A RIDDLE EXPLAINED: GENDER DISPARITIES IN EAST AFRICAN EDUCATION

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ABSTRACT

There can be little question that studying the relationship between education and inequality will benefit public investment in education. Although primary school enrolment for African girls has increased in many parts of the developing world, gender differences in performance persist, particularly in mathematics and science subjects. This study focused on three countries in East Africa with a female disadvantage in mathematics, and explored the influence of contextual factors and organisational processes that were associated with higher achievement and its improved gender distribution. Across countries, there was a positive and significant relationship between higher academic achievement in mathematics and the social class climate of the school. An important finding relating to gender was that the school setting seemed to favour boys. However, the particular features that were related to a wider gender gap were quite specific to individual countries. The implications for education sector reform and development are discussed.

Keywords: Africa, demand for schooling, development, education production function, gender

African Review of Economics and Finance
Volume 7 | Number 2 | 2015
pp. 29–59

Print ISSN 2042-1478 | Online ISSN 2410-4906

INTRODUCTION

Improving the quality of education in Africa is recognised as important, for many reasons. Human capital theorists concentrate on the economic value of education for development, but there are broader issues related to its social value. Both perspectives have merit. Education is central to a country's productivity and growth (Bhorat, 2004; Fägerlind & Saha, 1989; Hanushek & Wößmann, 2007; Harbinson & Myers, 1964). There are other gains associated with focusing on schooling for girls in Africa that touch upon community and national development. Formal education for girls has been linked to later marriage, smaller families and improved health (UNESCO, 2005). There are two aims to this article: the first is to explore what types of schools promote gender equity in Kenya, Tanzania and Uganda; the second is to determine whether equitable school environments in these countries can be achieved without compromising on overall quality.

Previous research has described how unequal gender relations and less education can lead to greater incidences of poverty among East African women (Otiso, 2012, 2000). Although African women often make a substantial contribution to the informal sector (Kiteme, 1992; Lawanson & Oduwaye, 2014), they remain underrepresented in formal employment and in decision-making structures. An important part of reversing this imbalance lies in ensuring widespread access to quality basic education. The current study adds to our understanding of the complexity of gender dynamics and development by focusing on gender differences in academic performance among school-aged children, and considering how schools respond to these gender differences. Data are drawn from a survey conducted in the late 1990s. This period coincided with major shifts in educational policies involving access to, and quality of, basic education for children in the developing world. Schools were struggling with competing alternatives for raising academic standards in primary schools. There was also the added concern of addressing glaring inequalities in performance between boys and girls.

Gender equity considerations are common across countries that are at different stages of economic development (Abidogun, 2007; Klasen, 2002) and certainly remain a serious educational challenge in the three East African countries that are the focus of this study. Although gender gaps in literacy have narrowed to some extent, and even reversed to favour girls (Zuze & Reddy, 2014), girls still lag behind in mathematics. Lack of progress may severely hamper female career choices later in life, particularly in developing countries where opportunities for further education and training are limited.

Data on African education systems have multiplied in recent decades, making it possible to address the challenges facing policy makers more precisely. Because educational policies are unique to each country, their systematic study has presented an excellent opportunity to determine best practices (Darling-Hammond, 2007; Heyneman, 2004). Interest in comparative studies has also grown, as decision makers come to recognise the relationship between education quality and economic competitiveness. A clear implication of these advances is that more care must be taken in choosing countries for comparative analysis so that meaningful recommendations for promoting development can be made. Cross-national research is especially useful where countries that have similar educational concerns also have strong historical and social ties to each other. However, the unique elements of each country lend themselves to more detailed discussions about the importance of a country's individual contexts.

Table 1 presents a summary of the social indicators for the three countries during the study period. At the turn of the century, when this study is based, Tanzania was clearly the least economically advantaged of the three study areas, with a per capita GDP far below the average for sub-Saharan Africa. Tanzania also had the largest population. Overall, Kenya was the most urbanised and advanced setting, enjoying a higher human development ranking, highly literate adult population, a lower infant mortality rate and a slower population growth rate. During this period, the impact of HIV on the adult population was considerably higher in Kenya than in either Tanzania or Uganda. Interestingly, life expectancy was lowest in Uganda, a likely indicator of the extent to which HIV/AIDS had ravaged the country in previous years (Mathers *et al*., 2001). Net enrolment was substantially higher in Uganda than in the other two countries. Uganda was the first of the three countries to introduce universal primary education (UPE) in 1997 and the only one of the three to have the policy in place at the time of data collection for this study in 2000. It is worth mentioning that some of these indicators have been shown to be problematic. For example, 'access to improved water sources' ignores issues of affordability and the unreliability in delivering water to certain communities (Obeng-Odoom, 2012). Similarly, GDP per capita has been criticised for not adequately capturing national wellbeing (Kahneman *et al*., 2004; Obeng-Odoom, 2014). A recent Kenyan study by Kaminchia (2014) showed that increasing output does not necessarily lead to an increase in wage employment. Nevertheless, these indicators give us a rough idea of the economic and social progress in the selected countries.

Table 1: Social indicators

Indicator	Kenya	Tanzania	Uganda	Sub-Saharan Africa
Population (000)	30.7	35.1	23.3	303
Percentage under 15	43.5	32.3	49.2	44.6
Percentage urban	33.4	32.3	14.2	33.9
Per capita GDP (PPP US$)	1 022	523	208	690
Life expectancy at birth (years)	50.8	51.1	44.0	48.7
Human Development Index rank [b]	134	151	150	-

Infant mortality rate (per 1,000 live births)	77	104	110	107
Percentage of population using improved water sources	49	54	50	54
Adults living with HIV/AIDS a	15.01	7.83	5.0	9.0
Adult literacy rate	82.4	75.1	67.1	61.5
Ratio of pupils to teachers at the primary levelc	34.4	41.4	52.7	-
Total spending on education as a percentage of GDPc	6.3	2.2	2.5	-
Net enrolment ratioc	66.3	51.4	89d	-

Source: UNDP (2002)

a. 2001 estimate;
b. 2002 rank;
c. World Bank education statistics;
d. World Bank (2006).

It made sense to focus on Kenya, Tanzania and Uganda, because in addition to the unique features of each country, the following held true: (a) average mathematics achievement in primary level mathematics differed significantly across schools; (b) boys consistently outperformed girls in primary level mathematics; and (c) the gender gap in performance varied between schools in each country (Lee *et al*., 2005; Ross *et al*., 2004). Although their political paths have often diverged (and sometimes even clashed), in all three countries various factors eroded the educational gains achieved after independence, but fresh commitments have since emerged to improve access to, and the quality of, primary education.

The article is structured as follows: the next section provides a brief overview of the key issues in the literature, which is followed by a description of the data. Analytical methods are discussed before turning to the results. The article concludes with a discussion of the findings and their implications.

