education. These efforts led to encouraging results as access to primary education experienced a significant improvement. For instance, the Gross Enrolment Ratio increased from 82.9% in 2000 to 99.7% in 2019 in the region. In addition, Sub-Saharan Africa experienced an increase in the Primary Completion Rate from 54.2% to 69.1% during the same period.

Despite this progress in access to education, gender inequality remains one of the most pressing issues plaguing the education sector in this region (GEMR, 2016; Johnson and Kposowa, 2018). In particular, males and females face various forms of inequality in learning outcomes. For instance, using data from various international and regional learning assessment surveys over the period 2005–2009, GEMR (2012) shows that girls overall perform better in reading, and boys perform better in mathematics in most countries, although the gap is narrowing. In francophone Africa, the Program d'Analyse des Systems Éducatifs de la CONFEMEN (PASEC) also shows that overall, girls outperform boys in reading while the opposite is observed in mathematics (PASEC, 2015).

Gender inequality in learning outcomes has some implications for gender inequality in the labour market. Given that girls are disadvantaged in mathematics at the primary education level, they are less likely to enrol in scientific programs at the post-primary levels which would lead to inequality in labour market outcomes in the future (Sikora and Saha, 2009; Borgonovi and Jakubowski, 2011). World Bank (2010) demonstrates that education is one of the most important factors explaining the gender gap in the Africa labor market. Evans, Akmal, and Jakiela (2020) show that despite the progress in gender equity, women are still not as educated as men and this contributes to huge inequalities in the labour market outcomes.

Gender inequality in education as well as in the labour market has some implications for economic growth. There are many empirical studies on the two-way relationship between economic development and gender inequality. For instance, Goldin (1990), Hill and King (1995), Dollar and Gatti (1999), Tzannatos (1999), Klasen (2002), Klasen and Lamanna (2009), and Perrin (2021) demonstrate that there is a positive effect of economic growth on gender equality and a negative effect of gender inequality on economic development. In particular, gender inequality in economic participation may undermine economic growth (Klasen, 1999). Stotsky (2006) and Elborgh-Woytek et al. (2013) show that the gender gap in economic participation can lead to large GDP losses across countries of all income levels. Galor and Weil (1996) argue that an increase in women's relative wage increases the cost of raising children, which lowers population growth, increases children's education levels, and leads to higher labour productivity and growth.

Understanding the gender gap in learning outcomes becomes important for implementing effective policies aiming to improve gender equity. SDG 5 aims to promote gender equity by empowering women and by improving their participation in the labour market. Ensuring gender equity in the labour market requires that boys and girls should be given equitable learning outcomes in all subjects. Therefore, there is a need to better understand the drivers of gender equity in learning outcomes. GEMR (2016) points out the lack of studies on the gender gap in learning outcomes and the current paper aims to fill this knowledge gap.

The current study is an attempt to better understand the factors behind the gender gap in learning outcomes in francophone Africa. Using PASEC data collected in 2014 from primary grade 6 students and teachers in ten African countries, this paper investigates four sets of factors that can potentially play a role in the gender gap in learning outcomes: student's characteristics, socioeconomic status, institutional factors, and school facilities. The paper is structured around six sections. The introduction (Section 1) is followed by a literature review on gender and learning outcomes (Section 2). Sections 3 and 4 present the data and the methodology respectively. Section 5 discusses the results and Section 6 the conclusion and policy implications.

2 Gender and learning outcomes: what we know

Very limited studies have addressed the topic of the gender gap in learning outcomes. This may be the result of the limited availability of reliable data on learning assessments. In fact, learning assessments can be classified into two main categories: national assessments on the one hand and regional and international assessments on the other hand. National assessments often suffer from problems related to consistency over time and across countries (Lalancette et al., 2012). Ma (2007) suggests that it is appropriate to use regional and international student assessments to evaluate gender differences in learning outcomes. Given that regional and international student assessments usually draw nationally representative samples, they provide opportunities to investigate gender differences in learning outcomes at a national level and to perform regional and international comparisons. Some studies have been conducted on gender inequality using data from international learning assessments such as Southern and Eastern Africa consortium for monitoring educational quality (SACMEQ) and trends in international mathematics and science study (TIMSS).

