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Gender Equity in Mathematics Achievement in East African Primary Schools: Context Counts

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Although primary school enrollment is gradually on the increase in the developing world, differences in mathematics achievement between girls and boys persist. A complex combination of factors that is related to issues of the home environment, the school context, and national policy influences the performance of female students when compared to their male peers. We focus on three countries in East Africa with a female disadvantage in mathematics achievement and use data from 8,795 primary school students in 529 schools. We explore the influence of contextual factors and organizational processes that are associated with better overall performance and with the improved gender distribution of achievement.

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Introduction

This study identifies conditions where the gender gap favoring boys in primary school mathematics in three African countries is most effectively narrowed. Research has consistently demonstrated that educating girls has a positive effect on various aspects of development (Caldwell, 1986; Curtis, Diamond, & McDonald, 1993; Hobcraft, McDonald, & Rutstein, 1985; Kishor, 2000; Kizito, 1998) but its progress has often been marred by misplaced notions about the wisdom of providing high quality education to girls. Although few would question that women played a prominent role in securing independence from colonial rule in East Africa, education opportunities for girls were not always forthcoming thereafter. Opposition to educational opportunities for girls has come in many forms and has cut across tribe and class. At issue were fears that formal schooling for girls would interfere with traditional norms and practices. For many girls in Africa who have chosen to pursue their educational ambitions, it has continued to be a lonely pursuit.

These concerns are not unique to East Africa. Gender discrepancies in schooling have long been a contentious issue in other parts of the world. Mathematics and science disciplines are traditionally dominated by men. Even in the most progressive societies some maintain that girls are mathematically inferior to boys, with more pronounced differences expected during adolescence. Girls who choose careers in these fields may find themselves facing acute challenges, even open hostility. Recent studies have suggested that expectations for students play an important role in how girls and boys perform in mathematics. Highly competent students fail to attain their potential if they are conditioned to believe that it is beyond social norms (Dweck, 1986; Fennema & Sherman, 1977, 1978). Often, at an early stage in a girl's academic career attitudes about mathematics are shaped. Thus, the study of gender equity in mathematics achievement in primary school levels is particularly relevant. Invariably, the school environment mirrors the society in which it is found. Understanding the interplay between external and internal forces has motivated this research. We argue that a child's educational domain can influence the gender gap -- the context of the school is especially important in determining the magnitude of gender differences within the school. We investigate the effects of primary school organization on gender equity and whether the nature of this influence remains after controlling for school context and the resource base of the school.

The countries we consider are Kenya, Tanzania and Uganda, motivated by their geographic proximity, their similar cultural backgrounds, and their close economic ties. More practically, the three represent a sample of countries where (a) boys consistently outperform girls in primary level mathematics and (b) where the gender gap in performance varies between schools in each country. Few international studies have examined the influence of organizational processes on the gender gap in achievement, especially in mathematics. In this paper we explore explanations of gender differences in educational outcomes in general and, in particular, the influence of the contextual and organizational processes of the school. Because the role of out-of-school factors in shaping attitudes of girls and boys toward this subject is so important, it is unsurprising that gender comparison across countries, even three countries with much in common, produces different explanations.

Literature Review

Over the last four decades, researchers have shown considerable interest in the gender–based achievement gap. Beginning with the pioneering work of Maccoby and Jacklin (1974) and closely followed by the Fennema-Sherman studies in the 1970s (Fennema & Sherman, 1977, 1978; Maccoby & Jacklin, 1974), a growing body of literature has explored the barriers and opportunities involved in the education of boys and girls (Alderman, Behrman, Ross, & Sabot, 1996; Baker & Jones, 1993; Felson & Trudeau, 1991; Friedman, 1989; Fuller, Hua, & Snyder, 1994; Hanna, 1989; Jimenez & Lockheed, 1989; Leder, 1982; V. E. Lee & Bryk, 1986; V. E. Lee & Lockheed, 1998; V. E. Lee, Marks, & Byrd, 1994; Mensch & Lloyd, 1998; Peterson & Fennema, 1985). In general the gender gap in educational achievement is narrowing over time; the extent of change mirrors the broader status of men and women in a given society (Baker & Jones, 1993; Friedman, 1989). Yet a study of education in Africa is incomplete without a discussion of student gender on educational outcomes, as differences in power and status between men and women in African countries has lagged behind more developed countries. Students spend the majority of their time living in a world where gender structures are strictly defined and these beliefs persist when they enter the school gates.

There has been a steady and universal move away from single-sex schools and toward co-educational learning environments. That co-educational schooling environments are on the increase is driven by questions of efficiency rather than effectiveness. For example, it eases the burden on parents if they have sons and daughters of school-going age who attend the same school. An environment that allows for regular interchange between girls and boys is also thought to benefit healthy social development. The majority of learners in this study are in their early teens, a time when young men and women are formally initiated into their differential social roles. In patriarchal systems such as those found in East Africa, a co-educational environment for girls who have reached puberty can be a source of anxiety for their families (Bendera, 1998; V. E. Lee & Lockheed, 1998). Some parents fear that educating their daughters will make them less obedient and that this will jeopardise the bride price that the family will receive upon their daughter’s marriage (Peasgood, Bendera, Abrahams, & Kisanga, 1997). Research on this topic provides empirical evidence that a longer enrolment period in school delays marriage and child bearing for young girls (Hobcraft, 2003). This study adds to this body of knowledge by focusing on mathematics achievement; an educational outcome where girls are traditionally disadvantaged and in a region where the male advantage in the gender gap persists between pupils and between schools.

The link between gender and educational support in the home is associated with gender-based tasks that hamper school preparation. If girls have more domestic chores at the beginning and the end of each day (such as walking long distances to collect water or firewood, cooking, cleaning, and taking care of the younger siblings and elderly family members), then they will have less time to complete homework and may even be forced to miss days of school in order to focus on domestic tasks (Gordon, Nkwe, & Graven, 1998; Peasgood et al., 1997). Although it is rarely discussed in the literature, in some communities the out-of-school responsibilities may actually be reversed. Fuller and colleagues (Fuller et al., 1994) argued that in Botswana, the pressure on boys to earn wages from an early age and to participate in such time-honoured traditions as looking after cattle meant that girls actually had more free time out of school. This is not the case in most countries, including those in this study.

Depending on its direction, the involvement of parents can either help or hinder the gender effect. Often a girl is viewed as a temporary resident in her parental home. In this case parents are reluctant to invest in her education, as the returns will be enjoyed by her husband's family (Kanogo, 2005; Kikampikaho & Kwesiga, 2002). There is some evidence that the importance of parental involvement on gender and achievement depends on the age of the child and diminishes as a child begins to demonstrate independence in school and life choices (Muller, 1998). In a Tanzanian study, negative parental attitudes about their daughters' inherent ability, strong cultural emphasis on the central role of marriage, and fears that educated women made poor marriage material all combined to create a poor self-image among female students, not only about their ability to achieve but also about the returns associated with educational achievement (Peasgood et al., 1997:51)

Expectations play a major role in how students measure their academic worth, even more so in a traditional context. If parents assume that boys are superior to girls in mathematics and if these ideas are echoed by teachers, girls lose confidence in their own abilities. Increasingly as they mature, they credit their success to external influences (perhaps a lenient teacher or an effective text book) and consider their failure a natural consequence of their academic limitations. For girls in this situation, there exist few opportunities for success because their accomplishments can never truly be linked to inherent aptitude. The social psychology literature on motivation has formalised the different gender-related attitudes toward mathematics that are transferred from parent and teacher to a student. According to Carol Dweck (1986), girls operate within an entity theory to mathematics. They believe that the ability to do mathematics is inherent and unchangeable and they are conditioned to think that they lack this innate aptitude. Boys, on the other hand, believe that skills in mathematics can be learned and improved through hard work. Treatment by teachers will reinforce these perceptions. If we follow this reasoning, student self-perceptions suggest that when boys under-perform it is because they are lazy or bored with their work, but when girls do the same it is because of limited ability. Therefore boys are encouraged to work harder whereas girls are advised to give up and face reality.