KEY ISSUES IN THE LITERATURE

The key issues in the literature can be discussed around the following themes: (a) explanations of gender differences in schooling in industrialised countries; and (b) a separate discussion related to gender differences in schooling in African countries.

Gender differences in schooling in industrialised countries

Early research into gender inequalities in education in industrialised countries raised concerns about the disadvantages faced by girls in virtually every aspect of education (Jacobs, 1996). Contrary to most previous research findings, current debates in advanced economies question whether gender gaps favouring boys still exist (Hedges & Nowell, 1995) or whether they have effectively disappeared (Feingold, 1988; Hyde *et al*., 1990; Machin & McNally, 2005). Most studies suggest that where gender gaps in mathematics do exist, they are typically small to moderate in size (Guiso *et al*., 2008; Penner, 2008). Cross-national assessments indicate that boys generally have higher test scores in mathematics, but that there are notable differences between countries in the size of the gender gaps (Buchmann *et al*., 2008).

The manner in which the discussion of gender gaps in mathematics has been framed is the subject of some criticism. This is because boys have been found to achieve higher scores in standardised tests, whereas girls have excelled in continuous assessments (Duckworth & Seligman, 2006; Voyer & Voyer, 2014). Therefore, basing analysis on standardised assessments may present a limited view of ability. Similarly, using average test scores also overlooks the fact that the gender gap is consistently wider among high-achieving students (Ellison & Swanson, 2010). Another point of contention in Western studies of gender inequality is at what point gaps in mathematics actually appear. Some research suggests that girls achieve lower test scores in mathematics as early as pre-primary school and that these gaps seem to increase in the early years of primary school (Fryer Jr & Levitt, 2010; Lubienski *et al*., 2013; Penner & Paret, 2008). Others claim that gaps in performance emerge at later stages of schooling and only in certain areas of mathematics (Leahey & Guo, 2001). In English schools, girls consistently outperform boys in virtually all subject areas including mathematics, and this advantage is maintained during all phases of compulsory education (Machin & McNally, 2005).

Explanations for the cross-country variability in gender gaps in advanced economies include: the participation of women in the labour force, gender parity in school enrolment, gender-targeted educational policies, women's share of jobs in research, and the level of female representation in parliaments (Else-Quest *et al*., 2010; Kane & Mertz, 2012; Marks, 2008). Claims of biological factors driving the male advantage in mathematics are steeped in controversy and the evidence is at best inconclusive (Ceci *et al*., 2009; Spelke, 2005). A number of social and economic factors have been linked to gender-based performance gaps among children in industrialised societies. Parental involvement has been found to differ according to some studies, with parents investing more time in boys' school activities (Stevenson & Baker, 1987). Other research proposes that the nature of parental involvement and the value that is attached to education are key to success for low-achieving children, irrespective of gender (Chen & Gregory, 2010; Hong *et al*., 2010). Attitudes about mathematics have been shown to differ among boys and girls, and to influence achievement patterns as well as career choices. A cross-national study of OECD (Organisation for Economic Cooperation and Development) countries revealed that girls had higher levels of anxiety and lower levels of confidence in their mathematics ability, even when they performed equally well to boys (OECD, 2013; Schleicher, 2008). Arguments about whether teachers favour boys over girls have shifted over time. Whereas girls were previously seen as neglected by teachers, the tide seems to be shifting towards a school climate that favours girls (Sommers, 2000). The advantage of having a teacher of the same gender is equally inconclusive (Buchmann *et al*., 2008).

Overall, the evidence from advanced economies has shown a degree of gender convergence in some (but not all) aspects of education, although with significant variation between countries.

Gender differences in schooling in African countries

The backdrop for the discussion of gender effects on education in developing countries differs considerably, although the literature can be organised around the same themes. Access to some form of education is virtually guaranteed for most girls living in advanced economies. In addition to ensuring that the education system is fair, policy makers in parts of the developing world have grappled with low enrolment and retention rates among girls. In response to these barriers, governments and international agencies have invested vast resources into improving access to education among girls (Behrman *et al*., 2005). The initial UPE policy in Uganda stipulated that a maximum of four school children from each household could attend school, of whom two were to be girls (Alubisia, 2005). The United Nations Millennium Development Goals (MDGs) have also prioritised narrowing gender gaps in access to schooling (United Nations, 2009). By the late 1990s, gender parity in terms of access to schooling was widespread in Asia and Latin America but had reached only a handful of African countries (Diaw, 2008; Wils & Goujon, 1998). Gender inequalities in enrolment were particularly acute among French-speaking African countries (Dickerson *et al*., 2013; Michaelowa, 2001). Even within countries, progress towards gender equality in education can be inconsistent. The pastoral districts of northern and eastern Kenya are an apt example of where participation in education within a country can be lower than average, but acutely low for girls (Leggit, 2005).

Of course, improvements in attainment do not guarantee that gaps in achievement will be overcome. If boys and girls in developing countries receive different treatment, either in school or out of school, this may result in systematic differences in educational outcomes. In the analysis of gender differences in mathematics across 15 African education systems, Saito (2011) showed that only in the Seychelles did girls outperform boys in primary school mathematics. In seven countries (including the three East African countries under study in this article), boys achieved significantly higher scores in mathematics and in seven other countries, the differences were not statistically significant (Saito, 2011). Explanations for these differences are many and varied. As data from developing countries have become more widely available, the most widely debated issue has been based on whether school quality or family background were more important influences on education in these contexts (Heyneman, 1976a and b; Heyneman & Loxley, 1983). In their seminal research of school effects on academic achievement in developing countries, Heyneman and Loxley (1983) conclude that the more impoverished a country, the weaker the influence of student social status on academic achievement. This finding has been challenged recently, particularly in countries where mass education drives have increased the diversity of the children attending school (Baker *et al*., 2005; Lee & Zuze, 2011).

Social and cultural practices remain important out-of-school influences on girls' education in developing countries. Sometimes marriage is prioritised over education for girls. Bommier and Lambert (2000) argue that lower levels of education among Tanzanian girls could be explained by parents viewing marriage as the ultimate prospect for their daughters. In the late 1990s, it would cost a poor rural Tanzanian family half of its annual income to send one child to school for a year (Watkins, 2000). Not surprisingly, paying for a girl to attend school might be viewed as a loss if a husband's family eventually reaped the rewards of the investment. In Kenya, an on-going concern is the practice of arranging marriages between very young girls and older men (Elimu Yetu Coalition, 2005). However, emphasis on marriage is not always negative. If families receive a dowry and if better-educated women are viewed as more marketable, this may encourage parents to keep their daughters in school (Global Campaign for Education, 2005).