Studies show that learning outcomes are mostly in favours of girls in reading and in favours of boys in mathematics. Using SACMEQ data, Saito (2011a) investigates gender differences in reading and mathematics in 15 SACMEQ countries. Results show that at Grade 6 level, girls perform better in reading while the achievement in mathematics was mostly in favours of boys in 2007. PASEC (2015) also shows that overall, girls outperform boys in reading while girls' overall achievement in mathematics is lower than that of boys. Saito (2011a) finds that from 2000 and 2007, while gender equality in Grade 6 participation has improved in many SACMEQ countries, the size and the direction of gender differences in learning achievement in SACMEQ countries have been very stable from 2000 to 2007. By examining different domains of reading and mathematics subjects of SACMEQ examination, Saito (2011b) shows that boys tend to do better in the 'documents' domain of reading and the 'measurement' domain of mathematics while girls tend to do better in the 'expository' domain of reading and the 'number' domain of mathematics. In addition, the gender gap in learning outcomes may not be always related to the availability of school resources and the wealth of the students. Using microdata for 19 African countries, Dickerson et al. (2015) show that there is a significant difference in mathematics test scores at the primary education level in favours of boys, similar to what was previously observed in developed countries. These authors find that the gender gap varies with characteristics of the regions in which the students live, and these regional characteristics are more predictive of the gender gap than parental education and school characteristics, including teacher gender.

In some countries, girls outperform boys in mathematics. Results from TIMSS show that gender equality in mathematics is achieved in many countries at grade 4 but the gender gap becomes higher at grade 8. Mullis et al. (2012) show that the gender difference varied across countries, with no difference in 22 of the 42 eighth grade countries, a difference favouring boys in seven countries, and a difference favouring girls in the remaining 13 countries. Detailed analysis shows that on average across the fourthgrade countries, boys had higher achievement than girls in the reasoning domain. However, across the eighth-grade countries, girls outperformed boys on average in both the knowing and reasoning domains.

Examining 3 regional and 4 international student assessments that cover 4 school subjects (language, mathematics, science, and civic education) and 6-grade levels, (2nd, 3rd, 4th, 5th, 6th, and 8th), Ma (2007) suggested three major conclusions. First, girls are advantaged in language across all regional and international student assessments. Second, girls are catching up with boys in mathematics achievement. Third, although boys manage to hold on to the male advantage in science, girls have gained ground, with historical female breakthroughs beginning to take place in this traditionally male domain.

Overall, results from international learning assessments show that in most countries, girls perform better than boys in reading while boys outperform girls in mathematics. However, there is very limited knowledge on the determinants of the gender gap in learning outcomes. Closing the gender gap in learning outcomes requires sound evidence-based policies. The purpose of the current paper is to understand the causes of the gender gap in reading and in mathematics and to suggest policy options designed to tackle this issue.

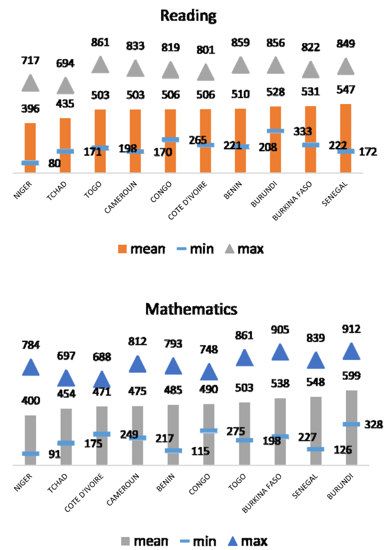
3 Gender inequality in learning outcomes in PASEC countries: a descriptive analysis

The (PASEC) has been conducting learning assessments in 13 francophone countries in West Africa since the 1990's. In 2014, a PASEC assessment was conducted in ten countries in West Africa. This assessment covers two topics: reading and mathematics. PASEC 2014 data show that Senegal is the country with the highest average score in reading while Burundi is the best performer in mathematics (Figure 1). Niger registers the lowest score both in mathematics and in reading.