In the long run, biased socialization patterns also influence the courses that boys and girls select when options are available (Parsons, Kaczala, & Meece, 1982). According to this theory, because girls believe that they lack mathematical ability, they become performance-oriented and are driven by a desire to avoid criticism at all costs. Even when they do well consistently, female high achievers refuse to attribute their success to their intelligence or to develop confidence in their ability. Interestingly, Dweck (1986) observed that this tendency toward suppressed personal affirmation is especially common in exceptionally bright girls. In an effort to formalise the effect of expectations on the gender perceptions about mathematics and science, researchers have developed and tested several attitude scales (Adams, 1984; Fennema & Sherman, 1977; Keeves & Kotte, 1992). Although the emphases of these studies differ, the consistent message is that the attitude of girls and boys toward mathematics and science differs, that society and local culture influences these views, and that schools can play a role in changing or rectifying these attitudes.

In their role in children's social development, school administrators and teachers face a special responsibility to promote gender equity, often in opposition to prevailing beliefs --and at the same time to serve the needs of the local community who entrusts its children into their care. Within the classroom, there is evidence that more attention is given to male students and more difficult questions are directed at them (Jimenez & Lockheed, 1989; Mensch & Lloyd, 1998). This pattern may be due less to conscious sexism than with discipline issues where more energy is required to keep male students in check. Linn and Hyde (1989) have argued that the direction may actually be reversed. Boys' tendency to be more vocal about their academic concerns may evince more attention from teachers. Any aggression or restlessness may in fact be taken to mask intelligence, leading teachers to devote more time to such boys. Greater confidence among male students may also motivate them to approach 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 and colleagues (1994) characterised the positive and negative effect of gender and the secondary school classroom environment in a way that is equally appropriate for this study:

> Negative engenderment, or sexism, is manifested in gender reinforcement, embedded gender discrimination, sex-role stereotyping, gender domination, active gender discrimination, and explicit sexuality. Positive engenderment in this context is a conscious effort to provide equitable education for both sexes, including attempts to counter sexism and its residual effects. (p.98)

Peterson and Fennema (1985) explored the link between differential treatment in the classroom and how girls and boys approach their academic tasks. They concluded that the effect of classroom practices was far more nuanced than previously suspected. Not only the attitude of teachers, but also the organization of learning tended to favour boys. One striking example given was that widely used competitive approaches to learning favoured boys whereas girls thrived within a more co-operative framework (Peterson & Fennema, 1985).

The organization of schools has long been associated with effective and equitably distributed learning outcomes and we expect the same will hold true for the gender gap. School social organization captures the collective attitude of teachers in a school toward their pupils. Schools with teachers who take personal responsibility for the progress of their students and feel that they can directly influence pupil performance are considered more effective and more equitable (V. E. Lee, 2001). The climate of discipline is also an element of the social organization. Social organization also defines a school's community. Active community involvement suggests a supportive context for student well-being. Finally, social organization leans heavily on a school head's conscious efforts to involve teachers and to create a co-operative climate. Instructional organization (or authentic pedagogy) deals with the practicality that a teacher injects into teaching, such as applying lessons to every day life. Once again, authentic instruction is shown to be highly effective especially for disadvantaged learners (V. E. Lee, 2001).

There is conflicting evidence with regard to whether a teacher of the same sex provides a level of mentorship and improves learning prospects for female students, especially in developing countries. Female teachers can operate as role models and help motivate girls to perform better (Fuller et al., 1994; V. E. Lee & Lockheed, 1998). In some instances, however, female teachers may reinforce gender stereotypes. In their research, Mensch and Lloyd (1998) found that female teachers in Kenya actually preferred teaching boys and considered that maths was more important for boys than for girls. In Tanzania, Peasgood and colleagues (1997) reported that teachers had lower expectations about the potential of their female than male students and actually assigned domestic tasks to girls while they were at school. Of course the presence of female teachers may be confounded by school location, with obvious logistical barriers related to accommodation and security for women teaching in rural areas. Thus, competent female teachers may prefer to teach in urban schools unless they have family connections in a rural community (Peasgood et al., 1997; Warwick & Jatoi, 1994).

The peer effects related to gender composition of classrooms appear to work in opposite directions for girls and boys. Coeducational 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 may be conditioned to believe that they cannot cope. Yet girls achieve better results in all subjects (including maths and science) and have higher academic aspirations in a classroom environment that is predominantly female whereas boys appear to excel in a coeducational setting (Jimenez & Lockheed, 1989; V. E. Lee & Lockheed, 1998; V. E. Lee et al., 1994). Lee and Bryk (1986) suggested that single sex secondary educational environments in Catholic schools provided an opportunity for girls to explore their interests and to fulfil their potential without the added strain of society's expectations. Aside from sector, structural features of the school have also been associated with better learning outcomes. For example, the conclusion of research on class size is that smaller classes may provide a more supportive learning environment (Angrist & Lavy, 1999; Case & Deaton, 1999; Glass & Smith, 1978; Hedges & Greenwald, 1996; Hedges, Laine, & Greenwald, 1994; Krueger, 2003; J. Lee & Barro, 1997; Willms & Somers, 2001).

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-educational primary schools. Interestingly, Felson and Trudeau (1991) found that in some aspects of mathematical achievement, girls were able to outperform boys and that the investigation into why girls lag behind should focus on more specific areas of a curriculum.

The social and academic backgrounds of students play an important role in academic performance and are certainly linked to gender disparities. A high socioeconomic status represents opportunities for students to learn outside of the school environment whereas academically challenged students require special attention (Entwisle, Alexander, & Olson, 1997). There is widespread evidence that family background has a positive effect on attainment and achievement in developing countries, including those in Southern and East Africa (Buchmann, 2000; Case & Deaton, 1999; V. Lee, Zuze, & Ross, 2005). Some authors contend that poorer students attending wealthier schools are greatly advantaged with no compensatory loss for wealthier learners in the same school (V. E. Lee, 2001; Teddlie, Stringfield, & Reynolds, 2001). In her review of several international studies, Buchmann also noted that the importance of home background was especially pronounced in the earlier stages of schooling.

With expanding access to education systems, private tuition has become an increasingly important phenomenon to monitor. It is especially interesting because it bridges both the social and academic background of students. The influence of private tuition varies across countries. For the present purposes, it includes extra lessons in academic subjects that are provided outside of formal schooling arrangements (Bray, 2003). In the best case scenario, it can provide benefits for students to reinforce their knowledge and to increase their confidence in the subject matter. On the other extreme, underpaid teachers can use this mechanism as a means to hold the education system at ransom and may even withhold material from formal class time to ensure extra pay for extra lessons (Bray, 1999).

To what extent can the gender gap in performance be attributed to innate differences in the approach to this discipline? In their ground-breaking work into gender differences in achievement Maccoby and Jacklin (1974) asserted that differences between the sexes were present in many areas including quantitative subjects, verbal ability and spatial ability. Spatial ability in particular has captured the imagination of mathematics educators--it deals with the way in which geometric figures can be mentally manoeuvred in order to solve problems. It is speculated that the demonstrated disadvantage in spatial ability among female students largely explains their mathematical limitations. The work by Fennema and Sherman and later Fennema and Tartre effectively showed that this was only true for girls who were on the very low end of mathematics ability (Fennema & Sherman, 1977, 1978; Fennema & Tartre, 1985). In other words, spatial ability problems do not affect all girls uniformly. Gray (1996) would add that there is evidence from European countries where mathematics is part of a compulsory curriculum and where female participation is the norm rather than the exception. Women’s attainment of science based doctoral degrees in these countries is far beyond other developed countries.

