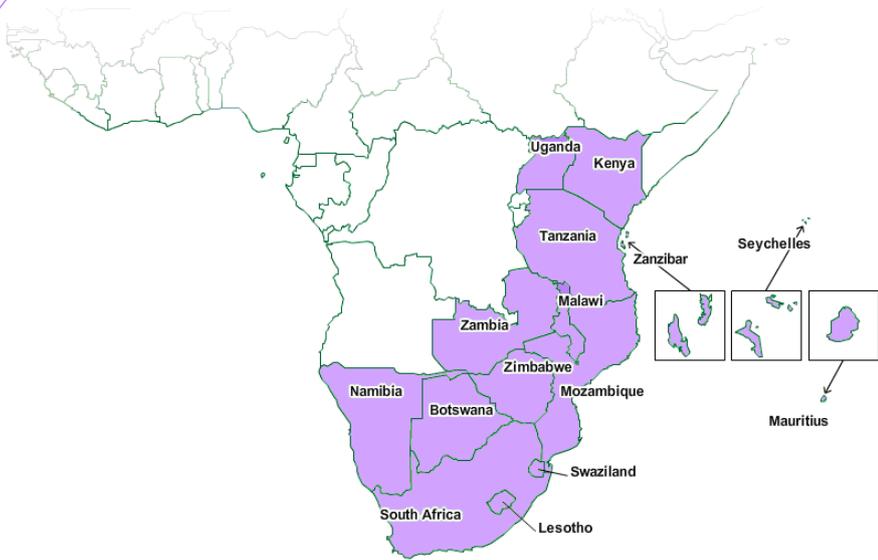


# Accounting for Variations in the Quality of Primary School Education

Njora Hungi





## **ABSTRACT**

This paper reports on the use of multivariate analyses procedures to examine pupil- and school-level factors that contributed to variations in reading and mathematics achievement among Grade 6 pupils in 15 African school systems (Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, the Seychelles, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zanzibar, and Zimbabwe). The data for this study were collected in 2007 as part of the major SACMEQ III Project, which sought to examine the quality of education offered in primary schools in these countries. (SACMEQ is an acronym for the Southern and Eastern Africa Consortium for Monitoring Educational Quality.)

At the pupil level, grade repetition, socio-economic background, pupil age, and pupil sex were found to be the most important factors affecting the variations in pupil achievement in these school systems, while at the school level, school resources and school location were identified as the important common factors. South Africa and Zimbabwe were among the school systems with the largest between-school variation (especially in reading), while the Seychelles and Mauritius had the largest within-school variation.

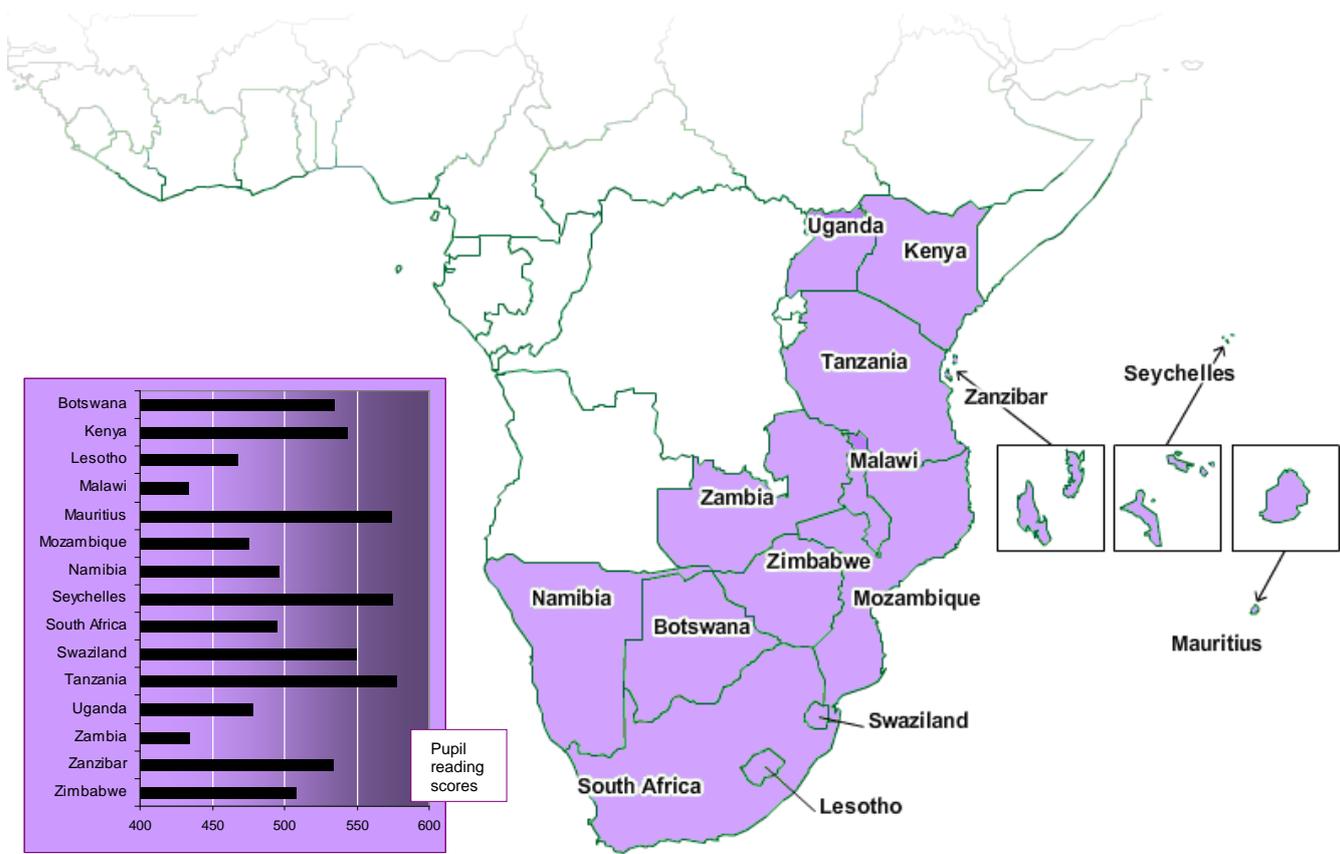
In addition, low social equity in pupil achievement was evident in South Africa, Mauritius, and Zimbabwe, while large gender differences in pupil achievement were evident in the Seychelles and to some extent in Tanzania and Kenya, especially in mathematics. Implications of the findings for policy and practice are outlined.

## **KEYWORDS**

Absenteeism; Grade repetition; Homework; Household tasks; Learning materials; Mathematics achievement; Multilevel models; Preschool attendance; Pupil achievement; Pupil age; Pupil sex; Pupil–teacher ratio; Quality of education; Reading achievement; SACMEQ school systems; School location; School resources; Socioeconomic background; Speaking the language of instruction; Textbooks.

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Source: SACMEQ Data, 2007

## The Fifteen SACMEQ School Systems

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## Introduction

In this paper, multilevel analyses of the SACMEQ III data are presented. These analyses were carried out to identify the major pupil-level and school-level factors influencing scores for reading and mathematics among Grade 6 pupils in 15 SACMEQ school systems.

The *Dakar Education for All (EFA) Framework for Action* recognized that education was central to individual empowerment, the elimination of poverty at household and community level, and broader social and economic development. It therefore resolved that governments and all other EFA partners must work together to ensure a basic education of quality for all children, regardless of their background. Thus, it is of interest to identify and understand the key factors that influence pupil achievement so that governments can focus on policies that could improve education quality for all children regardless of the children's background characteristics (such as socio-economic background and gender) and their schools' characteristics (such as school location and school size).