Teenage pregnancy is another factor that can interfere with educational progress. Pregnant girls are more likely to be expelled from school in Uganda and Tanzania than in Kenya. Boys do not face the same consequences for impregnating a girl. Although Kenya has a policy in place to ensure that teenage mothers can return to school, young mothers still face tremendous isolation (and even ridicule) if they choose to continue with their education (Elimu Yetu Coalition, 2005). The opportunity cost of girls spending time at school is often viewed as higher than for boys. Girls have the added responsibility of caring for younger children and even staying home from school on market days. According to one study, Ethiopian girls worked up to 16 hours each day (Watkins, 2000). In places hard hit by HIV and AIDS, girls can be required to care for sick relatives or to seek work in urban centres, thus increasing their vulnerability (Dungumaro, 2013).

The complex interplay between poverty and unequal gender relations in developing countries cannot be overlooked (Deininger, 2003; Yamada & Ampiah, 2009). When Uganda abolished school fees, enrolment among the poorest quintile of girls nearly doubled. Before school fees were abolished in Kenya, girls were twice as likely to be withdrawn from school as boys, owing to cost constraints (UNESCO, 2004). Girls have been more likely to succeed at schools where free meals are offered, especially in remote areas where distances between villages and schools are long and it is considered unsafe for girls to walk home at lunchtime (Elimu Yetu Coalition, 2005). It is not necessarily the case that traditional views about girls and education dominate other out-of-school factors. According to Buchmann's (2000) study of Kenyan family structures, gender stereotypes were less important than parental perceptions about the anticipated returns to education of individual children, irrespective of their gender. In contrast, a study of Ethiopia and Kenya concluded that the adverse effects of cultural practices operated independently of economic factors. Therefore, increasing the distribution of wealth was insufficient to guarantee favourable schooling outcomes for girls (Colclough *et al*., 2000).

Developing countries that have been successful in gaining greater equity in education have had high-level political support, the involvement of civil society and the sustained investment of resources, both locally and internationally (Global Campaign for Education, 2005). In their role in children's social development, school administrators and teachers face a special responsibility to promote gender equity, to eliminate practices that are discriminatory and to ensure that schools are safe environments for learning to take place.

Within the classroom, there is evidence that more attention is given to male students and that more difficult questions are directed at them (Jimenez & Lockheed, 1989; Mensch & Lloyd, 1998). This pattern may be due less to conscious sexism than to discipline issues. Linn and Hyde (1989) have argued that the direction may actually be reversing. Boys' tendency to be more outspoken in class may mean that they absorb more attention from teachers. Greater confidence among male students may also motivate them to approach the learning of mathematics in more innovative ways. Should girls lack confidence because they find themselves in unsupportive environments, they may cling to prescribed methods of learning, regardless of their effectiveness (Lee *et al*., 1994).

The link between differential treatment in the classroom and how girls and boys approach their academic tasks has been shown to be far more nuanced than previously suspected. Not only the curriculum and the attitude of teachers, but also the organisation of learning has tended to favour boys (Aikman & Unterhalter, 2007). Davison and Kanyuka's (1992) study of Malawian schools found that teachers projected a negative view of girls, characterising them as lazy and unambitious. Rugh's (2000) investigation in Nigeria suggested that although teachers were relatively neutral in the early years of primary school, by Grade 6, teachers had far more positive interactions with boys than with girls in the classroom.

The peer effects related to the gender composition of classrooms appear to operate differently for girls and boys. Co-educational learning environments may be a more natural platform for perpetuating the prevailing gender roles in society. The female gender disadvantage in coeducational settings is especially marked in science and mathematics, because girls can be conditioned to believe that technical subjects should only be attempted by boys. Yet girls seem to achieve better results in all subjects (including maths and science) and have higher academic aspirations in a classroom environment that is predominantly female (Jimenez & Lockheed, 1989). Lee and Bryk (1986) suggest that single-sex secondary educational environments in Catholic schools provide an opportunity for girls to explore their interests and fulfil their potential without the added strain of society's expectations. A few of these studies have actually been based on African data, but the issue has not been adequately addressed on a cross-national basis, in a development setting, with a sample of co-ed primary schools.

This review shows that a complex combination of factors contributes to the gender gap in mathematics, that issues in developing countries are unique and that the weight of different factors has much to do with the local context, both between and within countries. However, it raises important questions that require further attention. In particular, how extensive were gender differences among children attending East African primary schools in the 1990s? What role did school and non-school factors play in influencing overall academic achievement? Were some of these factors more important for boys than for girls?

DATA AND ANALYTIC METHOD

The study is based on a unique set of data collected by the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) in its second wave (Ross *et al*., 2004). The SACMEQ consortium consists of education systems in eastern and southern Africa. SACMEQ II data were collected in 2000. The desired target population for the surveys consisted of all Grade 6 pupils attending either government or non-government schools. The national sampling frames were drawn from information provided by each country's Ministry of Education. The data used are not without its limitations, and these are worth pointing out. The SACMEQ study, like many recent international education surveys, was cross-sectional in its design. The absence of longitudinal data in these studies places certain limits on how results can be interpreted. Without adjustments for prior achievement levels and the school environment in earlier grades, it is impossible to make any causal claims about the relationship between school quality on the one hand and educational outcomes on the other.

Whereas the outcome of interest was measured at the individual student level, many of the relevant predictors referred to the school level. Multilevel models address this incompatibility and were the appropriate methodology for analysing the data with this structure. In recent decades, progress has been made in developing software and formalised techniques to estimate multilevel models. There have been many applications showing the importance of multilevel analysis in educational research in various settings (Hox, 2002; Lee *et al*., 1997; Lee & Bryk, 1989; Lee & Smith, 1995; Raudenbush & Bryk, 2002; Snijders & Bosker, 1999).

The data analysis was conducted in four stages. The first and second stages involved conducting a descriptive analysis of the data and establishing whether there was systematic variation in the mathematics achievement outcome, and to partition its variance into its between-student and between-school components. By posing this question at the onset of the analysis, it was possible to determine whether a hierarchical model was actually necessary. It is only the variance between schools that we can investigate as a function of school characteristics. This initial analysis also provided important information about the reliability of the average achievement measure. Reliability is affected by the size of each cluster (i.e., the number of students in each school) with larger groups having more reliable estimates. It is also related to how much variation there is in each school's actual score. Greater variation is associated with higher reliability. The cluster size (average number of students per school) was quite similar across the three countries, ranging from 16 in Tanzania and Uganda, to 18 in Kenya.

The second step explored relationships between the achievement scores and characteristics of students. Student-level variables that captured each student's social and academic background were used here, with gender as the target measure. The roles that students' socioeconomic status, academic support in the home and grade repetition played on mathematics achievement were also considered, by including these measures to adjust the gender gap for them. Including these factors in the model created student control variables. In addition, by allowing the gender gap to vary for each school it was possible to determine whether there was a unique school effect that should be pursued later.