According to Linn and Hyde (1989), there are differences in how girls and boys perceive the utility of mathematics. It is quite possible that the greater utility that boys associate with technical subjects is related to the number of men that they see applying these subjects to their professions (Fennema & Sherman, 1977, 1978). As more women reach high-status positions, what girls see as within the realm of possibility is likely to change. Yet to form part of this critical mass, girls first need to succeed in these subjects in school. It is hardly surprising then that one of the recommendations of the Fennema-Sherman studies was to encourage girls to enrol in advanced level mathematics courses. An endorsement for this hypothesis in the developing country context is found in Duncan’s study of science achievement in Botswana (Duncan, 1989). This work showed that girls and boys were affected differently by their learning environment and that gender stereotypes regarding female professionals coloured female students’ attitudes. In summary, there is a complex combination of factors that contribute to the gender gap in mathematics and the weight of different factors has much to do with the local context.

Conceptual Model

From the literature, we see that although in general terms the gender gap in mathematics is narrowing across time, it has by no means closed. In some parts of the world including East Africa, it remains an acute problem. It is clear that gender differences vary not only across countries but also across schools. These differences across schools, which we explore in this study, may be accounted for by many factors that include the belief systems of the students themselves, the attitudes of teachers within the schools, the context of the school and its organization. By understanding what combination of factors helps to achieve gender equity it will be easier to plan policy interventions. Even with the myriad of potential relationships in this conceptual illustration, our conceptual model concentrates on the manner in which factors can be grouped together generally for the analysis and how they relate to our research themes. We develop our conceptual model from the literature and to the specific research questions that we address.

Student Characteristics – Before we consider the criteria for evaluating school performance, we need to understand the characteristics of the students attending the school. Typically, a student's socioeconomic status and academic background have been the focus of attention because of consistent association with academic achievement. The socioeconomic status of a student represents the physical and human resources that are available to support learning. Students with a stronger support system at home are more likely to perform well at school. Similarly, a student with a stronger knowledge base approaches a subject with an academic advantage over other students. From a methodological perspective, appropriate measures of student social and academic background allow us to estimate the net role of the school in achievement and to avoid the common pitfall of entangling the influence of the two effects. We have already discussed extensively in the literature that differences related to gender and mathematics achievement are likely to favor boys.

School Composition – The gender composition of the school refers to the gender distribution of students and teachers and the gender of the school head. There is evidence to suggest that the attitudes of adults within the school will determine the ways that girls and boys are treated and the ease with which they can progress in mathematics. Peer effects are equally important because of the extent that gender roles are emphasized in the home differs and these students bring with them their unique socialization experiences. The implication is that the concentration of girls and boys will influence the performance of boys and girls differently. In short, we define the composition of the school as the manner in which the gender experiences of the people who operate within the school creates a climate that is conducive to narrowing the gender gap.

Another important compositional effect relates to the social background of students who attend a school. In their homes, students are exposed to different education resources to support learning and their parents will convey different attitudes about the value of education. Students from different social backgrounds therefore contribute their individual experiences to the school's social climate. It is worth mentioning here that although the peer effects related to gender are identified with the social composition of the school, other authors have classified average social economic status of students as an element of school resources (V. E. Lee & Bryk, 1989) because it reflects the social capital that is part of the school, regardless of the gender of the students within the school. We hypothesized that factors of composition that were associated with narrowing the gender gap (while improving mathematics performance of all learners) included high average socioeconomic status and a higher concentration of girls within the teaching environment. Faced with limited resources, parents are likely to invest in their sons rather than in their daughters; especially in traditional settings where educating daughters who will later marry into another family is considered pointless.

School Structure – Whereas the composition of the school refers to who attends the school, school structure describes the school in its most fundamental and perhaps its most basic terms, irrespective of the types of students within the school. Here, we focus on average class size, and the location of the school. We hypothesized that urban schools would provide more progressive learning environments with narrower gaps between girls and boys. Greater attention to teaching support would mean that smaller classes were a more conducive learning environment.

School Resources –We consider physical and human resources separately. Physical resources represent the facilities available in the school. Human resources are defined in terms of the experience of mathematics teachers, their professional and academic background and their competence in the material that they teach. The availability of learning resources has been associated with improved performance in developing settings because of the scarcity of resources for learning in the home.

School organization – We define school organization as the processes through which the school operates to educate its students. We focus on two areas of organization already described in the literature: school social organization and instructional organization. We anticipated that an ordered environment that was characterized by minimal attendance and behavioral disturbances and active teacher and community involvement would be more effective and equitable. The active participation of the community in the school's affairs would at the very least increase levels of accountability among staff and possibly ease certain burdens from school administrators.

The conceptual framework is displayed in Figure 1.

Insert Figure 1 about here

Based on this general framework, we address the following specific research questions:

a) *What is the magnitude of the gender gap in the 3 countries in Grade 6 mathematics?*
b) *What characteristics of students and schools are associated with average achievement in the 3 countries?*
c) *What characteristics of students and schools are associated with the gender gap in mathematics achievement in the 3 countries?*

Education in East Africa

There are a number of historical ties that bind the educational histories of Kenya, Tanzania and Uganda. They each formed part of the British East African Protectorate during the colonial era which meant that the education of Africans was directed by the same colonial policy. Because the system was designed to support the colonial cause, only basic literacy and agricultural training were emphasized before independence. Agriculture still dominates the economies of all three countries, employing the vast majority of the population. Religious affiliation is diverse. The practice of Islam remains across the region, especially in Tanzania, where 35 per cent of the population is Muslim. Kiswahili is spoken across East Africa, but is more popular in Tanzania and Kenya than it is in Uganda. Although post-independence governments steered the country in different directions, the results were often the same.

In Kenya, the early years of independence were characterized by economic prosperity and heavy investment in education. Significantly, during the 1960s and 1970s the Kenyan government adopted a 'New Primary Approach" to primary education that transformed the delivery of primary education. Qualified teacher trainers were hired, smaller classes created, and appropriate training materials were developed. The combined effect of rapid population growth, ethnic divisions and government corruption eroded these early gains. During the 1990s, the primary enrolment rate declined rapidly. The country has experienced a respectable economic rebound since 2000 and free primary education was introduced in 2003. One of the policy priorities of the current Education Sector Strategic Plan (2003-2007) is to increase the decentralization of school management to the district and community levels. The challenge of extending educational gains widely persists, especially given entrenched ethnic divisions. Early marriage for girls is still promoted in parts of the country. This is especially so in the predominantly Muslim North East.

In the wake of independence, Tanzania's socialist outlook (Ujamaa) emphasized rural development and self-reliance. For education, this meant a drive toward free primary education. Students were expected to remain in rural areas and to contribute to its development. With time, the strain of supporting an ever expanding education system began to take its toll. Tanzania was not spared from the international economic decline of the 1980s and this was compounded by the costs of a 1978-79 war with Uganda. The solution offered by the international community involved cost sharing and primary school enrolment plummeted in the 1990s. Female participation rates were severely affected at this time, particularly at the secondary school level (Buchert, 1994). The decline in real incomes and the widespread perceptions about low returns to education encouraged many parents to force their children into the labor market (IMF, 2006). It also served as an indirect incentive for parents to marry off their daughters early in order to claim the bride-price in return (Mlama, 2000). Tanzania remains one of the poorest countries in the world with the majority of the population heavily dependent on agriculture. Like her neighbors, in Tanzania the recent introduction of free primary education (in 2001) resulted in an upsurge in enrollment.