The main research questions tackled in this paper are:

- What were the key pupil- and school-level factors influencing pupil achievement in SACMEQ school systems?
- What were the within-school and between-school variations in pupil achievement in SACMEQ school systems? What proportions of these variations could be explained in the final model? Were there substantial changes in the between-school variances over time?
- How do social and gender differences compare across SACMEQ school systems after controlling for other factors influencing pupil achievement?

The multilevel analyses reported in this paper were carried out using HLM6. This software allows the effects of variables at the different levels of hierarchy as well as their interaction effects to be examined simultaneously.

The structure of this paper is as follows. Four short sections describe (a) the sampling procedures employed in SACMEQ studies, (b) how pupil reading and mathematics scores were calculated, (c) an overview of SACMEQ questionnaires, and (d) how the predictor variables involved in this paper were constructed. These are followed by two sections in which the hypothesized multilevel model for pupil achievement and the analyses are described. Finally, sections are included in which the results of the analyses are presented and discussed.

## Sampling procedures

The desired target population for the SACMEQ III study was defined as “All pupils at Grade 6 level in 2007 (at the first week of the eighth month of the school year) who were attending registered mainstream primary schools”. This definition used a grade-based description (and not an age-based description) of pupils because an age-based description would have required the collection of data across many grade levels due to the high incidences of “late starters” and grade repetition in SACMEQ school systems.

The SACMEQ III data were selected using a stratified two-stage cluster sample design based on the technique of a lottery method of sampling proportional to size, with the assistance of SAMDEM software (Sylla et al., 2003). At the first stage, schools were selected in each region (province) in proportion to the number of pupils in that region in the defined target population. At the second stage, a simple random sample of 25 pupils was taken within each selected school (in the Seychelles, all Grade 6 pupils in all 25 schools in the island country were tested).

In order to avoid selection bias, precautions were taken to ensure that school heads and teachers did not have any influence over the sampling procedures within schools. This is because school heads and teachers might have felt they had a vested interest in selecting particular kinds of pupils, and this could have resulted in major distortions of sample estimates (Brickell, 1974).

The number of pupils tested in each country ranged from 1,480 (from 25 schools) in the Seychelles to 9,071 (from 392 schools) in South Africa. The numbers of pupils, teachers, and schools involved in the SACMEQ III study for each country are shown in *Table 1*.

**Table 1: Numbers of Grade 6 pupils, teachers, and schools in the SACMEQ III Project**

	Grade 6 Pupils	Teachers	Schools
Botswana	3,868	386	160
Kenya	4,436	733	193
Lesotho	4,240	315	182
Malawi	2,781	264	139
Mauritius	3,524	408	152
Mozambique	3,360	865	183
Namibia	6,398	827	267
Seychelles	1,480	116	24
South Africa	9,071	1,163	392
Swaziland	4,030	358	172
Tanzania	4,194	629	196
Uganda	5,307	744	264
Zambia	2,895	265	157
Zanzibar	2,791	679	143
Zimbabwe	3,021	274	155
<b>SACMEQ</b>	<b>61,396</b>	<b>8,026</b>	<b>2,779</b>

## Calculating pupil scores

The outcome variables of interest in the SACMEQ III study were pupil scores in reading, mathematics, and health knowledge tests, but in this paper only the reading and mathematics scores are considered. The SACMEQ tests were developed after careful curriculum mapping by a panel of subject specialists drawn from all the 15 SACMEQ school systems to identify those elements of curriculum outcomes that were considered important and which were to be assessed in the tests. The subject specialists also reviewed the test items to ensure that they conformed to the national syllabuses of SACMEQ countries. In addition, during the process of test development and before the tests were administered they were field-tested in all SACMEQ school systems, and their psychometric characteristics were examined using Rasch scaling techniques. Items that did not meet Rasch scaling requirements were dropped from the tests. The items were also examined for gender bias and country bias, and those found to function differently among boys and girls or among countries were dropped from the test. Most of the items survived these stringent examinations.

During the SACMEQ II study, the Rasch scores on the final pupil reading and mathematics tests were transformed to have a mean of 500 and a standard deviation of 100 (for the pooled data with equal weight given to each country). During the SACMEQ III study, Rasch measurement procedures were employed to equate the SACMEQ II and SACMEQ III scores. These are the scores that have been used as the criterion variables in this paper.

## About SACMEQ questionnaires

Apart from pupil achievement scores, SACMEQ studies are renowned for collecting a wide range of information about pupils, teachers, classrooms, school heads, schools, and school communities. For the SACMEQ III study, four main questionnaires (pupil, teacher, school head, and school information) were used.

It is important to note that SACMEQ questionnaires were subjected to careful thought, thorough examination, and stringent refinement before they were administered. For example, for the SACMEQ III study, the questionnaires were developed by a committee of experts consisting of members drawn from all SACMEQ countries, SCC staff, IIEP staff, and private consultants, following (a) field experiences gained from the SACMEQ II study, (b) recommendations arising from analyses of SACMEQ II data, and (c) policy questions raised by SACMEQ country ministries of education. These questionnaires were refined by the SACMEQ scientific committee, then piloted in each SACMEQ country and refined further before they were administered.

One important innovation in the development of questionnaires for the SACMEQ III study was introduction of a “Homework form” for pupils to take home. This consisted of questions to which the pupil might not know the answers (for example, parental education, estimates of travel distance to school, home possessions, whether or not their biological parents were

alive) that parents, family members, or guardians could help in filling in. This considerably reduced the number of missing values in the SACMEQ III study compared with previous SACMEQ studies.

The quality of the data provided by the school heads, teachers, and pupils was examined in two ways. First, at the time of data collection, the data collectors who visited the schools verified, for example, (a) the actual existence and conditions of the school resources such as library, school head office, and staff room, and (b) the official school records about the information provided by pupils such as their gender, age, days absent, and whether or not their parents were alive. Second, similar questions were included in the school head, pupil, and teacher questionnaires, and these helped to verify the responses given by the respondents during data cleaning. For example, a question on the existence of a class library was included in both the teacher and pupil questionnaires. Any inconsistencies between the responses of the school heads, teachers, and pupils were followed up by the national research coordinators (NRCs) and corrected during data cleaning.

## Construction of predictor variables

The information collected using the questionnaires mentioned above was used in the construction of the predictor variables involved in the analyses described in this paper.

In some cases, one question (for example, sex of pupil) was used as a predictor, while in other cases, questions were recoded to make them more meaningful for analysis purposes. For example, in the question below the original coding was from 1 to 5. but it was recoded into 0, 0.5, 1, 2, and 3 for the purpose of giving weights to the responses that roughly corresponded to the number of years of preschool attendance by the pupil.

How long did you attend a preschool, kindergarten, nursery, reception, etc., before Grade 1?  
(Please tick *only one* box.)

<i>Original coding</i>		<i>Recoded into:</i>
1	<input type="checkbox"/> I have <u>never</u> attended a preschool.	0
2	<input type="checkbox"/> A few months	0.5
3	<input type="checkbox"/> One year	1
4	<input type="checkbox"/> Two years	2
5	<input type="checkbox"/> Three or more years	3

In other cases, two or more variables were used to form a predictor; for example, the number of female teachers in the school was divided by the total number of teachers in the school to form the variable “Proportion of female teachers”. In yet other cases, a number of questions

were combined to estimate, for instance, a pupil socio-economic status factor (also referred to as “Pupil SES”), classroom resources factor, and school resources factors. Information about the predictor variables involved in the analyses described in this paper is given in *Appendix 1*.

An interesting aspect of the SACMEQ III study is that Grade 6 teachers were also tested in reading and mathematics (except in Mauritius where only pupils were tested). The teacher and pupil tests used different sets of items, but the two tests had some common items for purposes of comparison. The teacher tests were designed to be more difficult than the pupil tests. In addition, like the pupil tests, the teacher tests were field-tested and their measurement characteristics examined using Rasch analysis before they were administered. Teachers’ scores (also referred to as “Teacher subject matter knowledge”) in the tests are used as predictors of pupil score in the models analysed in this study.