If African schools are to be used to enrich the human capital base in developing countries, then effective and equitable learning environments need to be created. As stated earlier, there are two aims to this study: the first is to identify school environments that promote gender equity. The second is to determine whether school environments that promote gender equity (i.e., reduce the gender gap) could simultaneously maintain high achievement standards for all children (measured by mathematics achievement). In the final step, separate multilevel analyses of each country's data were carried. Groups of school variables were added sequentially. More fixed compositional factors were included before resource related and organisational variables. Variables that dealt with the organisation of schools and classes were the last to be included.

RESULTS

Gender differences in East African countries

Because one of the aims of this article is to identify gender-based differences in achievement, Table 2 presents descriptive details on the characteristics of boys and girls in the three study areas. Student performance based on country and gender showed that the average mathematics score for Kenyan girls was substantially higher than for the entire samples of Tanzanian and Ugandan students. On average, Kenyan girls achieved better results in mathematics than Tanzanian and Ugandan students, irrespective of gender. In fact, there was a considerable gap between the general performance of Kenyan students and Tanzanian boys on the one hand, and Ugandan students and Tanzanian girls on the other. The magnitude of gender differences in mathematics achievement was quite variable, with a very small gender gap for Uganda for the sample as a whole, and a much wider gap in Tanzania, where the gap in mathematics achievement was in excess of 30 points. Although grade repetition tends to be more frequent for boys, as stated in the literature, this trend was not reflected in these countries. Grade repetition was highest for both boys and girls in Kenya, where primary schooling examinations are extremely competitive (Onsomu *et al*., 2005).

Table 2: Some measures related to gender differences in mathematics achievement, 2000

	Kenya			**Tanzania**			**Uganda**		
	M	**F**	**Total**[b]	**M**	**F**	**Total**[b]	**M**	**F**	**Total**[b]
Sample proportion[a]	1 692	1 604	3 296	1 376	1 473	2 849	1 471	1 148	2 619
Mathematics achievement	574	552	563	540	507	522	508	504	506
SES[c]	0.29	0.39	0.34	-0.21	-0.25	-0.23	-0.27	-0.04	-0.17
Proportion grade repetition	0.65	0.63	0.64	0.23	0.23	0.23	0.52	0.54	0.53
Proportion academic support[c]	-0.06	0.08	0.00	0.17	0.14	0.16	-0.24	-0.10	-0.18

Source: SACMEQ Data Archive Version 4.0 (own calculations)

a. Unweighted sample size. This is the sample that took part in the mathematics test;

b. Estimates for male and female students combined;

c. In this table, the SES and academic support variables are in a standardised (z-score) metric, mean (M)=0, standard deviation (SD)=1 across countries. For the multilevel analysis, they are standardised within each country.

Figure 1 shows the relationship between gender and socioeconomic status across countries. The most striking result shown in this figure is that socioeconomic status is much higher for girls in Uganda, which was one of the first African countries to respond to the global push for high-quality UPE. It has been suggested that re-enrolments at higher grades of primary school were greater for boys than girls in Uganda after UPE was introduced in 1997, which would mean that more boys from low-income families were attending school (Appleton, 2001). These data seem to provide evidence to support such claims. In Tanzania, girls and boys were of very similar socioeconomic backgrounds, although the socioeconomic status of both girls and boys was below the average for the three countries. Tanzanian girls received greater academic support at home compared to their female peers in other countries.

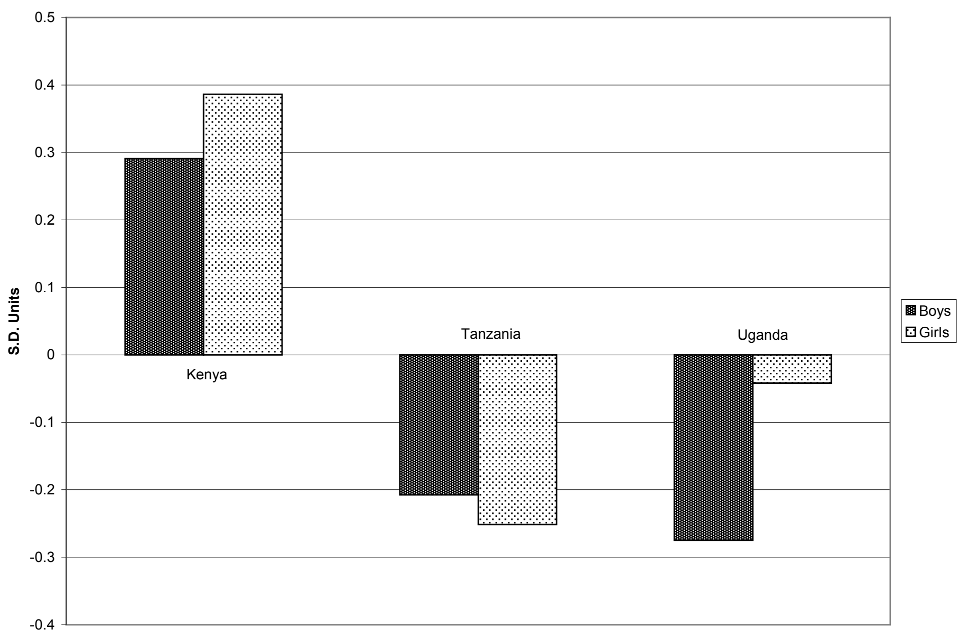

Figure 1: Student socioeconomic status and gender across East Africa, 2000

The descriptive analysis shown here is an early indicator of the educational realities confronted by girls in East Africa. Kenyan girls were clearly better off academically and socially than their female peers in the other two countries. However, they also repeated a grade more often. Average test scores for Tanzanian and Ugandan girls were virtually identical. Although Tanzanian girls were the most socially disadvantaged, the level of interest shown by members of their household was greater than what Kenyan or Ugandan girls received. This pattern may reflect societal views about adult responsibilities in student education that can operate independently of the student's socioeconomic circumstances. The opposite trend was true for Ugandan girls who, although wealthier than Tanzanian girls on average, compared unfavourably in terms of outside support for their academic work.

Variance decomposition for mathematics achievement

The decomposition of variance for each country is presented in Table 3. Intra-class correlation (ICC) is a measure of the distribution of inequality between schools – the higher the ICC, the larger the differences in achievement scores between schools. There was a notable difference between the ICCs for Kenya and Tanzania on the one hand and Uganda on the other. Such gaps, when taken together with Uganda's lower average maths test scores, seem to suggest that the expansion of Uganda's primary education system two years before these data were collected might have contributed to wider gaps in maths achievement between schools. Because Uganda did not take part in the first SACMEQ survey in 1995, ICC values for the period preceding UPE are unavailable. Reliability estimates for the outcome variable were satisfactory, although they were higher in Kenya and Uganda than in Tanzania. All reliabilities were above 0.8, where perfect reliability is '1'.