A series of internal and external shocks have led to severe setbacks in the progress of educational development in Uganda. These challenges have included political instability under the dictatorial regime of Idi Amin, fluctuating coffee prices, mounting debt and the war with Tanzania between 1978 and 1979. More recently, Uganda's involvement in regional conflicts (especially in the Congo) has been a major obstacle to progress. In spite of falling coffee prices, which is one of Uganda's main exports, and a devastating HIV prevalence, the country has made notable economic advances in the last decade and there has been substantial development of the country's infrastructure. In the late 1980s the Ugandan government introduced a series of fresh education innovations. Uganda was also the first of the three countries to introduce Universal Primary Education (UPE) in 1997 and the only one of the three to have free primary education in place at the time that data for this study were collected.

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 emerged to improve access and quality of primary education. Students attend seven years of primary school in Tanzania and Uganda and eight years of primary school in Kenya.

Methodology

The study draws upon a unique set of data collected by the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) in its second wave. The SACMEQ consortium consists of fourteen countries in Eastern and Southern Africa. SACMEQ II data were collected in 2000. The desired target population for the SACMEQ surveys consisted of all Grade 6 pupils who were attending either government or non-government schools. The decision to select Grade 6 pupils was motivated by three factors. First, this grade represented a point within the primary school cycle where enrolment ratios were still high but that was close enough to the end of primary school to estimate the cumulative effects of this period of education. Second, the Grade 6 level allowed sufficient time to lapse between the early grades of teaching in local languages in most SACMEQ countries and the switch to instruction in the official national language[1]. In many countries, the use of an earlier grade level would essentially capture the effects of this transition process. Finally, Grade 6 learners were considered mature enough to provide the type of information about home background that is required for statistical measures of socioeconomic status. This would not necessarily be the case with a younger sample (Ross et al., 2005).

The national sampling frames were based on information from each country's Ministry of Education. Stratification at the regional level was followed by the selection of schools with probability proportional to size (PPS). A simple random sample of 20 Grade 6 pupils from each school was chosen from across all Grade 6 classes in the school. The entire sample for SACMEQ II was 41,686 pupils from 14 countries in 2,305 schools. The samples for the three countries in this study totalled 8,792 students in 529 schools. The targeted response rate for SACMEQ II was 80 per cent for pupils within schools. In general, this response rate was achieved, although Tanzania fell slightly short with their pupil response rate of 77 per cent. Pupil response rates for Kenya and Uganda were 89 and 81 per cent respectively.

Measures

A detailed description of how all of the variables in the analysis were constructed can be found in Appendix 1. In this section we present our rationale for variable construction using the SACMEQ dataset. The goal of the student mathematics test was to assess as practically as possible how well students understood different dimensions of mathematics. Specifically, the definition of mathematics literacy was "the capacity to understand and apply mathematical procedures and make related judgements as an individual and as a member of the wider society" (Ross et al., 2005). It was designed by SACMEQ country representatives and based on national curricula as well as existing domains from the International Association for the Evaluation of Educational Achievement (IEA). These domains were modified to correspond with what was actually being taught in SACMEQ schools. Three domains were derived from this exercise: number, measurement, and space-data (a combination of the geometry and space domains in the IEA framework). One other domain (algebra) was dropped because it did not apply to the Grade 6 level in SACMEQ.

Variables Describing Students

The outcome variable was a continuously distributed measure of student Grade 6 mathematics achievement. This variable was equated using Item Response Theory (IRT) and standardised to a mean (M) of 500 for all SACMEQ countries and a SD of 100. An IRT equated measure of student socioeconomic status (SES) was also included[2]. Although on the original dataset, it was standardized to the same metric as the outcome variable, like all continuous predictors in our analysis, we made use of a z-scored (M=0, SD=1) format within each country. An indicator of student gender was coded ‘1’ for females and ‘0’ for males. Whether students had access to extra lessons was coded ‘1’ if extra mathematics courses were taken and ‘0’ otherwise. A proxy measure of students’ academic performance was his or her repetition history, coded ‘0’ if the student had never repeated a grade and as ‘1’ if the students had repeated a grade at least once.

Variables Describing Schools

Measures of School Composition

The social class climate of the school was a standardized measure of the average socioeconomic status of the Grade 6 students within the school (M=0, SD=1). Similarly, we represented the concentration of female students in Grade 6 and the prevalence of extra lessons through standardized measures based on the sample (M=0, SD=1).

Measures of School Structure

We used information from the mathematics teacher questionnaire to estimate the average size of Grade 6 mathematics class and standardized it (M=0, SD=1). The location of the school was categorized as ‘1’ for schools in large towns or cities and ‘0’ for all other school locations

Measures of Human and Material Resources

An IRT equated measure of school physical resources consisted of information on the type of school facilities that were available[3]. It was standardized for the purposes of our analysis. Schools with more physical resources were thought to have an advantage in terms of achievement and equity. We also considered other estimates of resources, such as teacher quality. However these constructs were unrelated to either school average mathematics achievement or the gender gap and were subsequently dropped.

Measures of School Social Organization

We based our proxies for school social organization on community involvement in school affairs, student and teacher absenteeism and the disciplinary climate within the school. We based community variables on the school head report of community help in maintaining the school's resources and their contribution to paying staff. Community support was further explored through a dummy variable for the assistance that the local community provided in preparing student meals. We developed separate constructs to measure disciplinary issues of pupils and teachers. Composite variables for attendance problems contained information about unjustified absence. Both were reported by the principal and both were standardized (M=0, SD=1). Variables for pupil and teacher behavioral problems were based on the principal's reports about intimidation, sexual harassment, and drug abuse.

Measures of School Instructional Organization

We included a single measure of instructional organization, a dummy-coded indicator of whether mathematics teachers tested their Grade 6 students at least once a week (1=yes, 0=no. We considered our measure of whether teachers regularly tested their students to be an indicator of positive instructional organization.

Analytic Method

A multistage sampling procedure guided the collection of SACMEQ data. Whereas the outcome of interest was measured at the individual level, many of the relevant predictors referred to the school level. Multilevel analysis addresses this incompatibility and is the appropriate methodology for the analysis of the data with this structure. In recent decades, progress has been made in developing software and formalized techniques to estimate multilevel models. Several studies have shown the importance of multilevel analysis in educational research in various settings (Fuller et al., 1994; Hox, 2002; V. E. Lee & Bryk, 1989; V. E. Lee & Smith, 1995; V. E. Lee, Smith, & Croninger, 1997; Luke, 2004; S. Raudenbush & Bryk, 1986; S. W. Raudenbush & Bryk, 2002; Snijders & Bosker, 1999). We used Hierarchical Linear Modelling (HLM) software (S. Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2004) for our multilevel analyses in this paper.

Our analysis was conducted in three stages. The first stage was designed to establish 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, we could 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 mean achievement measure. The 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 for Kenya.

In the second step we 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 our target measure. We also investigated the role that student SES, extra lessons, and grade repetition played on mathematics achievement, by including these measures to adjust the gender gap for them. By including these factors in the model, we created student controls. In addition, by allowing the gender gap to vary for each school we determined whether there was a unique school effect that should be pursued later. Because we were interested in gender differences between schools, we centered the gender variable on its school mean and allowed this slope to vary across schools. In this way, the model for school effects was designed to target the influence of school factors on quality (estimated by effect size on the intercept) and on equity (as shown through the impact on the gender gap). The remaining slopes were fixed and centered on the population mean.

Our central aim in this paper was to identify the school-level predictors that promoted gender equity (i.e. that reduce the gender gap) and were simultaneously associated with average mathematics achievement. We carried out separate multilevel analyses of each country's data. We added groups of school variables sequentially with more fixed compositional factors preceding the inclusion of resource related and organization variables. Variables that dealt with the organization of schools and classes were the last to be included. We only retained variables that showed significant results in at least one of the countries. In the final step of model building, the models were re-run with only the factors that were significant in each individual country.