## Multilevel model of pupil achievement

*Figure 1* shows the general two-level model that was hypothesized for factors influencing pupil achievement in reading and mathematics. This model was examined separately for each of 15 school systems involved in the SACMEQ III study, and separately for reading and for mathematics data. The general model is based on existing literature on pupil learning, especially Carroll’s model of school learning (Carroll, 1963) and Creemers’ model of effective classrooms (Creemers, 1994).

The hierarchical structure of the model, shown in *Figure 1*, has pupils at level 1 and schools at level 2: that is, pupils nested within schools. At an early point of this study a three-level model was considered (with pupils, schools, and provinces at levels 1, 2, and 3 respectively). However, this three-level model was discarded because multilevel analyses of the model were considered unstable for the Seychelles, which had too few level-2 units (25 schools nested under six provinces) and Swaziland which had too few level-3 units (172 schools nested under four provinces), as well as Uganda, which also had too few level-3 units (264 schools nested under four provinces). An alternative three-level model was also considered (with pupils, classes, and schools at levels 1, 2, and 3 respectively), but a decision was made to settle for the two-level model for this paper because it was considered sufficient for achieving the main aims – identification of the key factors, and estimation of within- and between-school variance.

As can be seen from *Figure 1*, three categories of variables were hypothesized to directly influence achievement at the pupil level: “*Individual characteristics*” (e.g. sex and age), “*Personalized learning support*” (e.g. preschool attendance, extra tuition, and homework help at home), and “*Home environment*” (e.g. pupil SES, number of siblings, and household tasks). Four categories of variables were hypothesized to directly influence achievement at the school level: “*Teacher characteristics*” (e.g. sex, education, and professional qualifications), and “*Classroom environment*” (e.g. class size and classroom resources). Other variables were

“*School head characteristics*” (e.g. sex, education level, and experience), and “*School environment*” (e.g. school resources, type of school, pupils’ behaviour problems, and the contextual climate such as average pupil SES and the proportion of girls in the school). A comprehensive list of all the predictor variables (and their details) in each of these categories is given in *Appendix 1*. Over 80 different variables were examined in this study, 21 at the pupil level and over 60 at the school level.

## **Analyses**

Before commencement of multilevel analyses the correlations between variables were examined in order to get a general “feel” of the associations between variables, and also to check potential problems because of any multicollinearity and suppressor variable relationships in the model (Keeves, 1997). This task was carried out successfully.

The variables were then examined using simple multiple linear regression (MLR) models using SPSS software to identify which of the variables (listed in *Appendix 1*) warranted further scrutiny using multilevel procedures. In other words, the MLR analyses were employed to select variables to be examined in the multilevel analyses. In this regard, a variable was deemed worth of further scrutiny using the multilevel approach if it was significant in the MLR models at the  $p \leq 0.05$  level.

The multilevel analyses were carried out using HLM6 software (Raudenbush *et al.*, 2005), following the logic employed by Raudenbush and Bryk (2002) in their descriptions of these types of model. For each school system, two multivariate data matrix (MDM) files were built, one for reading and the other for mathematics. Weighting (with sampling weights calculated to cater for the design of this study) was undertaken during the analyses.

The initial step in the HLM analyses was to run so-called “null models” in order to estimate the within- and between-school variations for each subject and for each school system. This was followed by building up the pupil-level models, which involved adding pupil-level predictors to the models, but without entering predictors at the school level. At this stage, a “step-up” approach (Bryk and Raudenbush, 1992) was followed to examine which of the pupil-level variables had a significant (at  $p \leq 0.05$ ) influence on the outcome variables. The step-up approach involved progressive addition of significant predictors into the model, one at time. Finally, school-level predictors were added into the models using the step-up strategy mentioned above. The level-2 exploratory analysis subroutine available in HLM6 was employed for examining the potentially significant school-level predictors (as shown in the output) in successive HLM runs.

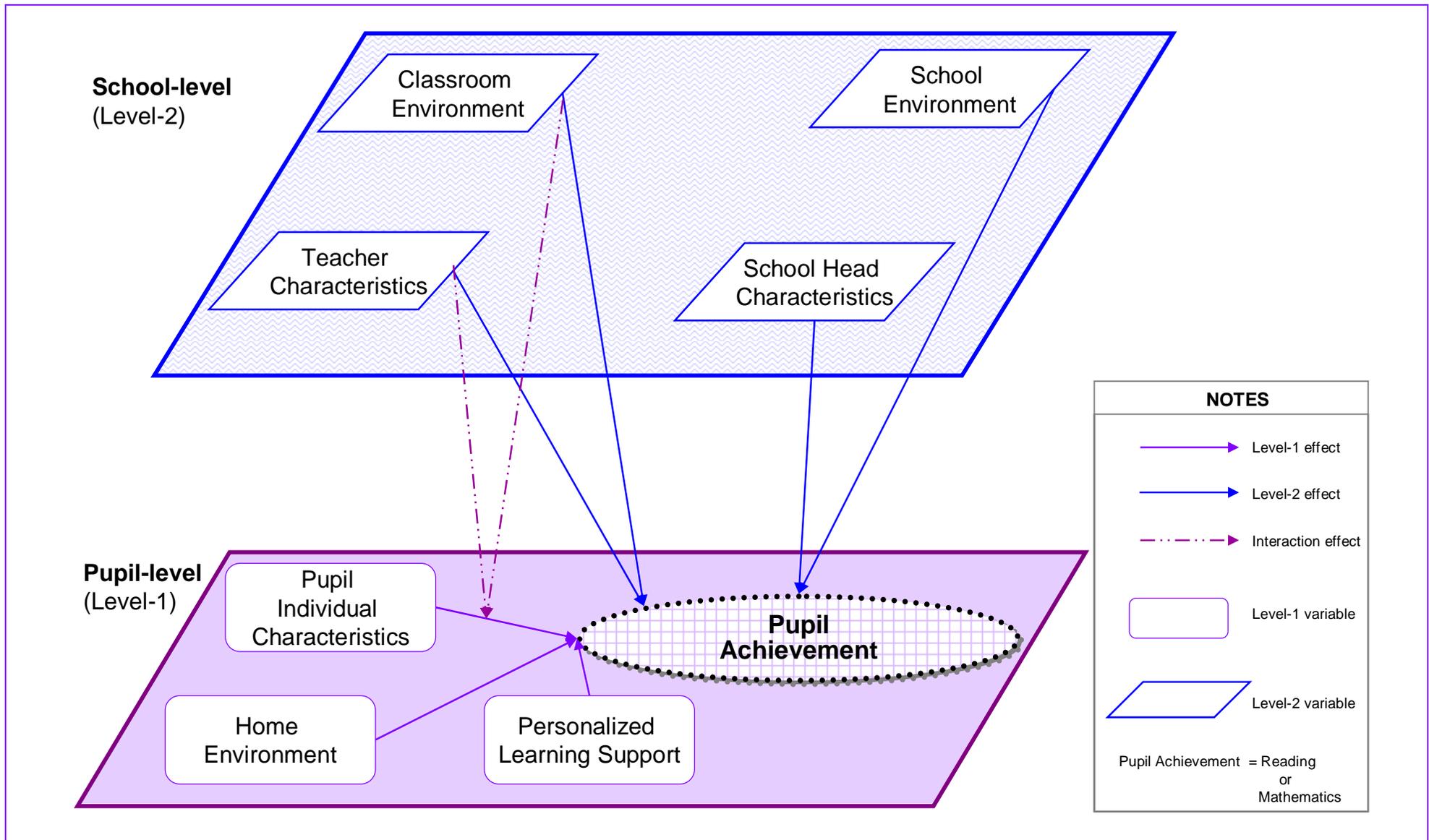


Figure 1: Hypothesized two-level model of pupil achievement for the SACMEQ III study

## Results

The standardized regression coefficients of the variables that were significant (at  $p \leq 0.05$ ) in the final models are presented in *Tables 2* and *3* for the reading and mathematics models respectively. Coefficients for the pupil-level variables are in the first panels of *Tables 2* and *3* while those for school-level variables are in the second panels. The corresponding unstandardized (metric) coefficients for these variables are displayed in *Appendices 2* and *3* for reading and mathematics respectively, together with the variance components.