A breakdown of the PASEC scores by gender shows that countries are facing some gender inequalities to varying extents. The difference between boys and girls' scores in reading is significant in only five countries. Boys outperformed girls in two countries, while girls outperformed boys in three countries. Boys are the most advantaged in reading in Chad while girls are the most advantaged in Congo. Overall, girls' average score is about 8 points higher than boys' average score and the difference between the average of boys' and girls' scores is statistically significant.

The gender gap in mathematics is statistically significant in nine countries. Boys outperformed girls in seven countries while girls outperformed boys in two countries. Boys are the most advantaged in mathematics in Senegal, Chad, Côte d'Ivoire, Togo, Burkina Faso, Niger, and Congo while girls are the most advantaged in Benin and in Burundi. Even though boys' average score in mathematics is higher than that of girls in most of the countries, overall, the difference between boys and girls' average scores is not statistically significant. This result may be driven by the fact that Burundi seems to be an outlier. As shown in Figure 2, the difference between boys and girls' average scores in mathematics is about 33 points in Burundi. When Burundi is removed from the sample, boys' average score in mathematics becomes significantly higher than that of girls and the difference is statistically significant.

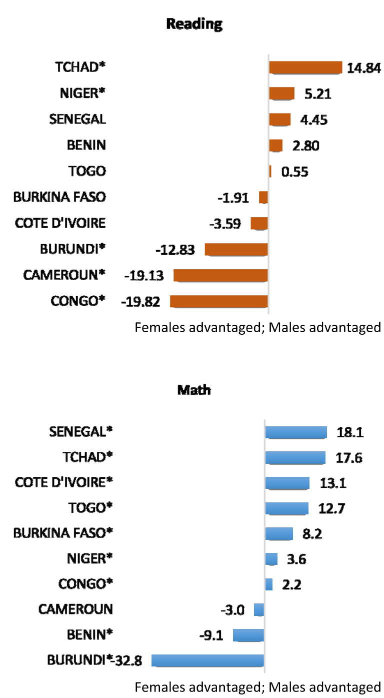
Figure 1 PASEC scores by country (see online version for colours)



Note: Scores are weighted

Source: Authors' calculation based on PASEC 2014

Figure 2 Difference between boys and girls average PASEC score by country (see online version for colours)



Note: *Difference between girls and boys statistically significant at 5% level

Source: GPE calculation based on PASEC 2014

4 Methodology

As already mentioned, some inequalities exist between boys and girls in learning outcomes. In PASEC countries, girls tend to be advantaged in reading while boys seem to be advantaged in mathematics. The current study is trying to better understand the determinants of the gender gap in learning outcomes. In the literature, several methodologies are applied to analyse inequality in learning outcomes. Descriptive statistics is one of the techniques that is widely used. Authors such as Horn et al (2006) as well as Freeman et al. (2011) applied regression techniques to investigate the correlates of learning outcomes across groups of individuals.

Decomposition techniques are another category of methodologies that are applied to study the contribution of different groups of factors to learning outcomes gaps across different groups of individuals. Oaxaca-Blinder decomposition methodology is one of the most commonly used decomposition techniques. For instance, Nieto and Ramos (2013) applied the Oaxaca-Blinder decomposition technique to PISA microdata for 10 middle-income and 2 high-income countries to measure the contribution of different sets of variables to learning outcomes gaps across different groups of students. Nieto and Ramos (2013) show that teacher quality and better teaching practices matter for learning outcomes gaps across groups of students. Barrera-Osorio et al. (2011) applied Oaxaca-Blinder methodology to analyse the increase in Indonesia's score in PISA mathematics between 2003 and 2006. Results suggest that almost the entire test score increase is explained by the returns to characteristics, mostly related to student age.

Oaxaca-Blinder decomposition technique is applied in the current paper to investigate the determinants of the learning outcomes gap between boys and girls using PASEC 2014 data. The Oaxaca-Blinder decomposition method was originally introduced by Oaxaca (1973) and Blinder (1973) to decompose earning gaps between males and females and to estimate the degree of gender discrimination in the labour market. This decomposition technique was later applied to many other topics in various disciplines including education. Following Hanushek, (1986 and 2002), Glewwe (2002) and Barrera-Osorio et al. (2011) we define an education production function as follow:

$$P_i = E\left(A_i, F_i, S_i, I_i\right) + \varepsilon_i \tag{1}$$

where P_i is the PASEC score for individual I (in reading or in mathematics), E is the education production function, Ai is a vector of individual student characteristics, Fi is a vector of family inputs including socioeconomic status, Ii is a vector of school-related inputs, Si is a vector of the school institutional characteristics, epsilon and error terms. Following Barrera-Osorio et al. (2011), epsilon includes all the omitted variables including those that relate to the history of past inputs, endowed mental capacity, and measurement errors. Assuming a linear specification for the function E, equation (1) can be re-written as follow:

$$P_i = \beta_0 + \beta_1 A_i + \beta_2 F_i + \beta_3 S_i + \beta_4 I_i + \varepsilon_i \tag{2}$$

where β is a set of parameters to be estimated. Assuming P_i^m and P_i^f the PASEC score for boys and girls respectively, equation (2) can be re-written:

$$P_i^m = \beta_0^m + \beta_1^m A_i^m + \beta_2^m F_i^m + \beta_3^m S_i^m + \beta_4^m I_i^m + \varepsilon_i^m \tag{3}$$

$$P_i^f = \beta_0^f + \beta_1^f A_i^f + \beta_2^f F_i^f + \beta_3^f S_i^f + \beta_4^f I_i^f + \varepsilon_i^f \tag{4}$$

Using equations (3) and (4) and assuming that all parameters are estimated and variables are given by their mean, the gender gap in PASEC score can be decomposed as follow:

$$\begin{aligned} P^f - P^m = {} & \beta_1^f \left(A^f - A^m\right) \\ & + \beta_2^f (Ff - Fm) + \beta_3^f \left(S^f - S^m\right) + \beta_4^f \left(I^f - I^m\right) \{EXPLAINED\} \\ & + \left(\beta_0^f - \beta_0^m\right) + \left(\beta_1^f - \beta_1^m\right) Am + \left(\beta_2^f - \beta_2^m\right) F^m + \left(\beta_3^f - \beta_3^m\right) S^m \\ & + \left(\beta_4^f - \beta_4^m\right) I^m \{UNEXPLAINED\} \end{aligned} \tag{5}$$

The first four elements in the right-hand side of equation (5) are the explained part of the learning outcomes gap between boys and girls while the five following terms capture the unexplained gender gap. Basically, the EXPLAINED part of equation (5) captures the part of the gender gap in learning outcomes that is explained by differences in individual characteristics, family background, school characteristics, and institutional factors between boys and girls, respectively. In other terms, the EXPLAINED portion of the decomposition captures the effect of differences in endowments between boys and girls on the gender gap. The effects of individual characteristics, family background, school characteristics, and institutional factors on learning outcomes can be different for boys and girls. The UNEXPLAINED part captures the portion of the gender gap due to differences in the effects of these factors on boys and girls. In other terms, the UNEXPLAINED part captures differences in the effect of being male or being female on the gender gap. Applying Oaxaca-Blinder decomposition technique on PASEC data, the gender gap in learning outcomes is analysed. In fact, equations (3) and (4) are estimated applying ordinary least square (OLS) and estimates are used in equation 5 to decompose the gender gap in learning outcomes into the described two components. Using equation (5), it is possible to measure the proportion of the gender gap explained by each element considered in the analysis.

The test scores can be correlated at the school level due to clustering effects. It is supposed that the error terms are independently and identically distributed. In the presence of clustering effects, this assumption may not hold. Thus, regressions are controlled for clustering effects applying the method of OLS with cluster-robust standard errors. Possible reverse causality between the learning outcome variables and the explanatory factors would lead to some endogeneity problems in equations (3) and (4). We believe that the observed PASEC test scores may not explain student's characteristics, family background, school facilities, and institutional factors. Thus, equations (3) and (4) do not suffer from any endogeneity issues. Following Hanushek (1986, 2002), Glewwe (2002), Todd and Wolpin (2003) and Barrera-Osorio, et al (2012) the observed factors that can impact students' learning achievements can be grouped into the following categories: individual characteristics, family background, school characteristics, and institutional factors. We thus believe that the current analysis includes all key elements that can explain students' learning outcomes and the estimated model does not suffer from any identification issues. Results from the analysis are presented in Section 5.