Results

In Table 1, we present characteristics of students in the three study areas. In all countries, average mathematics achievement is above the SACMEQ mean of 500 meaning that for the region as a whole, the performance of these three countries is quite favorable. In contrast, the average wealth status differs considerably within countries. SES is higher for girls in Kenya and Uganda but lower for Tanzanian girls. There is a degree of similarity across the countries in terms of student academic background. A few results do stand out as unique. Grade repetition in Tanzania is less widespread than in either Kenya or Uganda and extra lessons are more common in Kenya.

It is interesting to compare the mathematics scores by gender across countries. If we were to compare performance of students based on country and gender, it is quite apparent that the mean score for Kenyan girls is higher than the mean score for all Tanzanian and Ugandan students, irrespective of gender. In fact, there is a considerable gap between all Kenyan students and Tanzanian boys on the one hand and Ugandan students and Tanzanian girls on the other. It is certainly not the case that girls are uniformly at the lower end of the achievement spectrum. The extent of gender differences is quite variable, with a very small gender gap for Uganda for the sample as a whole and a much wider gap in Tanzania especially, where the gap in mathematics achievement is in excess of 30 points.

The characteristics of schools shown in Table 2 follow similar pattern to the school data. The average school socioeconomic status and the school resource base are highest in Kenya and lowest in Tanzania. The majority of schools situated outside large urban centers. In Uganda, virtually all schools are situated in either small towns or rural areas. The average Grade 6 mathematics class size falls within quite a narrow range across countries with the largest classes in Tanzania. Community support varies considerably across countries. In Uganda, for example, the percentage of communities that provide support to pupil feeding programs is more than twice what is found in other countries. When it comes to support for building and maintaining school facilities and for remunerating staff, this is fairly rare in Uganda and quite widespread in Kenya. Turning to issues of school discipline, attendance seems to be a widespread concern and poor behavior among teachers stands out in Uganda especially. The pedagogical practices associated with social organizations are very similar across countries with about one third of teachers test their pupils at least on a weekly basis.

We show the psychometric properties of the three study areas in Table 3. The intraclass correlation (ICC) can be best described as a measure of the distribution of inequality between schools. The higher the ICC the larger the differences in achievement scores between schools. Based on established standards (Hox, 2002; S. W. Raudenbush & Bryk, 2002; Snijders & Bosker, 1999) the ICCs found here are sufficiently large to warrant the use of a multilevel model. There appear to be vast differences 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, may be a consequence of sudden expansion of the education system two years before these data were collected. It is quite likely that students who entered school after Universal Primary Education (UPE) was introduced in 1998 poured into certain schools and not others. Such a pattern would explain the large heterogeneity between schools in maths achievement. Unfortunately, since Uganda did not take part in SACMEQ I, it is impossible to compare this ICC to the period before free primary education was introduced.

In Table 5, we present the results of the within-school model. This model addresses the first research question into the influence of student social and academic background on mathematics achievement. Four variables are used to capture the nature of this effect: student gender, grade repetition history, extra lessons in mathematics and student socioeconomic status. The adjusted scores across all countries are still above the SACMEQ mean of 500 but performance in Uganda and Tanzania lags behind Kenya. Interestingly, the influence of student social and academic background is greatest in Tanzania. This should come as no surprise given that, compared to Kenya and Uganda, Tanzania has a smaller ICC and therefore a greater concentration of variation between students within schools. The behavior of variables across countries is predictable and consistent. Both student socioeconomic status and extra tuition raise mathematics achievement, whereas gender (female) and grade repetition reduce the mean outcome. The influence of extra lessons on achievement in Kenya is weak, probably because of its universality. However, owing to its theoretical importance and for ease of comparison with other countries, it was retained in the analysis.

Not only is there a male advantage in mathematics achievement, but as shown in the bottom of Table 5, the gender gap also varies significantly between schools in each country. 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 our school effects model. Clearly, larger between-school variation will make it easier to isolate significant school effects. The gender gap is three times as large between Tanzanian schools compared to Kenyan schools. The situation is somewhat reversed for gaps in average achievement, with larger gaps for Uganda and Kenya and smaller differences for Tanzania. Therefore although we see that issues of quality and inequality are important in all three places, questions of quality are paramount in Kenya and Uganda, whereas gender equity concerns are relatively greater in Tanzania.

Predictably, the within-school model has explained some of the within school variation (8 per cent for Kenya, 16 per cent for Tanzania and 7 per cent for Uganda). What’s more, the within-school model has addressed the first research question by confirming the importance of student social and academic background in influencing educational achievement. It has also shown that the pattern of effects is consistent across all three countries and that the influence of student characteristics is strongest in Tanzania, which is the most impoverished of the three countries.

Results of the HLM Analysis

The results of the HLM analysis are reported in Table 5. Our purpose here was to identify school factors that raised achievement levels of all learners and narrowed the gender gap in mathematics achievement between girls and boys. The decision behind the selection of countries was twofold. First, they represent a group of countries with some natural linkages, meaning that it would make sense to draw policy lessons about where one country was making advances. Second, all three have significant gender gaps that favor boys over girls. Ideally the desired combination of school effects that we sought would be represented by variables that are significant and positively related to mathematics achievement. Because the coefficient was coded ‘1’ for female and was negative across all countries, narrowing the gender gap would also be reflected by positive coefficients for school factors that are modeled on the gender slope.

Earlier, we discussed how our model building strategy needed to accommodate our dual objectives of comparing results across countries while examining the unique combination of factors at play in individual countries. Therefore in the preliminary stage of our analysis, we retained variables if they achieved at least a 0.10 level of significance in one of the three countries. Despite our best efforts to explore the same issue with the same analytic models in three countries that share a number of characteristics, we soon found that the school effects driving gender equity were unique for each country. Therefore in our final model, we removed any variables that were insignificant within each country, thus creating unique final models for each. We begin by discussing gender effects for each individual country before making school effects comparisons and drawing together the broader policy implications of these results.

School Effects and the Gender Gap

In spite of the clear similarities that unite these countries, we failed to find a common thread that tied school effects to the gender gap. Moreover, although the pattern of gender differences was the same, the magnitude of the gender gap was quite different in each country. In Tanzania, the male gender advantage was twice what it was in either Kenya or Uganda. It is in Tanzania where the gender gap favoring males was significantly less in urban schools than in rural schools. The gender gap was also less pronounced in wealthier schools (i.e. with higher average SES). In Uganda, what seemed to be associated with a narrower gender gap was a higher proportion of girls in school. The relationship between an increased gender gap and teacher behavioral problems was also exclusive to Uganda. Unlike the other two countries, we found no school effects that were associated with gender equality for Kenya.

School Effects and Average Mathematics Achievement

Across countries, there was a positive and significant relationship between higher achievement in mathematics and the social class climate of the school. In Kenya, active community involvement, regular student and teacher attendance, and smaller classes were also beneficial. Beyond average SES, it was only teacher behavior was related to educational quality in Tanzania. Schools with low levels of teacher behavioral problems achieved better mathematics results. Of the three countries considered here, it is in Uganda that the relationship between mathematics achievement and contextual factors was the strongest. Schools with fewer repeaters actually fared better, as did schools situated in rural areas and small towns (a likely reflection of areas that though isolated, maintain a level of economic productivity).

The question of how to support academically weak students is an important one. At the student level, we have already discussed how students who have a repetition history have significantly weaker results in mathematics in all three countries. Could repetition be the cause rather than the consequence of poor achievement? After all, the direction of causality is difficult to confirm without longitudinal data. What is quite clear is that in Uganda, over and above the effect on individual students, there was a strong association between schools with a large number of repeaters and overall poor academic performance. In short, repetition was unsuccessful in helping weak students do better. Table 5 also shows that the variance explained by the final model differed from country to country. Generally, the model was more successful in explaining variance in achievement (ranging from 17 per cent in Tanzania to 33 per cent in Kenya) than in explaining the gender gap (only 4 per cent in Kenya, 10 per cent in Tanzania and 17 per cent in Uganda).