Perhaps it is worth noting that the signs of coefficients indicate directions of effects, which can be interpreted from the coding. It might also be worth noting that absolute values of standardized regression coefficients can be used to rank variables by their relative degree of influence on the outcome within the same sample (Hox, 1995). Generally, in research studies in education, a standardized regression coefficient is considered important if its magnitude taken in absolute terms is  $\geq 0.10$ .

The columns labelled T1 and T2 in *Tables 2* and *3* give counts of the numbers of times the variable was identified as “significant” ( $p \leq 0.05$ ) and “important” (standardized coefficient  $\geq |0.10|$ ) respectively across the 15 school systems.

## Discussions

*What were the common pupil-level factors contributing to the differences in pupils’ scores across the 15 SACMEQ school systems?*

Seven pupil-level predictors (*Pupil SES*, *Pupil sex*, *Pupil age*, *Grade repetition*, *Days absent*, *Homework*, and *Speaking language of instruction*) emerged as significant across most of the 15 school systems for both reading and mathematics. In addition, four variables (*Meals per week*, *Household tasks*, *Number of siblings*, and *Books at home*) came out as significant in most countries in the reading models.

From the results displayed in *Tables 2* and *3*, it can be seen that pupils from richer families were estimated to achieve better scores than pupils from poor families in 14 school systems for reading and in 13 school systems for mathematics. The *Pupil SES* variable was not significant in the final models for Uganda (for both subjects) and in the final mathematics model for Malawi.

The estimated difference in achievement scores between pupils from richer families (one standard deviation unit above the country’s mean SES score) and pupils from poorer families (one standard deviation unit below the country’s mean SES score) is shown in *Figure 2*. This figure was plotted using the results from simple models involving the *Pupil SES* and *mean Pupil SES* variables as the only predictors in the model.

**Table 2: Standardized regression coefficients of the variables in the reading models**

	BOT	KEN	LES	MAL	MAU	MOZ	NAM	SEY	SOU	SWA	TAN	UGA	ZAM	ZAN	ZIM	T1	T2
<i>Pupil-level variables</i>																	
Pupil age	-0.10	-0.17	-0.13	-0.07		-0.04	-0.11	0.05	-0.05	-0.12		-0.10	-0.03		-0.04	12	6
Pupil sex	0.08	-0.06		-0.12	0.03	-0.08	0.03	0.20	0.05		-0.10	-0.06	-0.06			11	3
Grade repetition	-0.17	-0.10	-0.11	-0.07	-0.22	-0.07	-0.13	-0.06	-0.09	-0.13	-0.14	-0.05	-0.09	-0.14	-0.10	15	9
Days absent	-0.03	-0.05	-0.05	-0.08	-0.13	-0.04	-0.02	-0.08			-0.12	-0.04	-0.06	-0.09	-0.05	13	2
Preschool attendance	0.07		0.04		0.05			0.08	0.03		0.04			0.05		7	0
Speaking language of instruction	0.09				0.17	0.05	0.05	0.23	0.09	0.03			0.09		0.06	9	2
Socio-economic status	0.23	0.05	0.12	0.06	0.19	0.12	0.09	0.11	0.16	0.10	0.13		0.13	0.17	0.13	14	11
Number of siblings	-0.03	-0.04			-0.06	-0.05	-0.05	-0.11	-0.02	-0.06						8	1
Meals per week	0.03		0.05		0.04	0.04	0.03		0.02		xxx	0.04	0.03		0.06	9	0
Household tasks	-0.04		-0.05		-0.07	-0.04	-0.04	-0.08	-0.03				-0.04	-0.05		9	0
Homework help at home	0.04					0.04								0.05		3	0
Parents alive	0.03				0.03											2	0
Living with parents/relatives	0.03						0.03	0.07	0.02				0.04	0.08		6	0
Learning culture (books at home)	0.03	0.07	0.03	0.03	0.06			0.16	0.05		0.07					8	1
Pupil learning materials					0.06		0.03	0.11	0.03				0.05	0.06		6	1
Reading textbook ownership	0.09					0.08			0.02	0.05		0.04				5	0
Homework (given, corrected and explained)	0.06	0.10	0.05		0.08	0.08	0.03		0.04		0.05	0.11	0.06	0.11	0.09	12	3
Extra tuition in reading					0.11		-0.03	0.06	-0.03							4	1
Travel distance to school		-0.04	-0.05		-0.04										-0.03	4	0
Working place									0.03		0.06				0.09	3	0
<i>School-level variables</i>																	
Teacher age			-0.08				-0.05									2	0
Permanent teacher			0.16													1	1
Teacher education level															0.10	1	1
Teacher years of professional training				0.12												1	1
Teacher teaching hours per week										-0.08						1	0
Teacher in-service training		0.07	0.04													2	0
Teacher visits to education resources centre											0.07					1	0
Teacher subject matter knowledge					xxx		0.05		0.07		0.07					3	0
Teacher frequency of meeting parents		0.06														1	0
Teacher hours of preparation per week										0.08						1	0
Teacher housing condition									0.06							1	0
Frequency of reading tests			-0.06						0.07							2	0
Teacher days absent													-0.04			1	0
Teachers' behaviour problems									-0.04					xxx		1	0
Proportion of female teachers		0.10		0.15												2	2
Class size				-0.18									-0.07			2	1

**Table 2: Standardized regression coefficients of the variables in the reading models (Continued)**

	BOT	KEN	LES	MAL	MAU	MOZ	NAM	SEY	SOU	SWA	TAN	UGA	ZAM	ZAN	ZIM	T1	T2
<i>School-level variables (Continued)</i>																	
School head sex		0.07														1	0
School head age		<b>-0.13</b>														1	1
School head professional training									0.05							1	0
School head education level										0.06						1	0
School head experience as a head				<b>0.14</b>												1	1
School head management course					0.06											1	0
School head teaching hours per week											-0.05					1	0
Condition of school buildings											0.06					1	0
School resources		<b>0.11</b>	0.06	<b>0.12</b>	0.06				<b>0.13</b>	<b>0.11</b>		<b>0.18</b>	0.07	0.08	<b>0.19</b>	10	6
Pupils allowed to borrow books									<b>0.11</b>							1	1
School location		<b>0.11</b>	0.09				<b>0.19</b>			<b>0.15</b>	<b>0.15</b>	<b>0.18</b>		<b>0.10</b>	<b>0.18</b>	8	7
School inspections							0.06						xxx			1	0
School community contribution						0.08										1	0
School community problems	-0.04			<b>-0.11</b>	-0.09					-0.09		-0.08				5	1
Pupil-teacher ratio		-0.08		<b>-0.10</b>	-0.06					<b>-0.12</b>			xxx		-0.07	5	2
Private school												<b>0.12</b>				1	1
Free school meals	<b>-0.20</b>				-0.06		-0.08		<b>-0.13</b>			<b>-0.14</b>				5	3
School size					0.09			-0.09								2	0
Pupil behaviour problems				<b>0.10</b>										xxx		1	1
Mean pupil age											<b>0.18</b>					1	1
Mean days absent							<b>-0.10</b>									1	1
Mean preschool attendance						<b>0.10</b>										1	1
Mean speaking language of instruction			0.08													1	0
Mean socio-economic status						<b>0.21</b>			0.09							2	1
Mean meals per week	0.06										xxx					1	0
Mean household tasks												-0.09				1	0
Mean learning materials													0.06	0.09		2	0
Mean reading textbook ownership							0.04									1	0
Mean homework						0.06										1	0
Mean extra tuition in reading	0.06										0.07					2	0
Mean working place							0.03									1	0

**NOTE:** BOT is Botswana, KEN is Kenya, LES is Lesotho, MAL is Malawi, MAU is Mauritius, MOZ is Mozambique, NAM is Namibia, SEY is the Seychelles, SOU is South Africa, SWA is Swaziland, TAN is Tanzania, UGA is Uganda, ZAM is Zambia, ZAN is Zanzibar, and ZIM is Zimbabwe. Standardized regression coefficients in **bold** text are  $\geq|0.10|$ ;

T1 and T2 are numbers of times the variable was identified as significant ( $p \leq 0.05$ ) and important (standardized regression coefficient  $\geq|0.10|$ ) across the 15 school systems respectively;

xxx - Indicates that the variable was not available for testing in the model for the mentioned country.