Table 3: Variance decomposition for mathematics achievement in Kenya, Tanzania and Uganda, 2000

	Kenya	**Tanzania**	**Uganda**
Grade 6 Maths achievement	563.25	522.40	506.28
Average within-school sample size	17.81	15.74	16.07
Total variance within schools (sigma-squared)	5 253.82	5 045.17	4 258.99
Total variance between schools (tau)	2 877.53	1 919.48	7 262.17
Intraclass correlation (ICC)[a]	0.35	0.25	0.63
Reliability (lambda)	0.91	0.83	0.96
a. ICC = tau/(tau + sigma-squared)			

Source: SACMEQ Data Archive Version 4.0 (own calculations)

Student background and academic achievement

In Table 4, the results of the model of student background and achievement are shown. This analysis addresses the research question directed at the influence of student background on mathematics achievement. Four variables were used to capture the nature of this effect: student gender, grade repetition history (a proxy for academic preparedness), academic support outside of school (an indicator of parental support) and student socioeconomic status. The adjusted scores across all countries were still above the SACMEQ mean of 500, but students in Uganda and Tanzania lagged behind students in Kenya. Interestingly, the influence of student background characteristics was greatest in Tanzania. This should, however, come as no surprise given that, compared to Kenya and Uganda, Tanzania had a smaller ICC and therefore a greater concentration of variation between students within schools. The behaviour of variables across countries was predictable and consistent. The influence of academic support on achievement in Kenya and Uganda was negligible. However, owing to its theoretical importance and for ease of comparison of school effects across countries, it was retained in further analysis. Both student socioeconomic status and academic support were related to higher mathematics achievement, whereas gender (female) and grade repetition were associated with a lower mean outcome. On average, the test scores of girls were between 20 and 30 points below the average test scores for boys.

Table 4: Student-level multilevel models for mathematics achievement in Kenya, Tanzania and Uganda (SACMEQ II), 2000

	Kenya	**Tanzania**	**Uganda**
Fixed effects			
Intercept	575.49***	533.57***	512.29***
Socioeconomic status	17.80***	17.02***	6.48***
Female	-22.39***	-29.51***	-19.05***
Grade repetition	-19.14***	-23.31***	-11.93***
Academic support	-1.16	7.96***	-1.04
Random effects			
Variance in school mean achievement	2 379.89***	1 878.97***	6 880.48***
Variance in gender slope	738.58***	724.31***	443.51***
Rij	4 791.68	4 682.04	4 032.45
Reliability of OLS regression-coefficient estimates			
Mean Achievement	0.81	0.73	0.92
Student Gender	0.39	0.36	0.28

Source: SACMEQ Data Archive Version 4.0 (own calculations)

~ p < .10; * p < .05; ** p < .01; *** p < .001

Not only was there a male advantage in mathematics achievement, but as shown in the bottom of Table 4, the gender gap also varied significantly between schools in each country at this time. It is worth considering the size of variance for both the gender gap and for average school achievement, because this will provide an early indication of where the influence of the school can be assigned. It is only differences between schools that can be explained through the school effects model. Clearly, larger between-school variation will make it easier to isolate significant school effects. The gender gap was largest in Kenyan and Tanzanian schools. The situation was different for gaps in average achievement, with larger gaps for Uganda and smaller differences for Kenya and Tanzania. Therefore, although it appears that issues of quality and inequality were important in all three places, questions of quality were paramount in Uganda, whereas in relative terms, gender equity concerns were a more serious issue in Kenya and Tanzania. The relationship between student gender and achievement is illustrated graphically in Figures 2 to 4, which represent a random sample of schools in each country. Each line shows average achievement for boys and girls in a single school. Not surprisingly, in virtually every instance, the lines slope downward because average achievement was higher for boys than for girls. It is also important to recognise that the gradient of the lines differed slightly across countries. In general, the gradients were steeper in Kenya and Tanzania than in Uganda, because as shown in the top panel of Table 4, achievement gaps were more prominent there. Even more essential for exploring how school characteristics were related to gender equity, within each country the steepness of the slopes differed. These slope differences are what contribute to the random effects shown in the bottom panel of Table 4. Understanding which school characteristics lessened the impact of gender on achievement is what will direct the equity analysis to be discussed later in this article.