Discussion

Our purpose in conducting this study was to try to isolate the characteristics of schools that explained why gender gaps in mathematics achievement were still unacceptably wide among East African primary schools. Many of the results found remind us of the importance of local context in improving gender equity. The nature of the gender differences in mathematics has also been found to fluctuate across countries in the developed world with comparable economic backgrounds, as well as other parts of the developing world, such as Latin America. Koblitz (Koblitz, 1996) has pointed out that the proportion of female mathematicians in the United Kingdom and Northern Europe is vastly different to the United States, Southern, and Eastern

Europe. This is a reminder that this phenomenon is not unique to the developing world. Nor is it confined to a period of time because the gender gap has been found to widen and narrow within the same country during different periods. At the student level we found that the student body was broadly similar in terms of their social and academic background but our results about the influence of the school on the gender gap were less consistent. In fact we were unable to find any school characteristics that were associated with the gender gap in Kenya. Structural and compositional features of the school appeared to impact on the gender gap in Tanzania and Uganda but the actual factors themselves were quite different, social class climate in Tanzania and the gender composition of the school in Uganda. This result from Uganda reinforces the widely used socialization argument for why girls are less competitive than boys in mathematics and science subjects and (Jimenez & Lockheed, 1989; V. E. Lee & Lockheed, 1998; V. E. Lee, Marks, & Byrd, 1994).

That the gender gap in mathematics was widest in Tanzania may be linked to stronger Islamic traditions there, where early marriage is not uncommon and where girls are removed from school when they reach puberty because parents fear that they may become pregnant. It is hardly surprising then that the location of the school was so important for the gender gap because traditional practices are likely to be stronger in remote areas. Tanzania is also the poorest of the three countries and the urban setting could be capturing an added lifestyle advantage, as well as more progressive attitudes about girls in school. The average social background of students in Tanzania was the only school effect in the entire study that we identified as raising quality while simultaneously narrowing the gender gap. Children in higher SES schools had higher mathematics achievement in Tanzania and the gap between boys and girls was narrower in these schools. Although noteworthy, there is a limit to the policy interventions that can be extracted from such a finding.

We found some evidence of negative effects on academic achievement that were related to attendance and behavioral problems in all countries and positive effects associated with community inputs. This association between attendance and behavioral problems and lower achievement in Kenya supports existing literature related to absenteeism and poor educational performance in East Africa (Chapman, 1994; Hungi, 2005). The implication is that structured interactions between role players at the local level can be quite effective. All the countries in this study have taken steps toward decentralizing their educational systems and placing more authority in the hands of local and district administrators. Therefore such findings are quite encouraging.

Improving attendance and school discipline requires the co-operation not only of students, teachers and school leadership, but of parents and the wider community where the school is situated. Problems of drug and alcohol abuse are often community based and require community solutions if they are to be kept out of schools (Entwisle et al., 1997). Lee and colleagues have discussed how targeted conditional transfers have been used effectively in Brazil to improve attendance among poor learners (V. E. Lee, Franco, & Albernaz, 2004). Similar incentives for teachers would surely be worthy of consideration, especially as teaching loads increase with the Education for All (EFA) drive. Behavioral disturbances are closely linked with wider issues of discipline and once again require school leadership to interface tactfully with parents – not often a practical or culturally acceptable exercise. This research adds to the body of literature on the importance of smaller classes (Case & Deaton, 1999; Krueger, 2003; V. Lee et al., 2005; Murnane & Levy, 1996). In Kenya, class size stands out among the contextual effects related to academic achievement. Smaller classes are beneficial for all students, regardless of gender, academic background or social status. With mounting pressure on the school system from increasing primary school enrolment, this is among the factors that are the easiest to compromise.

Can the way teachers organize learning actually make a difference? Our evidence from Kenya shows that those teachers who test their students regularly are more effective. The success of this method of organizing learning suggests a level of involvement and commitment among teachers that makes learning of mathematics more successful. It also points to wider organizational support within the school that has been associated with improved learning outcomes in other leading research (V. E. Lee, 2001).

In any cross-national analysis, consistency in the measures used to represent the different school effects is important. In our study, a number of our key measures (the mathematics outcome, the measure of SES) were IRT equated to a SACMEQ mean and standard deviation. This made it possible to make very precise comparisons across countries. Other variables that represented school organization were based on responses to questions from the school head and teacher questionnaire. One limitation of the data was that there were no questions about student attitudes toward mathematics. We attempted to capture this effect indirectly through teacher attitudes toward their students' learning. We based this on evidence that the organization of learning may favor boys and shape attitudes of both boys and girls toward a subject (Peterson & Fennema, 1985) but this proved to be ineffective. A valuable addition to future study design would be the inclusion of questions about student attitudes toward their subject matter so that existing attitude scales (Adams, 1984; Fennema & Sherman, 1977; Keeves & Kotte, 1992) can be developed and tested.

Future Role of Cross-National Research

The origins of cross-national comparisons of educational quality can be traced back to the 1950s when the International Association for the Evaluation of Education Achievement (IEA) was established by a group of eminent educational researchers who reasoned that because educational policies were unique to each country, the systematic study of their quality across countries would provide an excellent opportunity to determine best practices. Initially, interest in this initiative was limited, mainly because it was restricted to a selective group of academics with a specialized interest in a quantitative approach to comparative research (Ross, Paviot, & Genevois, 2006). In recent years, the educational push from international agencies, national governments and the general public has increased the popularity of such surveys.

The shift toward making comparative surveys as relevant as possible has been strongly recommended by researchers involved in cross-national studies. In their interesting discussion of educational quality in different settings, Heyneman and Loxely (Heyneman & Loxley, 1983) cautioned against extrapolating findings from developed to developing countries. Fuller and Clarke also questioned any attempt at generalizing results about how to perfect education systems based on narrowly focused studies. In conducting this study, one of the questions we posed was: to what extent can comparisons be made across a group of countries that actually shared much in common? It proved difficult to establish findings related to educational quality that were global although effects in individual countries were often quite strong. We were even less successful in drawing broad conclusions about narrowing the gender gap in different settings, although where they materialized, factors related to context were the most important. This is due in part at least to the importance of local conditions. However, given a more detailed survey of student attitudes toward their subject matter, it is quite possible that we would find more results to compare.

The SACMEQ study, like many cross-national surveys (PISA and TIMMS are two examples), is cross-sectional in design. The absence of longitudinal data in such studies places serious constraints on the interpretation of the outcome variable and may limit comparison. How serious a concern is the absence of longitudinal data and what then is the value of a cross-national research design? The absence of a measure of prior achievement makes it difficult to capture what the student actually learns while exposed to a particular school's environment. Without adjustments for prior aptitude, it is impossible to make any conclusions about the direction of causality between school effects and educational outcomes. Even if pre-tests are included, it has been argued that a certain level of bias will remain because teachers will always adjust their teaching approach to suit the aptitude level of the student (S. W. Raudenbush & Bryk, 2002). Raudenbush and Kim have suggested that one possible alternative would be to use cross-national surveys to determine *possible* causal explanations that can then be verified in experimental trials. Of course, the methodological precision of any new survey design must be weighed up against the obvious cost and administrative complexity that it will involve, especially in developing countries where resources are limited. The important point here is not to completely discount the value of cross-national surveys, but rather to encourage researchers to tread carefully and to make substantive interpretations about the analysis of the data that take cognizance of data limitations.