**Table 3: Standardized regression coefficients of the variables in the mathematics models**

	BOT	KEN	LES	MAL	MAU	MOZ	NAM	SEY	SOU	SWA	TAN	UGA	ZAM	ZAN	ZIM	T1	T2
<i>Pupil-level variables</i>																	
Pupil age	-0.08	<b>-0.14</b>	<b>-0.13</b>	-0.05			<b>-0.10</b>		-0.05	<b>-0.11</b>		-0.04			-0.05	9	4
Pupil sex		<b>-0.15</b>	-0.05	<b>-0.10</b>	-0.03	<b>-0.10</b>	-0.05	<b>0.10</b>		<b>-0.12</b>	<b>-0.18</b>	-0.09	-0.09	-0.06	-0.04	13	7
Grade repetition	<b>-0.15</b>	-0.05	<b>-0.10</b>		<b>-0.18</b>	-0.06	<b>-0.11</b>		-0.08	-0.07	<b>-0.10</b>	-0.04	-0.09	-0.07	<b>-0.12</b>	13	6
Days absent	-0.03	-0.04	-0.06	-0.04	<b>-0.11</b>		-0.02	-0.06			<b>-0.11</b>	-0.03	-0.04		-0.05	11	2
Preschool attendance	0.06				0.06		0.03	0.06	0.03					0.05		6	0
Speaking language of instruction	0.07			0.06	<b>0.11</b>	0.04	0.04	<b>0.21</b>	0.05				0.06		0.06	9	2
Socioeconomic status	<b>0.18</b>	0.05	<b>0.11</b>		<b>0.21</b>	0.08	<b>0.10</b>	<b>0.13</b>	<b>0.12</b>	0.04	0.09		<b>0.11</b>	<b>0.11</b>	0.09	13	8
Number of siblings	-0.05	-0.04			-0.05			-0.09	-0.01	-0.05						6	0
Meals per week	0.03			0.07	0.04		0.03				xxx				0.06	5	0
Household tasks					-0.05		-0.04	-0.06			-0.03					4	0
Homework help at home	0.05					0.04									0.08	3	0
Parents alive	0.03															1	0
Living with parents/relatives				0.05				0.08						0.05	0.04	4	0
Learning culture (books at home)				0.02	0.04	0.04		<b>0.17</b>	0.07		0.07					6	1
Pupil learning materials		0.03			0.08			<b>0.10</b>	0.03	0.04		0.04			0.05	7	1
Mathematics textbook ownership	0.08				0.05	0.04	0.04	<b>0.15</b>								5	1
Homework (given, corrected and explained)	0.04	0.05	0.07		0.07	0.08			0.04	0.06	0.05	<b>0.10</b>		0.05	0.05	11	1
Extra tuition in mathematics		0.05			<b>0.11</b>			0.08	-0.03		0.06			<b>0.12</b>		6	2
Travel distance to school		-0.05	-0.05		-0.05											4	0
Working place											0.04	0.05		0.06	0.06	4	0
<i>School-level variables</i>																	
Teacher sex						0.08										1	0
Teacher age											-0.09					1	0
Teacher education level											0.05					1	0
Teacher teaching hours per week					-0.07					-0.06						2	0
Teacher subject matter knowledge		0.07			xxx		0.08		<b>0.10</b>	0.06	0.09					5	1
Teacher days absent		-0.07		-0.07	-0.06				-0.07							4	0
Report on mathematics			<b>0.11</b>													1	1
SH advice teacher				0.08												1	0

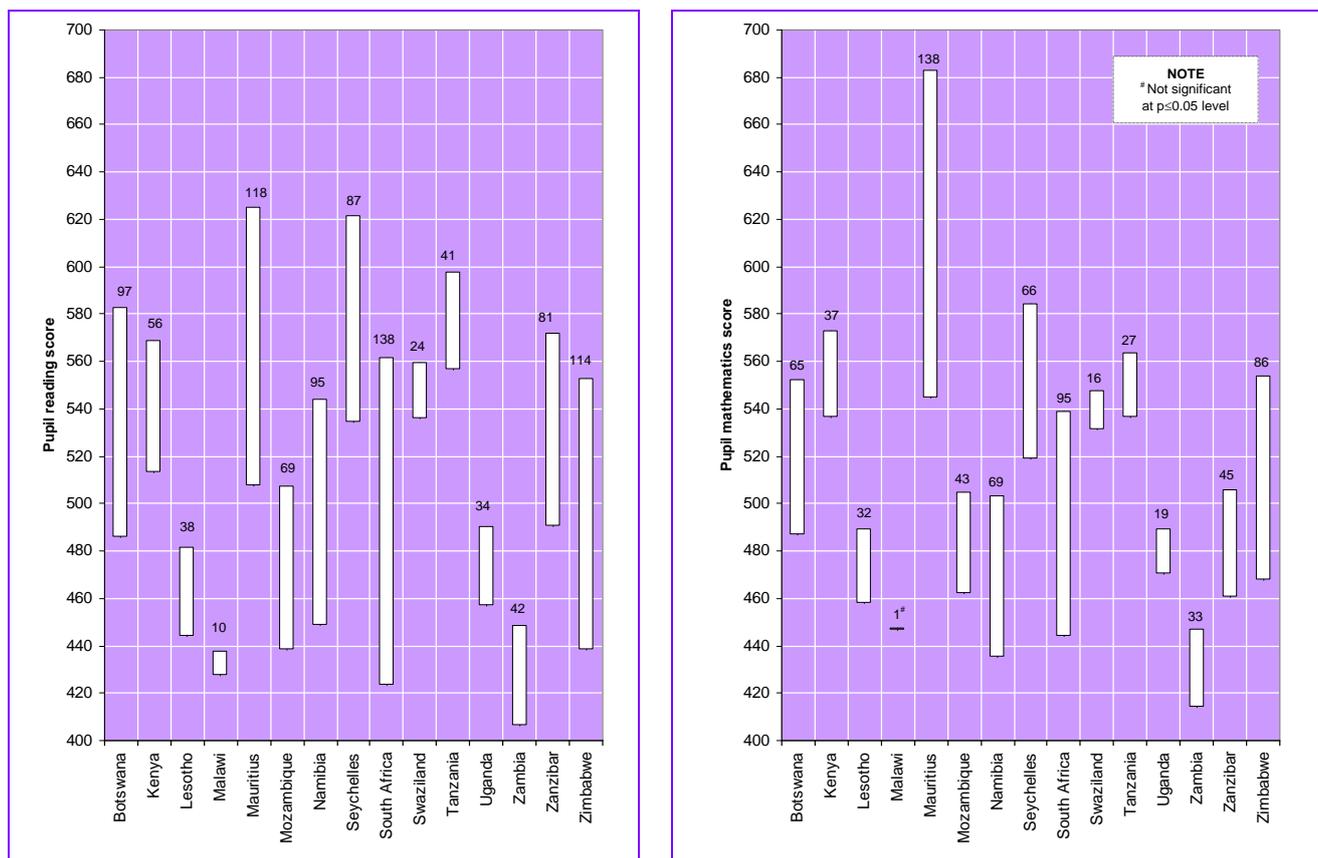
**Table 3: Standardized regression coefficients of the variables in the mathematics models (Continued)**