Table 1 OLS regressions

Dependent variable: log of the PASEC test scores	*Model 1 French all*	*Model 2 math all*	*Model 3 French girls*	*Model 4 French boys*	*Model 5 math girls*	*Model 6 math boys*
Students' characteristics and area						
Gender (male)	0.002	0.012				
	(0.84)	(3.99) ***				
Age	–0.009	–0.008	–0.009	–0.009	–0.008	–0.007
	(9.22) ***	(7.72) ***	(5.36) ***	(5.09) ***	(5.11) ***	(3.80) ***
Area (rural)	–0.081	–0.058	–0.078	–0.084	–0.056	–0.060
	(20.41) ***	(14.58) ***	(7.81) ***	(7.77) ***	(5.65) ***	(5.72) ***
Socioeconomic status						
Poor (quintile 2)	0.004	–0.006	0.002	0.008	–0.003	–0.009
	(0.98)	(1.45)	(0.30)	(1.02)	(0.37)	(1.20)
Middle (quintile 3)	0.014	–0.008	0.011	0.018	–0.004	–0.010
	(3.00) ***	(1.68) *	(1.40)	(2.26) **	(0.47)	(1.26)
Rich (quintile 4)	0.025	–0.000	0.022	0.030	0.003	–0.001
	(5.49) ***	(0.01)	(2.60) ***	(2.95) ***	(0.36)	(0.14)
Richest (quintile 5)	0.034	0.005	0.031	0.038	0.006	0.005
	(6.65) ***	(0.94)	(3.34) ***	(3.55) ***	(0.61)	(0.55)
Teachers' characteristics						
Teachers' gender (female)	0.030	0.027	0.037	0.024	0.033	0.022
	(7.05) ***	(6.14) ***	(3.21) ***	(2.01) **	(2.79) ***	(1.76) *
Teachers' experience	0.000	0.000	0.001	0.000	0.000	–0.000
	(2.33) **	(1.12)	(1.50)	(0.18)	(0.86)	(0.21)
Teachers: regular salary	0.054	0.042	0.040	0.067	0.035	0.047
	(7.86) ***	(5.87) ***	(2.17) **	(3.70) ***	(1.86) *	(2.36) **
Teachers: salary level	0.004	0.002	0.005	0.002	0.002	0.003
	(1.56)	(0.89)	(0.87)	(0.38)	(0.30)	(0.48)

Notes: * significant at 10%, ** significant at 5 %, *** significant at 1%, robust standard errors are given under brackets.

Source: Authors' estimation based on PASEC data

Table 1 OLS regressions (continued)

Dependent variable: log of the PASEC test scores	*Model 1 French all*	*Model 2 math all*	*Model 3 French girls*	*Model 4 French boys*	*Model 5 math girls*	*Model 6 math boys*
Schools' facilities						
Index of pedagogical resources	0.002	0.002	0.002	0.002	0.002	0.002
	(10.06) ***	(12.06) ***	(3.64) ***	(3.31) ***	(3.77) ***	(4.59) ***
Index of infrastructure	0.001	0.001	0.002	0.001	0.002	0.001
	(6.08) ***	(6.30) ***	(2.88) ***	(1.17)	(2.50) **	(1.68) *
Canteen	–0.019	–0.024	–0.018	–0.021	–0.027	–0.021
	(5.70) ***	(7.15) ***	(1.94) *	(2.14) **	(2.86) ***	(2.17) **
Institutional factors						
Multi-level classroom	–0.020	–0.021	–0.017	–0.023	–0.021	–0.020
	(4.07) ***	(4.18) ***	(1.21)	(1.63)	(1.45)	(1.40)
Multi–flux classroom	0.008	0.011	0.006	0.011	0.005	0.021
	(1.51)	(2.14) **	(0.42)	(0.67)	(0.34)	(1.32)
Private school	0.071	0.064	0.060	0.084	0.057	0.072
	(13.28) ***	(12.05) ***	(3.54) ***	(5.06) ***	(3.35) ***	(4.65) ***
Other variables						
Access to French textbook	0.021	0.011	0.022	0.021	0.008	0.017
	(4.42) ***	(2.39) **	(2.29) **	(2.04) **	(0.82)	(1.81) *
Access to Math textbook	0.017	0.025	0.009	0.027	0.021	0.029
	(4.27) ***	(6.25) ***	(1.02)	(3.05) ***	(2.63) ***	(3.51) ***
Controls for countries	YES	YES	YES	YES	YES	YES
Constant	6.093	6.019	6.046	6.152	5.993	6.056
	(263.23) ***	(258.88) ***	(100.21) ***	(99.49) ***	(98.74) ***	(97.70) ***
F	235.945	340.221	36.768	36.271	54.926	83.283
R2	0.316	0.352	0.300	0.340	0.326	0.396
N	12,829	12,829	6,772	6,057	6,772	6,057