Summary

Our aim in this study was to establish systematic cross-national patterns of school effects in a region that was considered similar enough to warrant reasonable comparison. And yet, the pattern of school effects on both the gender gap and on average mathematics achievement was quite inconsistent. There are two possible reasons for these results. Either the variables had different meaning in different countries (even though there was considerable local input in the survey process), or the organizational structures of the schools in the three countries are quite different. The implication of the second possibility is that the scope for future cross-national research must be seriously re-evaluated. At such a critical developmental stage in students' educational and social lives, we found that girls are scoring significantly below their male counterparts, even after taking into account the differences in family background, repetition history, and whether they have availed themselves of extra lessons in mathematics outside of school hours. This remains an important policy issue but unfortunately, our analyses have revealed that school-by-school differences in composition, structure, or organization don’t seem to explain the reason for this serious disadvantage.

Figure 1: Conceptual Framework

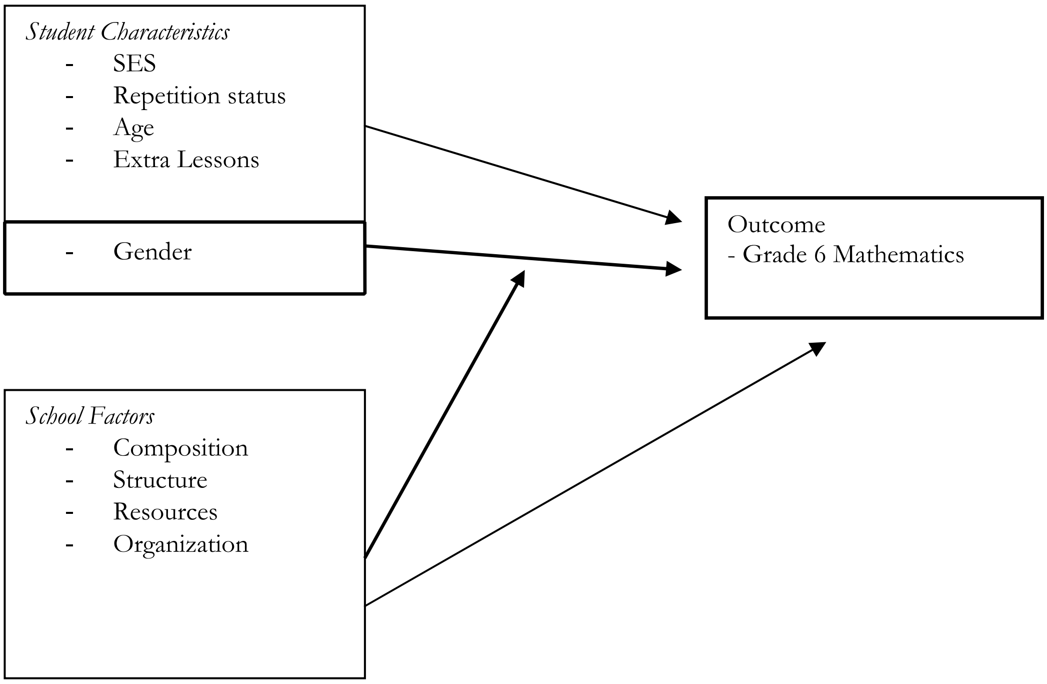

Table 1: Academic and Social Background Characteristics of Grade 6 Students in East African Countries

	Kenya	**Tanzania**	**Uganda**
Student Sample Size[a]	3299	2854	2642
Mathematics Achievement	563	522	506
Score vs. SACMEQ 500 Mean, 100 *SD*	0.63	0.22	0.06
Female	0.50	0.52	0.45
Socioeconomic Status	470.21	449.96	440.83
Score vs. SACMEQ 500 Mean, 100 *SD*	-0.30	-0.50	-0.59
Extra Maths Lessons	0.60	0.58	0.46
Grade Repetition	0.64	0.23	0.53
Net Primary Enrolment in Education [b]	86.5	58.8	89[c]

a. Whereas the table above shows unweighted sample sizes, the SACMEQ pupil weight is used in calculating other estimates.
b. Data Source: Onsomu, E., J. Nzomo, et al. (2005). The SACMEQ II Project in Kenya: A Study of the Conditions of Schooling and the Quality of Education. Harare, Nairobi, SACMEQ, MOEST.
c. The reported Net Enrollment figure that appears in the SACMEQ II Project report was 110.7. The figure exceeded 100 due to errors in the census age based estimates for that year and was later corrected to 89 per cent.

Table 1: Gender Differences in Achievement of Grade 6 Students in East African Countries

	Kenya			Tanzania			Uganda		
	M	**F**	**Total[b]**	**M**	**F**	**Total[b]**	**M**	**F**	**Total[b]**
Sample Proportion[a]	1695	1604	3299	1378	1476	2854	1483	1159	2642
Mathematics Achievement	574	552	563	540	507	522	508	504	506
SES[d]	0.28	0.34	0.31	-0.18	-0.22	-0.20	-0.26	-0.04	-0.16
Proportion Extra Lessons	0.60	0.61	0.60	0.58	0.58	058	0.46	0.45	0.46
Proportion Grade Repetition	0.65	0.63	0.64	0.23	0.23	0.23	0.52	0.54	0.53

a. Unweighted sample size.
b. Estimates for the total sample (male and female combined).
c. Significant difference between boys and girls at $p<0.001$.
d. In this table, the SES variable is in a standardized (z-score) metric, mean (M)=0, standard deviation (SD)=1 across countries.

Table 2: Characteristics of Schools in East African Countries

	Kenya	Tanzania	Uganda
School Sample Size[a]	185	181	163
Average SES[b]	0.40	-0.23	-0.20
Percentage Extra Lessons	61	62	50
Percentage Urban Location	10	20	3
Percentage Female	50	54	46
Average Class Size	37	44	38
Community Support for Pupil Meals	18	16	43
Student Attendance Problems[b]	-0.48	0.31	0.20
Teacher Behavioral Problems[b]	-0.23	-0.08	0.35
Community Support for School Resources[b]	0.76	-0.01	-0.85
Community Support for Staff Pay[b]	0.59	-0.43	-0.19
Teacher Testing Policy[c]	32	39	35

a. Unweighted sample size.
b. In this table, these variables are standardized (z-score) metric, mean (M)=0, standard deviation (SD)=1 across countries.
c. Percentage Grade 6 mathematics teachers testing students at least once per week.

Table 3: Psychometric Properties of Achievement in Kenya, Tanzania and Uganda

	Kenya	Tanzania	Uganda
Average Within-School Size	17.81	15.74	16.07
Total Variance Within Schools (sigma-squared)	4690.39	5045.17	3661.92
Total Variance Between Schools (tau)	2936.84	1919.48	8273.96
Intraclass Correlation (ICC) (a)	0.35	0.28	0.69
Reliability (lambda)	0.91	0.83	0.97

a. ICC = tau/(tau + sigma-squared)

Table 4: Level-1 HLM Models for Mathematics Achievement in Kenya, Tanzania and Uganda

	Kenya	Tanzania	Uganda
Fixed Effect			
Intercept	565.16***	518.38***	508.75***
Socioeconomic Status	14.58***	16.61***	5.17~
Female	-21.81***	-33.97***	-13.48**
Extra Maths Lessons	4.84	19.59***	7.88~
Grade Repetition	-18.59***	-24.12***	-12.68**
Random Effects			
Mean Achievement	2412.73***	1272.36***	7902.65***
Student Gender	454.55***	1018.13***	580.73***
Rij	4349.41	4349.46	3469.60
Reliability of OLS Regression-Coefficient Estimates			
Mean Achievement	0.91	0.77	0.96
Student Gender	0.30	0.42	0.32

Table 5: Final Level-2 HLM Model for Mathematics Achievement in Kenya, Tanzania, and Uganda