	BOT	KEN	LES	MAL	MAU	MOZ	NAM	SEY	SOU	SWA	TAN	UGA	ZAM	ZAN	ZIM	T1	T2
<i>School-level variables (Continued)</i>																	
Teachers' behaviour problems			-0.07											xxx		1	0
Proportion of female teachers	-0.06															1	0
Class size				<b>-0.17</b>		<b>-0.10</b>							-0.06			3	2
Classroom resources				<b>0.10</b>												1	1
SH professional training									0.06							1	0
SH experience as a head											0.08					1	0
SH experience as a teacher	0.04				<b>0.13</b>	0.08						0.08				4	1
SH teaching hours per week				<b>-0.10</b>												1	1
School resources			0.08				0.08	<b>0.12</b>	<b>0.12</b>	0.09			<b>0.11</b>		<b>0.15</b>	7	4
Pupils allowed to borrow books									0.08							1	0
School days lost					-0.05								xxx			1	0
School location	0.05	0.09	0.08				<b>0.12</b>			0.08			<b>0.13</b>		<b>0.11</b>	7	3
School inspections										0.07	0.06	0.09	xxx			3	0
School community contribution	0.07								0.06							2	0
School community problems					-0.09											1	0
Pupil-teacher ratio	-0.06	-0.09			<b>-0.10</b>					-0.07			xxx		-0.09	5	1
Private school		<b>0.14</b>											<b>0.14</b>	<b>0.20</b>		3	3
Free school meals	<b>-0.15</b>	<b>0.10</b>										-0.09				4	3
School size					<b>0.15</b>			-0.09	-0.06							3	1
Mean socioeconomic status						<b>0.16</b>			0.06							2	1
Mean meals per week								0.08			xxx			<b>0.10</b>		2	1
Mean household tasks													-0.06			1	0
Mean learning materials			0.08										0.07			2	0
Mean extra tuition in mathematics	0.08															1	0

**NOTE:** BOT is Botswana, KEN is Kenya, LES is Lesotho, MAL is Malawi, MAU is Mauritius, MOZ is Mozambique, NAM is Namibia, SEY is the Seychelles, SOU is South Africa, SWA is Swaziland, TAN is Tanzania, UGA is Uganda, ZAM is Zambia, ZAN is Zanzibar, and ZIM is Zimbabwe. Standardized regression coefficients in **bold** text are  $\geq|0.10|$ ;

T1 and T2 are numbers of times the variable was identified as significant ( $p \leq 0.05$ ) and important (standardized regression coefficient  $\geq|0.10|$ ) across the 15 school systems respectively;

xxx - Indicates that the variable was not available for testing in the model for the mentioned country.



**Figure 2: Differences in achievement between pupils one standard deviation above and below the national mean SES score without controlling for any other factors**

Thus, a large difference in reading scores between the rich and poor pupils was evident in South Africa (138 points), Mauritius (118 points), and Zimbabwe (114 points). These three countries also recorded the largest differences in mathematics scores (South Africa 95 points, Mauritius 138 points, and Zimbabwe 86 points), which indicates low social equity in pupil achievement at Grade 6 level in these school systems. Other countries that recorded large social differences for both subjects were Botswana, Namibia, and the Seychelles. For Botswana, these findings were somewhat surprising because social inequities were not particularly obvious in the SACMEQ II data (see Hungu and Thuku, 2010a).

In the reading models, the variable *Pupil sex* was significant in 11 out of the 15 school systems (the exceptions were Lesotho, Swaziland, Zanzibar, and Zimbabwe), and in the mathematics models, this variable was significant in 13 school systems (the exceptions were Botswana and South Africa). However, the direction of effect for *Pupil sex* varied across these school systems and across subject, as shown in *Figure 3*. This figure was plotted using the results from models in which all other significant factors were controlled.

For example, in six school systems (Kenya, Malawi, Mozambique, Tanzania, Uganda, and Zambia) boys outperformed girls in both subjects, while in one school systems (the Seychelles) girls outperformed boys in these two subjects. In Mauritius, Namibia, and Zanzibar, girls did better than boys in reading while boys did better than girls in mathematics.

The Seychelles recorded the largest gender difference in *Figure 3* (i.e. a difference of 48 points in reading, which is about half a standard deviation on the SACMEQ reading scale). This indicates that pupil sex had the greatest impact on pupil reading score in this school system, with girls greatly outperforming boys. Other countries that recorded relatively large gender differences were Tanzania and Kenya, especially for mathematics achievement.

The large gender differences in pupil achievement in the Seychelles were also evident in the SACMEQ II data. Leste *et al.* (2005) blamed within-school streaming (ability grouping) for these large gaps between the academic performances of girls and boys in the Seychelles. They reported that streaming in the Seychelles is based on teachers' judgements, which are more influenced by subjective and social criteria than by ability. They argued that in making these judgements, teachers tend to place girls in the better-performing classes because they see girls as more passive and less disruptive than boys.

In the vast majority of the 15 school systems, younger pupils were generally estimated to achieve better than their older counterparts in both reading and mathematics (see *Figure 4*). However, in the Seychelles older pupils were more advantaged than younger pupils, especially in reading. It is perhaps worth noting that the Grade 6 pupils from the Seychelles were on average much younger (around 11 years) than the pupils from most of the other SACMEQ school systems (around 14 years), and this could explain why the variable *Pupil age* had a different effect in the Seychelles.

Pupils who had never repeated grades were likely to achieve better than pupils who had repeated grades in all the 15 schools system in reading, and in all but in two of the school systems (Malawi and Swaziland) in mathematics. In addition, pupils who were rarely absent from school were likely to perform better in both subjects than pupils who were frequently absent from school, except in Swaziland (both subjects), South Africa (reading), and Mozambique (mathematics), where this variable did not have significant effects. Pupils who were given homework more frequently and had it corrected and explained most days were estimated to achieve significantly better than pupils who were hardly given any homework, or pupils who were given homework but rarely had it corrected or explained. Moreover, pupils who spoke the language of instruction at home more often were estimated to achieve better than pupils who rarely or never spoke the language of instruction at home in most of the 15 school systems. (English is the language of instruction in most SACMEQ school systems, except for Tanzania and Zanzibar, where Kiswahili is used, and Mozambique, where Portuguese is used. A few schools in South Africa use Afrikaans.)