Notes: * significant at 10%, ** significant at 5 %, *** significant at 1%, robust standard errors are given under brackets.

Source: Authors' estimation based on PASEC data

5 Result

5.1 Determinants of learning outcomes

Understanding the factors that matter for girls' and boys' learning outcomes would help understand the determinants of the gender gap in learning outcomes. Table 1 presents the results of a series of econometric regressions that investigates the determinants of learning achievements in mathematics and reading both for girls and boys. Models 1 and 2 show that gender matters for learning outcomes in mathematics while the influence of gender on achievements in reading is not statistically significant. More specifically, after controlling for students' personal characteristics (age and area of living), family background (socioeconomic status) school characteristics (teachers and school facilities), and institutional factors, being a boy is associated with an average PASEC score in mathematics that is 12% higher compared to being a girl, while gender does not have any significant effect on students' achievement in reading. Being a girl is negatively associated with achievement in mathematics. Even though girls have a higher average learning achievement in reading, this is not explained by their gender. Factors other than gender might explain the observed gender gap in learning outcomes and the decomposition proposed later in this paper will help identify these factors.

Factors other than gender have effects on learning outcomes. Models 1 and 2 show that socioeconomic status is a significant determinant of students' achievements in reading but not in mathematics. Coming from a family that belongs to the richest quintile is associated with an average score in reading that is 3.4% higher compared to the poorest quintile. While teachers' salary level does not matter for learning outcomes, having a regular salary has a positive effect on learning outcomes both in reading and in mathematics. In addition, access to reading and mathematics textbooks is associated with better learning outcomes both in reading and in mathematics. As expected, the effect of reading textbooks is higher on reading achievements, while the effect of mathematical textbooks is higher for achievements in mathematics. Results also show that age is negatively correlated with learning outcomes both in mathematics and in reading. In other terms, delayed entry into the education system is negatively associated with learning outcomes. Living in a rural area is negatively correlated with learning outcomes. Students from rural areas are disadvantaged in terms of learning outcomes.

The effects of socioeconomic status, teachers, and school facilities as well as institutional factors differ across genders. Models 3 and 4 in Table 1 show that girls from the richest quintile have 3.1% higher score in reading compared to girls from the poorest quintile. The effect of socioeconomic status is slightly higher for boys. Boys from the richest quintile record an average score that is 3.8% higher in reading compared to boys in the poorest quintile. Having a female teacher is associated with better learning outcomes especially for girls both in mathematics and in reading (models 3, 4, 5, and 6 in Table 1). Having a female teacher is associated with 3.7% better achievement in reading and 3.3% better achievement in mathematics for girls. Female teachers are also positively associated with boys learning outcomes but the impact is lower compared to girls. Similar findings are provided in the literature. For instance, Gong et al. (2016) show that female teachers provide feedback differently to girls and boys, and having a female teacher alters girls' beliefs about commonly held gender stereotypes and increases their motivation to learn. Muralidharan and Sheth (2013) show that female teachers are more effective overall, resulting in girls' test scores improving when they are taught by a female teacher, with no adverse effects on boys when they are taught by female teachers. Dee (2007) finds that assignment to a same-gender teacher can play a role in improving the learning outcomes of both girls and boys. Furthermore, being enrolled in a public school is associated with a lower score in mathematics and in reading compared to private schools especially for girls. In other terms, private schools tend to provide better learning outcomes, especially for girls.

Overall, results show that gender does not have any significant effect on reading achievements while being a boy is correlated with better achievement in mathematics. Other factors such as teacher's gender, school facilities, age, area of living, and access to textbooks have significant effects on learning outcomes. The next section investigates the contribution of these factors to the gender gap in reading and in mathematics.