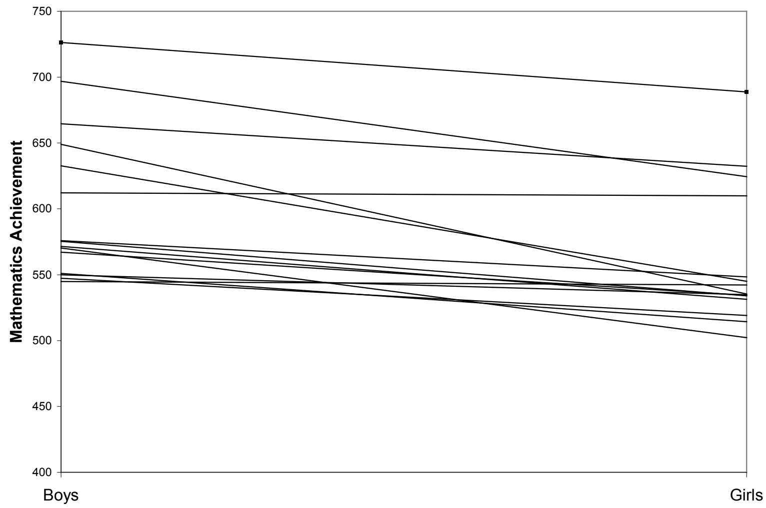

Figure 2: Gender differences in achievement in Kenyan primary schools, 2000

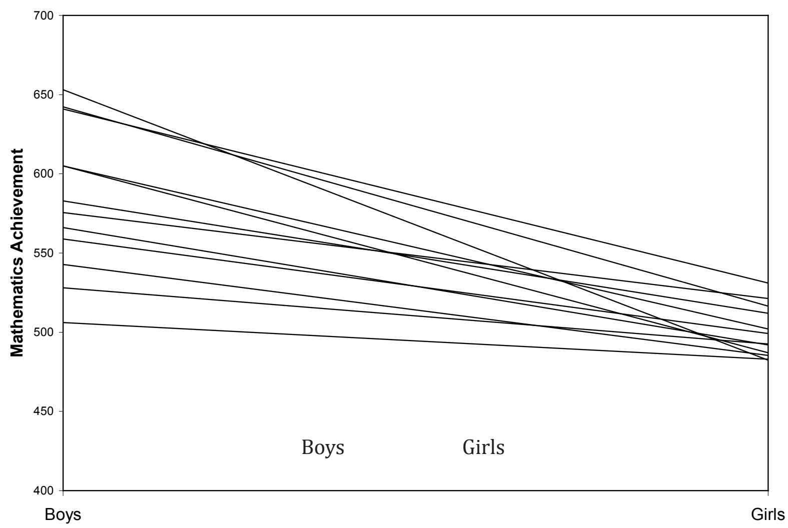

Figure 3: Gender differences in achievement in Tanzanian primary schools, 2000

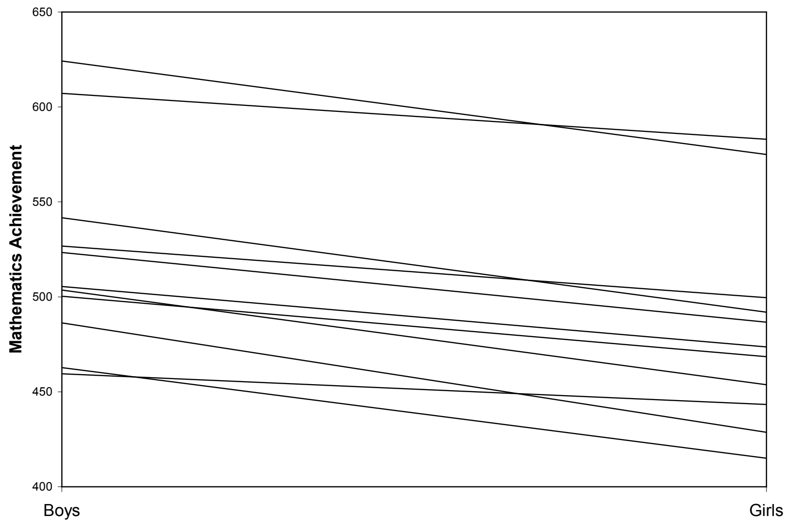

Figure 4: Gender differences in achievement in Ugandan primary schools, 2000

School characteristics and the gender gap

The results of the gender analysis are presented graphically in Figures 5 to 8. Full details of the final statistical model can be found in Appendix 1. Across countries, there was a positive and significant relationship between higher achievement in mathematics and the social class climate of the school (shown as average social background). This was the only measure to be systematically related to average achievement in all three countries. That schools with a wealthier student body achieved significantly better results is not unique to developing countries. Although noteworthy, there is a limit to the policy interventions that can be extracted from such a finding. In general there was more room for comparison of school effects between Kenya and Tanzania. In both countries, measures of school composition, structure and organisation were shown to be related to student achievement. Schools with students who received greater academic support performed better, as did schools with smaller Grade 6 classes. Where schools had more committed staff members achievement tended to be higher. This was captured by a variable for teacher attendance in Kenya and teacher discipline in Tanzania. Evidence from Ugandan schools appeared to be less comparable – a likely reflection of dramatic changes to the education system prior to the collection of these data that had not yet taken place in the other two countries.

Because the variable for gender was coded ‘1’ for female and ‘0’ for male and its coefficients were negative across all countries, narrowing the gender gap that favoured boys would require positive coefficients for school factors that were modelled on the gender slope. Conversely, when school variables that were modelled on the gender slope yielded negative coefficients, this meant they were associated with a wider gender gap. Despite the clear similarities uniting these countries, a common thread that tied specific school effects to the gender gap did not emerge. What did become apparent, however, was that school characteristics that were related to higher academic quality invariably benefited boys more than girls, and therefore had the effect of widening rather than narrowing the gender gap.

In Kenya this was seen in the gender composition of students. After adjusting for the effects of intake characteristics (socioeconomic status, gender, academic support and academic support outside of school), schools with a higher percentage of boys achieved significantly better results in mathematics. Every 1 SD increase in the percentage of female students yielded a nine-point drop in the mathematics test score. Although schools with a higher concentration of boys performed better, the gender gap favouring males was also significantly wider in these education environments. It would appear that in schools with more female students, quality was low but equity was high, implying that students performed equally poorly. Conversely, in schools where boys dominated, quality was high but at the cost of gender equity. Figure 5 depicts this effect more clearly. Irrespective of the gender composition of schools, boys outperformed girls in mathematics in Kenyan primary schools by a wide margin, but the gap was most acute where the percentage of girls in school was lowest. The definition of an effective and equitable school used in this study is one where there is higher academic achievement, after accounting for student background characteristics and a more equitable distribution of achievement between boys and girls. Based on this definition, effective schools would require that girls attending certain types of schools would benefit, but with no compensatory loss to boys. This was certainly not the result achieved here. The decline in average test scores as the percentage of females increased, was due mainly to a deterioration in the average test scores of boys in the late 1990s. There was no notable change in the average test scores among girls, irrespective of the gender composition of schools.

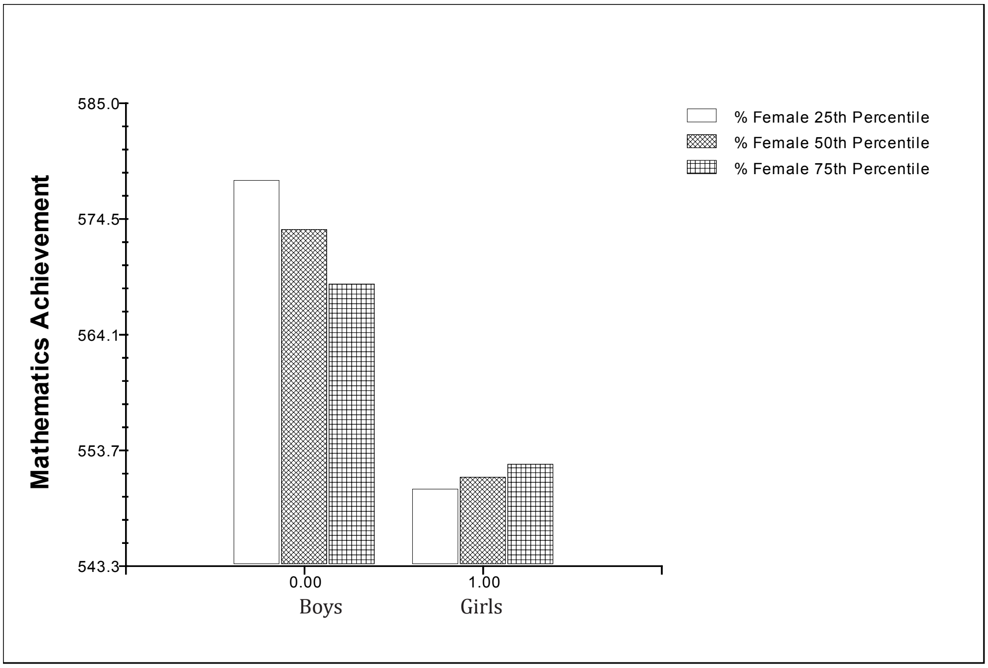

Figure 5: Effects of gender composition on the gender gap in mathematics achievement in Kenya, 2000

There was also some evidence to support claims that class size differentially affected the achievement of boys and girls. On average, the benefits for mathematics achievement of receiving instruction in smaller class units were greater for Kenyan boys than for Kenyan girls. Figure 6 illustrates the relationship between class size and the gender gap in the two countries where class size was important. As explained earlier, an increase in the gender gap would be represented by a negative effect size. Most of the effects were negligible, but the most striking finding was that Kenyan boys benefited slightly more than girls from small class size arrangements. For class sizes of up to 25 students, the existing gap in test scores between boys and girls increased by nearly 20 points.