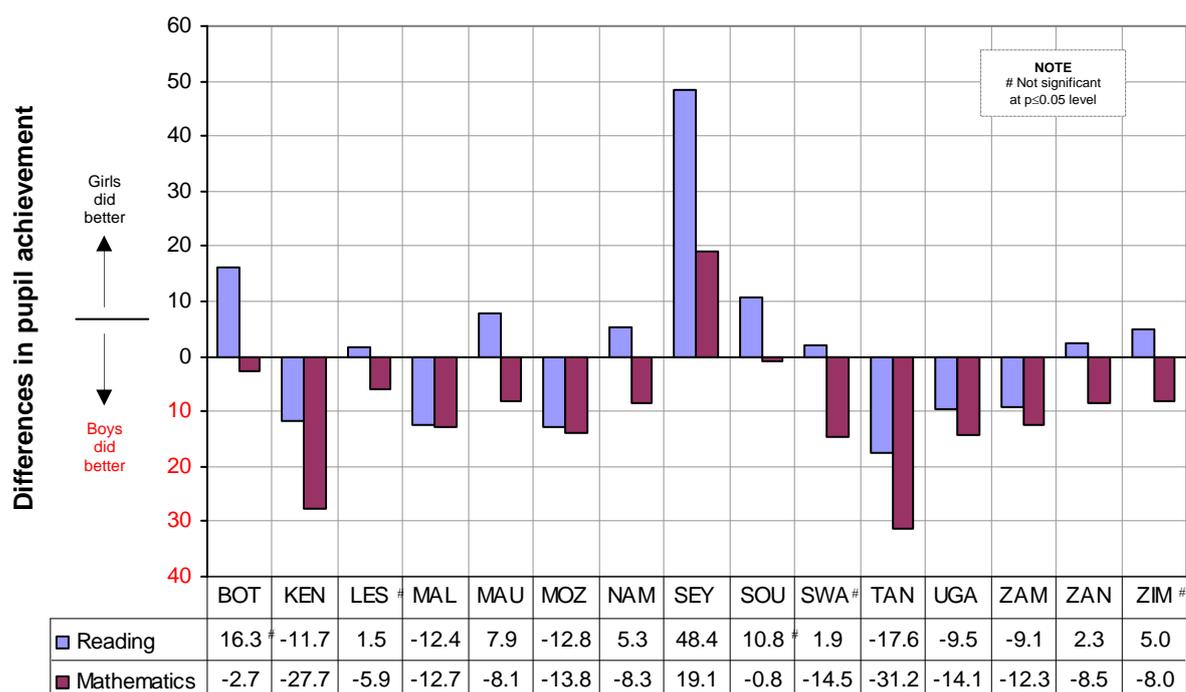


Figure 3: Differences in achievement between girls and boys after controlling for all other significant factors

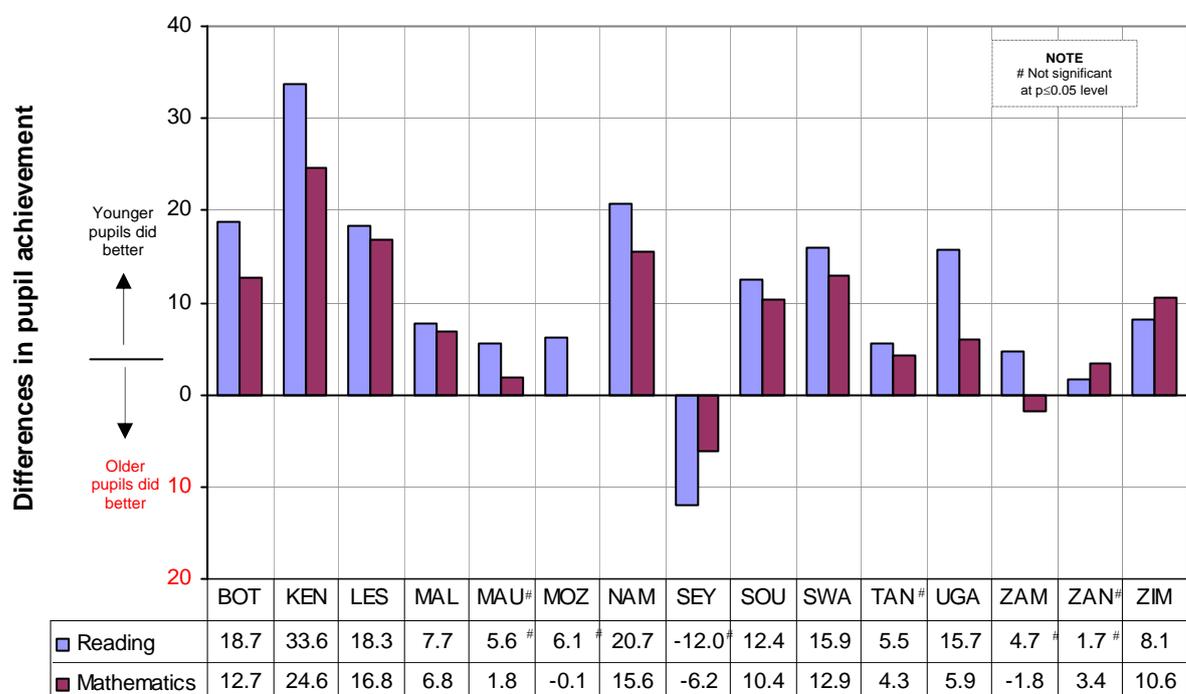


Figure 4: Differences in achievement between pupils one standard deviation above and below the national Grade 6 mean age after controlling for all other factors

Some variables were only significant in a few school systems, but nonetheless their effects on pupil achievement should interest authorities in most SACMEQ countries, especially the malleable variables such as *Household tasks*, *Preschool attendance*, and *Textbook ownership*.

For *Household tasks*, pupils who undertook fewer household tasks were estimated to perform better than pupils who undertook more such tasks at home in nine and four schools systems for reading and mathematics, respectively. This could imply that parents need to be encouraged to reduce the time spent on household tasks by pupils, because it is likely that it interferes with the time pupils need for academic activities at home such as homework and revision of school work.

For *Preschool attendance*, pupils who attended preschool for longer durations achieved better than pupils who attended preschool for shorter durations or pupils who never attended preschool at all, in seven and six school systems for reading and mathematics, respectively. This means that education authorities plus other interested parties might need to invest more in early childhood education programmes and encourage parents to take their children through these programmes. For *Textbook ownership*, pupils who said they had sole use of textbooks during classroom lessons achieved better than pupils who said they had to share textbooks (or had no textbooks at all) in five school systems for reading and also in five school systems for mathematics.

Further analyses were undertaken to investigate in detail the effects of (a) usage of textbooks during classroom lessons, and (b) duration of preschool attendance, on pupil achievement. Perhaps it is worth noting that there were four options for the variable *Textbook ownership*: “No textbook”, “Share with two or more pupils” (this option was used as a dummy in these analyses), “Share with one pupil”, and “Sole use”. For *Preschool attendance*, the options were five: “Never attended”, “A few months”, “One year” (used as the dummy in these analyses), “Two years”, and “Three years”.

The effects of various usages of mathematics textbooks on pupil mathematics achievement are depicted in *Figure 5*, while the effects of various durations of preschool attendance are depicted in *Figure 6* (the graphs for reading achievement followed similar patterns).

From *Figure 5*, it is clear that pupils generally achieved better if they had sole use of textbooks during lessons (especially in Botswana, Mauritius, and the Seychelles). It is also clear that sharing of textbooks between two pupils was better than situations where pupils had to share books with many others, or had no textbook at all.

For *Preschool attendance*, it is clear from *Figure 6* that pupils who had attended preschool for two or three years generally achieved better than pupils who had attended preschool for shorter durations of time, or who had never attended preschool before joining Grade 1.

A summary of the effects of the common pupil-level variables is given in *Table 4*.