5.2 Determinants of the gender gap in learning outcomes

Oaxaca-Blinder decomposition allows decomposing the gender gap into two components: an EXPLAINED component which is linked to differences in endowments and an UNEXPLAINED which reflects the differences in the effects of certain factors on boys and girls. While the EXPLAINED part can be associated with the effects of differences in individual characteristics, socioeconomic status, school characteristics, and institutional factors on the gender gap in learning outcomes, the UNEXPLAINED part is related to the differences in the effect of certain factors on girls and boys. In other words, the gender gap is decomposed into two components including a component that reflects differences related to factors other than the gender and a component related to the gender itself.

Table 2 Oaxaca decomposition: contribution of groups of factors to the gender gap

Primary	*Reading*	*Mathematics*
Overall		
Girls	489.680	494.352
	(383.56)***	(365.45)***
Boys	485.540	496.504
	(424.45)***	(418.01)***
Difference	4.141	–2.152
	(2.42)**	(1.20)
Explained	4.116	3.637
	(5.16)***	(4.69)***
Unexplained	0.025	–5.789
	(0.02)	(3.56)***

Notes: The marginal effects provide the contribution of each set of variables as a percentage of the overall predicted test score difference. *Significant at 10%; **significant at 5%; ***significant at 1%; Robust standard errors are given under brackets.

Source: Authors' estimation based on PASEC data

Table 2 Oaxaca decomposition: contribution of groups of factors to the gender gap (continued)

Primary	*Reading*	*Mathematics*
Explained		
Students' age and area	1.034	0.169
	(2.89)***	(0.98)
Socioeconomic status	0.016	–0.128
	(0.37)	(1.78) *
Teachers' gender	1.317	2.016
	(4.26)***	(4.30)***
Teachers' experience	–0.025	–0.022
	(0.28)	(0.28)
Institutional factors	0.111	0.137
	(0.44)	(0.47)
School facilities	1.411	1.238
	(3.56)***	(3.50)***
French textbook	0.226	0.194
	(2.16)**	(2.10)**
Math textbook	0.025	0.033
	(0.30)	(0.30)
Unexplained		
Students' age and area	19.144	61.096
	(1.54)	(4.57)***
Socioeconomic status	2.893	1.165
	(0.98)	(0.37)
Teachers' gender	0.077	1.399
	(0.08)	(1.33)
Teachers' experience	–2.088	0.334
	(0.89)	(0.13)
Institutional factors	0.049	0.230
	(0.05)	(0.23)
School facilities	–9.419	–7.734
	(0.79)	(0.61)
French textbook	0.101	5.557
	(0.03)	(1.39)
Math textbook	6.936	2.910
	(2.36)**	(0.93)
Constant	–17.667	–70.745
	(0.96)	(3.66)***
N	11,858	11,858

Notes: The marginal effects provide the contribution of each set of variables as a percentage of the overall predicted test score difference. *Significant at 10%; **significant at 5%; ***significant at 1%; Robust standard errors are given under brackets.

Source: Authors' estimation based on PASEC data

Overall, results show that in reading, the predicted gender gap is 4.11 points and 98% of the predicted gender gap is linked to differences in factors' endowment while only 2% of the gender gap is related to differences in gender (Table 2). This finding is consistent with the results presented in Table 2 which indicate that gender is not a significant determinant of reading achievements. In other terms, girls are advantaged in reading not necessarily because of their gender, but because of other factors. Table 3 shows that among the factors that are included in the current analysis, school facilities and teachers' gender (female teachers) are among the most important factors explaining the gender gap in favours of girls in reading. Overall, school facilities are positively associated with learning outcomes in reading and girls seem to concentrate in schools with better facilities (better infrastructure and pedagogical resources). In addition, the proportion of girls is overall higher in classrooms taught by female teachers and given the positive effect of female teachers on learning outcomes, girls benefit more from female teachers. Overall, school facilities explain 34% of the predicted gender gap in learning outcomes while having a female teacher explains 32% of the gender gap. Differences between boys and girls in age and area of living also explain 24% of the overall predicted gender gap. In fact, PASEC data show that girls are more likely to experience delayed entry into the education system, compared to boys and they are more exposed to the negative effects of delayed entry on learning outcomes. In addition, the proportion of girls enrolled in rural areas is lower than the proportion of boys enrolled in rural areas. So, girls are less exposed than boys to the negative effects that living in a rural area may have on learning outcomes.