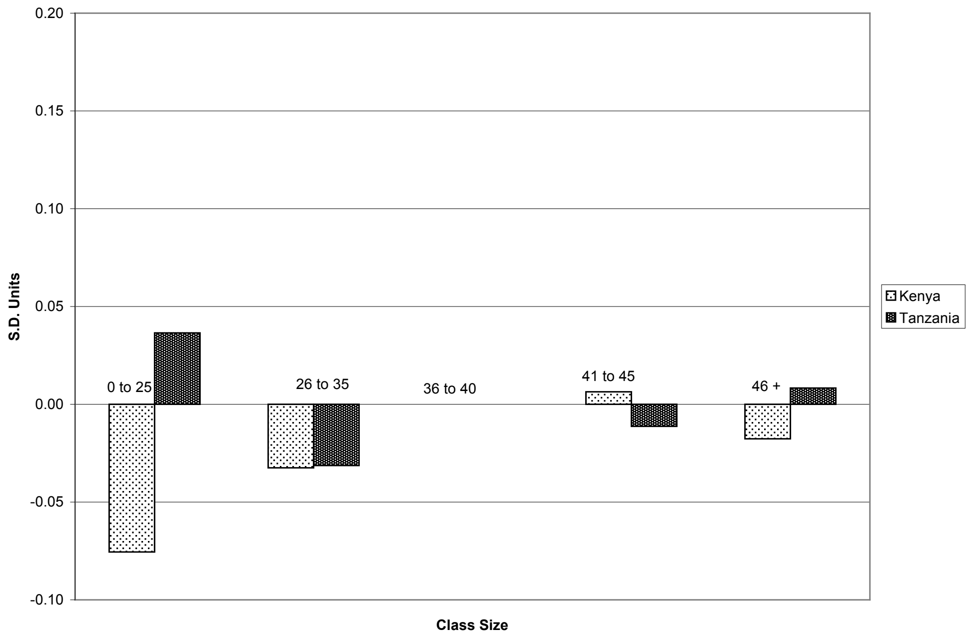

Figure 6: Effects of class size on the gender gap in mathematics achievement in Kenya and Tanzania,[a] 2000

Note: For ease of comparison, the results of this graph are presented in standard deviation units calculated as: γ [S.D(X)/S.D (Y)], where γ is the value of the adjusted class size coefficient, S.D. (X) is the standard deviation of the class size variables and S.D. (Y) is the standard deviation of the outcome variable (Hox, 2002; Snijders & Bosker, 1999).

A similar dichotomy of school effects appeared in Tanzania, where schools situated outside of urban centres were simultaneously found to have higher test scores on average and wider gender gaps in achievement. The implication is that schools in urban centres, although more equitable, were academically weaker. In Tanzanian primary schools where external interest in a student's work was prevalent achieved higher test scores, but the greatest gains once again were experienced by male students (see Figure 7).

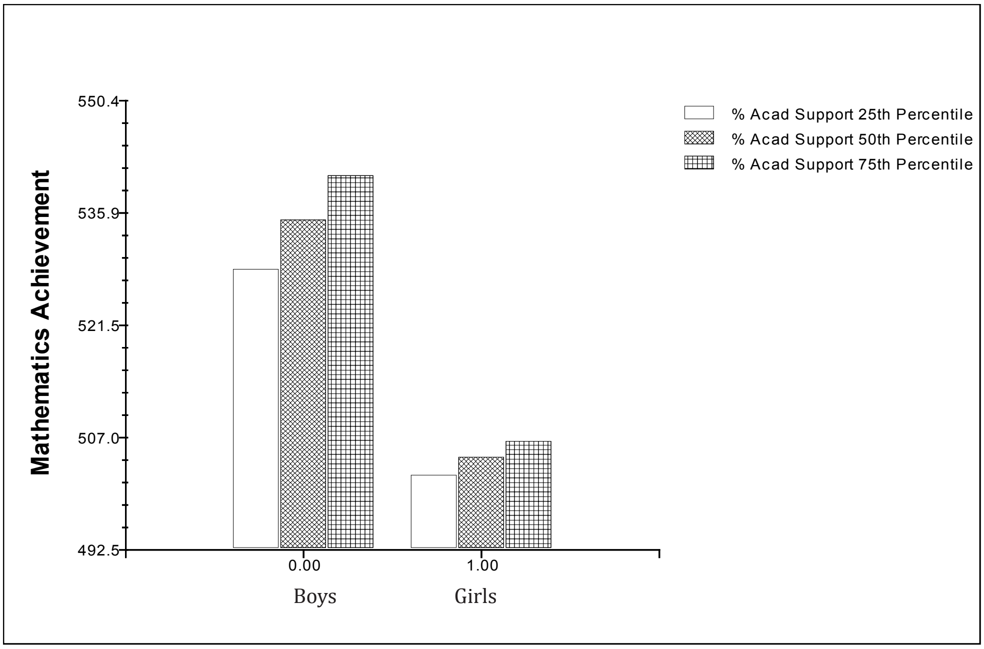

Figure 7: Academic support and the gender gap in mathematics achievement in Tanzania, 2000

The pattern persisted for resource effects in Uganda (see Figure 8). Whereas a greater availability of resources was linked to higher educational quality, the gender gap was also more apparent in resource-rich schools. Moreover, this gap widened most when comparing schools with low resources and schools with average resources (i.e., between the 25th and 50th percentiles), implying that it was in deprived areas that boys made the greatest gains from resources compared to girls.