	Kenya	Tanzania	Uganda
Intercept (Average Achievement)	559.13***	516.98***	512.56***
Measures of School Composition			
Average Social Background	22.04***	14.28**	31.49**
Percentage Repetition	-	-	-16.30*
Measures of School Structure			
Class Size	-9.80**	-	-
Urban School Location	-	-	-57.76*
Measures of School Social Organization			
Community Support for Pupil Meals	17.06*	-	-
Student Attendance Problems	-7.37~	-	-
Teacher Behavioral Problems	-	-7.58**	-
Community Support for School Resources	-	-	26.67*
Teacher Attendance Problems	-14.37***	-	-
Measures of School Instructional Organization			
Teacher Testing Policy	13.99~	-	-
Gender Achievement Gap (a)	-21.25***	-37.70***	-14.62***
Measures of School Composition	-	-	-
Percentage Female	-	-	10.21*
Average Social Background		14.28***	-
Measures of School Structure			
Urban School Location	-	30.41*	-
Measures of School Social Organization		-	-
Teacher Behavioral Problems	-	-	-6.79*
Extra Lessons/Achievement Gap (a)	5.09	18.58***	7.94*
Repetition Achievement Gap (a)	-18.25***	-22.91***	-11.66**
SES/Achievement Slope (a)	11.29***	12.17***	3.74

Random Effects	**Variance Components**		
Intercept, $\mu 0j$	1,616.69***	808.74***	6,459.03***
Gender slope, $\mu 1j$	435.81***	341.25***	505.79***
Level-1 error, rij ($\sigma 2$)	4,352.15***	4,593.70	3,542.64

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

a. Only the gender achievement slope was allowed to vary between schools and was centered on each school's respective school mean.

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Appendix 1: Description of Variables Used in the Multilevel Analysis

In this appendix, we present additional details about the variables that were used in the HLM analysis. In addition to a description of each student and school-level variable, we also indicate the name of the variable as it appears on the original SACMEQ dataset in parentheses [ ].

Student-level Variables

Mathematics Achievement: A mathematics test score for Grade 6 students. . The test consisted of 63 questions in total of which 27 questions covered numeric ability, 18 questions tested measurement and 18 questions assessed spatial ability. It was standardized to a SACMEQ mean of 500 and standard deviation of 100 [ZMALOCP].

Socioeconomic Status: An index of socioeconomic status of students was derived using five areas of a pupil's home environment: the level of education of the father and mother, the number of books in the home, the presence of eleven items in the home (a newspaper, a magazine, a radio, a television, a VCR, an audio cassette player, a telephone, a refrigerator, a car, running water and a table), the structural quality of the house (floor, outside walls and roof) and the main source of light. SES was originally created as a standardized and z-scored composite for all of SACMEQ (M=500, SD=100). It was re-standardized within each country (M=0; SD=1) [ZPSESSCR].

Female: A dummy-coded variable for student gender. It was coded '1' for female and '0' for male [ZPSEX].

Extra Maths Lessons: A dummy-coded variable for whether a student had access to extra lessons in mathematics. It was coded '1' if extra mathematics courses were taken and '0' otherwise [PEXTMAT].

Grade Repetition: A dummy-coded variable for whether a student had repeated a grade. It was coded '1' if the student had repeated a grade at least once and '0' otherwise [ZPREPEAT].

School-level Variables

Average SES: School-level aggregate of Grade 6 student socioeconomic status. We standardized the variable within each country, mean (M)=0, standard deviation (SD)=1.

Percentage Repetition: School-level aggregate of the prevalence repetition among Grade 6 students. We standardized the variable within each country, mean (M)=0, standard deviation (SD)=1.

Class Size: We based this variable on information from Grade 6 mathematics teachers on the number of students in the Grade 6 mathematics class. In schools where there was more than one Grade 6 mathematics class, an average was taken [YCLSIZE].

Urban School Location: A dummy-coded variable coded ‘1’ for large town or city and ‘0’ otherwise [SLOCAT].

Percentage Female: The gender composition of Grade 6 students. It was the school-level aggregate of the Grade 6 student gender variable. We standardized the variable within each country, mean (M)=0, standard deviation (SD)=1.

Community Support for Pupil Meals: A dummy-coded variable based on a response from the school head on the presence of community support in preparing school meals. We coded the variable ‘1’ if there was community support for this activity and ‘0’ otherwise [SCOMM14].

Student Attendance Problems: We constructed the variable based on the school head report of students arriving late at school, students’ unjustified absence, students skipping classes and students dropping out of school. There were three possible response categories for each variable – never, sometimes and often. Within each country, we aggregated and standardized all four variables, mean (M)=0, standard deviation (SD)=1. Higher values indicated higher levels of student attendance problems [SPUPPR01 SPUPPR02 SPUPPR03 SPUPPR04].

Teacher Behavioral Problems: We based the variable on information from the school head on intimidation or bullying of pupils by teachers, sexual harassment of teachers by other teachers, sexual harassment of pupils by teachers, use of abusive language by teachers, drug abuse by teachers, alcohol abuse or possession by teachers. There were three possible response categories for each variable – never, sometimes and often. Within each country, we aggregated all six variables and z-scored them, variables, mean (M)=0, standard deviation (SD)=1. Higher values indicated higher levels of behavioral problems [STCHPR04 STCHPR05 STCHPR06 STCHPR07 STCHPR08 STCHPR09].

Community Support for School Resources: We constructed the variable based on the school head report of community help in supplying furniture and equipment, textbooks, stationery and other materials. Within each country, we aggregated all four variables and z-scored them, mean (M)=0, standard deviation (SD)=1. Higher values indicated greater levels of community support [SCOMM03 SCOMM04 SCOMM05 SCOMM06].

Teacher Attendance Problems: We based this variable on the school head report of teachers arriving late, teacher absenteeism, and teachers skipping classes. There were three possible response categories for each variable – never, sometimes and often. Within each country, we aggregated and standardized all three variables, mean (M)=0, standard deviation (SD)=1.

Higher values indicated higher levels of teacher attendance problems [STCHPR01 STCHPR02 STCHPR03].

Teacher Testing policy: A dummy-coded variable for how often mathematics teachers in the school tested their students. We coded the variable '1' if testing occurred at least once a week and '0' otherwise [TTESTMAT].

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[1] This point does not necessarily apply to Tanzania and Zanzibar, where testing was conducted in Kiswahili. The Mozambique test was carried out in Portuguese. All other countries used English.
2 For further details about the construction of the socioeconomic index, please refer to Dolata, S. (2005). The scale includes information on parental education, the structural features of the home and the material resources available in the home.
3 Saito (2005) provides a detailed description of the construction of the SACMEQ resources index using Rasch Scaling. The scale was based on questions from the SACMEQ School Head Questionnaire about the physical resources available in the school.

The Southern Africa Labour and Development Research Unit

The Southern Africa Labour and Development Research Unit (SALDRU) conducts research directed at improving the well-being of South Africa's poor. It was established in 1975. Over the next two decades the unit's research played a central role in documenting the human costs of apartheid. Key projects from this period included the Farm Labour Conference (1976), the Economics of Health Care Conference (1978), and the Second Carnegie Enquiry into Poverty and Development in South Africa (1983-86). At the urging of the African National Congress, from 1992-1994 SALDRU and the World Bank coordinated the Project for Statistics on Living Standards and Development (PSLSD). This project provide baseline data for the implementation of post-apartheid socio-economic policies through South Africa's first non-racial national sample survey.

In the post-apartheid period, SALDRU has continued to gather data and conduct research directed at informing and assessing anti-poverty policy. In line with its historical contribution, SALDRU's researchers continue to conduct research detailing changing patterns of well-being in South Africa and assessing the impact of government policy on the poor. Current research work falls into the following research themes: post-apartheid poverty; employment and migration dynamics; family support structures in an era of rapid social change; public works and public infrastructure programmes, financial strategies of the poor; common property resources and the poor. Key survey projects include the Langeberg Integrated Family Survey (1999), the Khayelitsha/Mitchell's Plain Survey (2000), the ongoing Cape Area Panel Study (2001-) and the Financial Diaries Project.

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