Table 3 Oaxaca decomposition: contribution of groups of factors to the explained gender gap

	Reading	*Mathematics*
Students' age and area	25.1***	4.7
Socioeconomic status	0.4	–3.5*
Teachers' gender (female)	32.0***	55.4***
Teachers' experience	–0.6	–0.6
Institutional factors	2.7	3.8
School facilities	34.3***	34.0***
French textbook	5.5**	5.3**
Math textbook	0.6	0.9
Total	100	100.0

Notes: A positive sign means that the contribution is in favours of girls while a negative sign indicates that the contribution of the variable/set of variables is in favours of boys. The marginal effects provide the contribution of each set of variables as a percentage of the explained test score difference, * significant at 10%, ** significant at 5%, *** significant at 1%, Robust standard errors are given under brackets.

Source: Authors' estimation based on PASEC data

In mathematics, differences in individual characteristics, socioeconomic status, school characteristics, and institutional factors on one hand and the effect of gender on the other hand play opposite roles in explaining the gender gap. Overall, the predicted gender gap is 2.15 points in favours of boys. The decomposition shows that being a boy is associated with a 5.8 points higher score in mathematics while individual characteristics, socioeconomic status, school characteristics, and institutional factors contribute to a 3.6 points higher score in favours of girls. Since the effect of gender is higher than the effect of other variables, the overall score in mathematics is higher for boys. In other terms, boys are advantaged in mathematics mostly because of their gender although factors other than gender play in favours of girls. These factors are mostly related to having female teachers and school facilities. Having a female teacher is particularly important for closing the gender gap in mathematics. Access to textbooks is also another factor that can contribute to closing the gender gap in mathematics.

Overall, the gender gap in mathematics is mostly driven by gender itself. Some psychological factors may contribute to explaining why boys have a better ability to learn mathematics, compared to girls. For instance, Sian et al. (2009) show that female teachers' anxiety about teaching mathematics has a negative effect on girls' achievement in mathematics in the US. This study shows that the more anxious female teachers are about mathematics, the more likely girls endorse the common stereotype about the fact that boys are good at math, and girls are good at reading. This negatively contributes to undermining girls' achievement in mathematics. Another study conducted in Sweden by Samuelson and Samuelson (2016) shows that the difference in the perception that boys and girls have regarding the importance of mathematics contributes to explain why boys outperform girls in mathematics. In fact, these authors demonstrate that boys perceive mathematics to be more important than girls do. More qualitative studies are needed in order to understand the psychological factors that can contribute to explaining the difference between girls and boys in terms of the ability to learn mathematics in Sub-Saharan Africa.

6 Conclusions

The current study is an attempt to better understand the gender gap in learning outcomes. Overall, girls seem to be advantaged in reading while boys are advantaged in mathematics. Results show that being a boy or being a girl does not necessarily have any effect on reading achievements. As a result, the gender gap in reading is not related to the effects of gender. Other factors such as teachers' gender, school facilities, age, and area of living mostly explain the gender gap in reading. In mathematics, the gender gap in favour of boys is mainly explained by gender. Being a boy is associated with better achievements in mathematics. Factors such as teachers' gender, school facilities, and access to textbooks contribute to girls' learning outcomes in mathematics but given the strong positive effect of gender on boys' learning outcomes in mathematics, the overall gender gap is in favour of boys. Overall, results show that promoting better school facilities, access to textbooks, and female teachers can help mitigate the negative effect of gender on girls' achievement in mathematics. The effect of female teachers on girls' achievement in mathematics is particularly important. Promoting female teachers can play an important role in narrowing the gender gap in mathematics. The current study helps understand that environmental factors can play a role in reducing the gender gap in learning outcomes. Interventions aiming at addressing the gender gap in learning outcomes should be tailored to tackle the barriers that girls have in learning mathematics. This requires a deeper dive into certain psychological factors behinds girls' lower performance in mathematics.

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