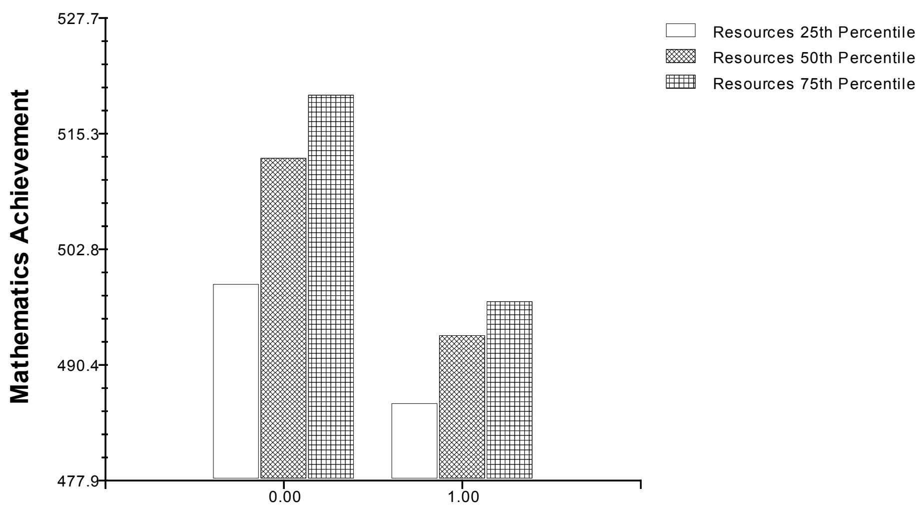

Figure 8: School resources and the gender gap in mathematics achievement in Uganda, 2000

CONCLUSION AND POLICY RECOMMENDATIONS

Whatever the national context, there are aggregate consequences when the potential of any group is not fully developed. Gender gaps favouring boys still remain in many African countries and women are still underrepresented in maths-intensive fields. This article first sought to identify the size of the gender gaps and then to explain what contributed to these gaps in East African primary education at the turn of the century. Results from this study showed that although statistically significant gender gaps in primary school mathematics existed, patterns were different both within and across countries. The gender gap was narrower in Uganda, and girls were relatively better off than boys in that country. This anomaly can be explained by higher re-enrolment among boys in Uganda after school fees were abolished. On average, Kenyan girls achieved higher mathematics test scores than both boys and girls in the other countries. Kenya had a stronger economy at the time of the study, and girls were better off socioeconomically than their peers in Tanzania and Uganda. Across the sample of female learners, Tanzanian girls who were enrolled in primary school received the greatest level of academic support.

A trend that was of great concern emerged regarding school characteristics and the gender gap in East Africa. For the school effects that were important, the general pattern was that characteristics of schools that raised academic achievement also tended to widen the gender gap. This is an important finding, because it raises questions about whether the climate of schooling is somehow tailored to serve male students. How this can occur is quite obvious in some ways. For example, it is known that gendered themes exist in many textbooks used in African schools. Even when gender-sensitive material and curricula are introduced, teachers need to be trained in how to use these resources effectively.

It is also recognised that gender differences in schooling may be related to social and cultural practices in some parts of sub-Saharan Africa. Early marriage is common in East Africa, and girls – particularly those living in rural areas – girls may be removed from school when they reach puberty or become pregnant (Biddlecom *et al*., 2008). Girls are also more likely to be tasked with caring for younger siblings than boys. However, the relationship between discriminatory practices and the gender gap in achievement is often confounded by poverty and geographical location. Remote rural settings that are steeped in poverty are perhaps more likely to subject girls to this treatment than thriving urban centres. Remote locations have fewer secondary schools available, making it more likely to view a girl's education as ending at primary school. It is hardly surprising, then, that the geographical location of the school proved to be important for the gender gap, because traditional practices are likely to be stronger in remote areas. In Tanzania, an urban location was associated with greater equity in achievement. Tanzania was the poorest of the three countries and was where the urban setting could have captured an added lifestyle advantage, as well as more progressive attitudes about girls in school.

In Kenya the gender composition of the school was found to be related to gender differences in achievement. Single-sex classrooms within co-ed schools have been proposed as a way to increase the safety of the school environment for girls. Equally important is integrating life skills education and sexual and reproductive health information into the mainstream curriculum. In addition, promoting early childhood care will mean that girls who frequently stay home to look after younger siblings will be afforded the opportunity to attend school more regularly. It remains to be seen whether such arrangements are feasible. Great care must be taken in interpreting the nature of these effects. The characteristics that were of interest were those that benefited girls without any compensatory loss to boys. In this case, no significant gains were made for girls, but instead the average achievement of boys fell as the concentration of females in the school increased. Therefore equity was achieved at the expense of an advantaged group, rather than through the gains of the other, which was not a sought-after outcome.

In an interesting discussion of trends in mathematics-based gender differences, Baker and LeTendre (2005) attributed successful efforts at narrowing gender gaps to the recognition of the economic value of a labour force that included women scientists. Following this reasoning, it would appear that as developing countries advance economically and demands for an educated workforce increase, educational opportunities will expand across gender lines. Even these researchers acknowledged that the pace of change will be influenced by cultural contingencies that are specific to different parts of the world. There is surely something to be said for the relationship between national indicators of progress and the quality of education, but ultimately a host of complex factors will drive gender differences in achievement in particular contexts. To have found that the school environment consistently reinforces gender biases across a geographical region is, in itself, an important contribution.

ACKNOWLEDGEMENT

The author is grateful for the editorial guidance provided by of Dr. Franklin Obeng-Odoom and the anonymous referees. Thanks go to the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) for access to their data archive. Any remaining errors in this study are the author's alone.

BIOGRAPHICAL NOTE

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APPENDIX 1

Final multilevel model of mathematics achievement in Kenya, Tanzania and Uganda (SACMEQ II)

	Kenya	**Tanzania**	**Uganda**
Intercept (average achievement)[a]	575.60***	536.24***	524.04***
Measures of school composition			
Average social background	11.73*	14.03**	23.18**
Percentage repetition	12.89**	-	-12.36*
Percentage female	-9.17*	-	-
Percentage academic support	10.69**	12.23**	-
Average age of Grade 6 students	-12.04*	1.69	-6.50
			-
Measures of school structure			
Class size	-7.32*	-5.52*	-
Urban school location	3.51	-20.65*	-38.08*
Sector	-5.45	N/A	-9.75
Measures of resources			
Physical resources	-	-	13.39*
Measures of school social organisation			
Community support for pupil meals	16.50*	-	-
Teacher behavioural problems	-	-5.46*	-
Teacher attendance problems	-10.25**	-	-
Gender achievement gap (a)	-23.17***	-33.07***	-18.94***
Measures of school composition			
Percentage female	11.55**	-	-
Average social background	-	-	-
Percentage academic support	-	-9.02**	-
	-	-	-
Measures of resources		-	-

Physical resources	-	-	-6.20~
	-	-	-
Measures of school structure	-	-	-
Urban school location	-	28.07****	-
Random effects	**Variance components**		
Variance in school mean achievement	1852.73***	1678.63***	5678.24F
Variance in the gender slope	648.02***	626.71***	417.36**
Level-1 error	4800.18	4675.03	4031.11

~ p < .10; * p < .05; ** p < .01; *** p < .001
a. In this table, dashed lines represent variables that were dropped due to non-significance.