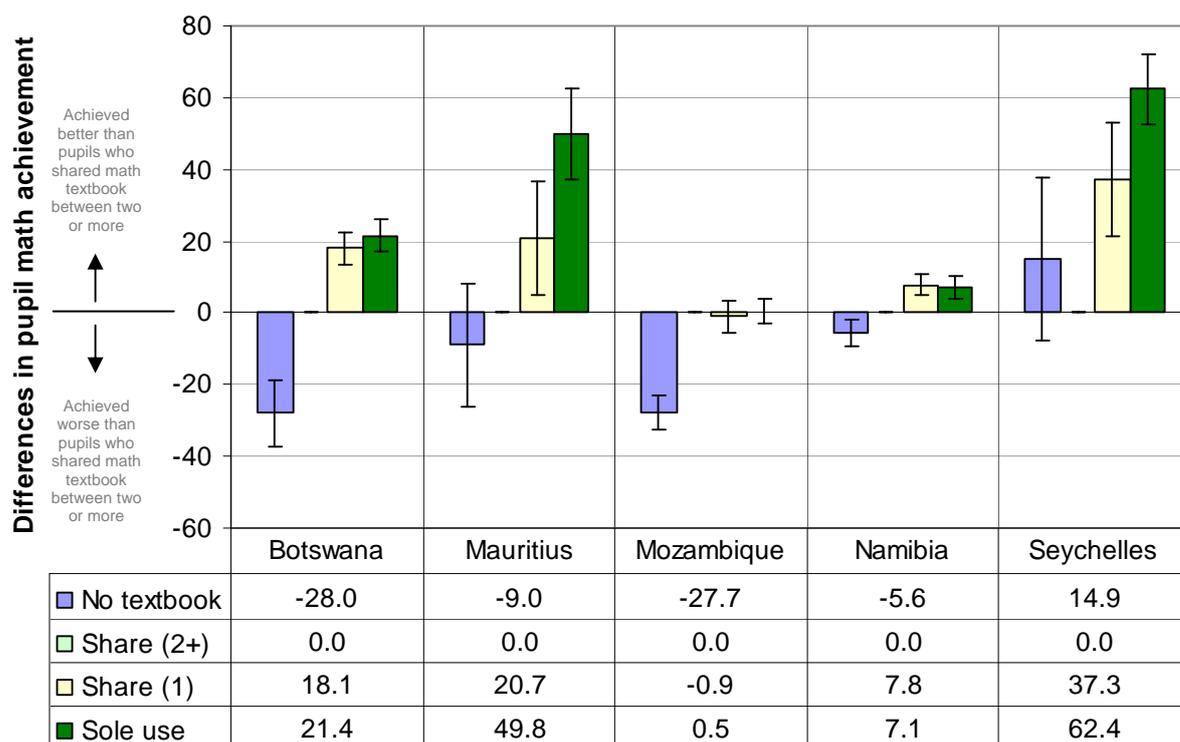


Figure 5: Effects of various uses of mathematics textbooks on pupil achievement after controlling for pupil SES

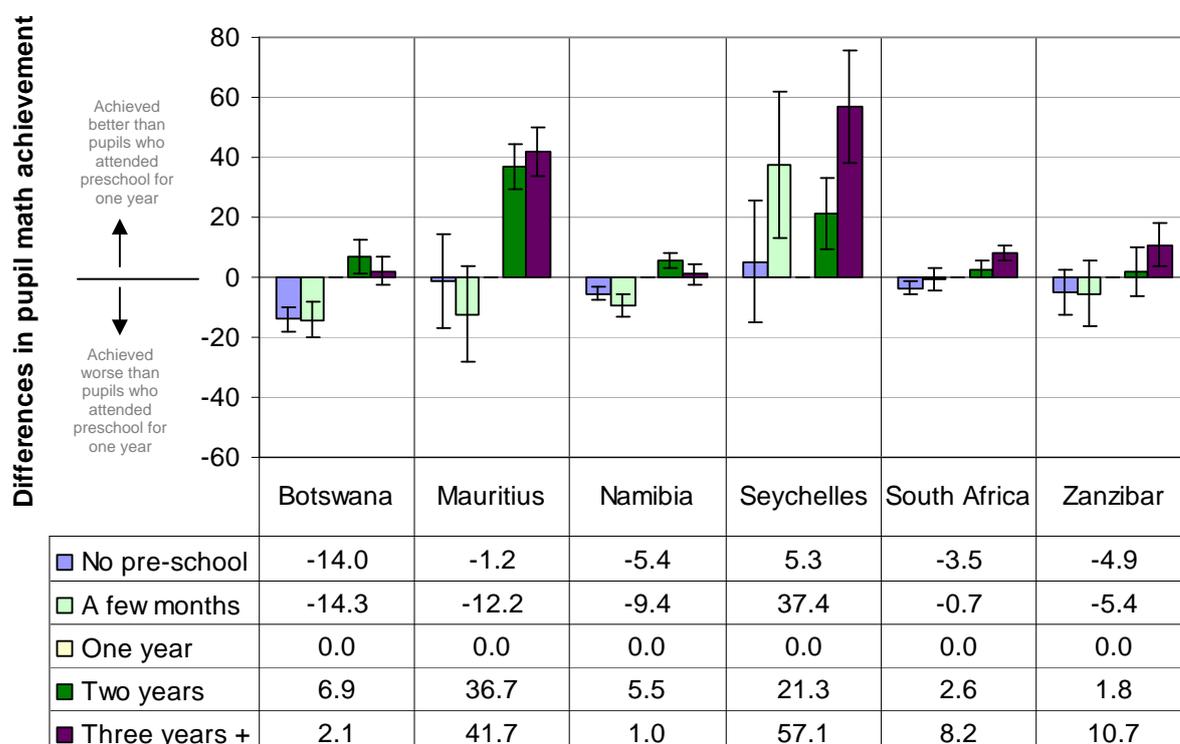


Figure 6: Effects of various durations of preschool attendance on pupil achievement after controlling for pupil SES

**Table 4: Summary of the effects of the common pupil-level variables**

Variable	Variable had significant effects in these models	
	Reading	Mathematics
<b>Grade repetition</b> (Effect: Pupils who had repeated grades performed poorly)	<b>15</b> school systems ALL	<b>13</b> school systems ALL except two: • Malawi • Seychelles
<b>Socioeconomic status</b> (Effect: Pupils from richer homes achieved better)	<b>14</b> school systems ALL except one: • Uganda	<b>13</b> school systems ALL except two: • Malawi • Uganda
<b>Days absent</b> (Effect: Pupils who were rarely or never absent from school did better)	<b>13</b> school systems ALL except two: • South Africa      • Swaziland	<b>11</b> school systems ALL except four: • Mozambique      • Swaziland • South Africa      • Zanzibar
<b>Homework</b> (Effect: Pupils who were given more homework and had it homework corrected and explained by the teachers did better)	<b>12</b> school systems ALL except three: • Malawi      • Swaziland • Seychelles	<b>11</b> school systems ALL except four: • Malawi      • Seychelles • Namibia      • Zambia
<b>Pupil age</b> (Effect: Younger pupils did better except in the Seychelles where older pupils did better in reading)	<b>12</b> school systems ALL except three: • Mauritius      • Zanzibar • Tanzania	<b>9</b> school systems ALL except six: • Mauritius      • Tanzania • Mozambique      • Zambia • Seychelles      • Zanzibar
<b>Pupil sex</b> (Effect: Varied across school systems and across subject) <u>Interpretation:</u> (+) Girls did better (-) Boys did better	<b>11</b> school systems • Botswana (+)      • Seychelles (+) • Kenya (-)      • South Africa (+) • Malawi (-)      • Tanzania (-) • Mauritius (+)      • Uganda (-) • Mozambique (-)      • Zambia (-) • Namibia (+)	<b>13</b> school systems • Kenya (-)      • Swaziland (-) • Lesotho (-)      • Tanzania (-) • Malawi (-)      • Uganda (-) • Mauritius (-)      • Zambia (-) • Mozambique (-)      • Zanzibar (-) • Namibia (-)      • Zimbabwe (-) • Seychelles (+)
<b>Speaking the language of instruction</b> (Effect: Pupils who spoke the language of instruction at home performed better )	<b>9</b> school systems • Botswana      • Seychelles • Mauritius      • South Africa • Mozambique      • Swaziland • Namibia      • Zambia • Zimbabwe	<b>9</b> school systems • Botswana      • Seychelles • Malawi      • South Africa • Mauritius      • Zambia • Mozambique      • Zimbabwe • Namibia
<b>Meals per week</b> (Effect: Pupils who ate more meals per week did better)	<b>9</b> school systems • Botswana      • South Africa • Lesotho      • Uganda • Mauritius      • Zambia • Mozambique      • Zimbabwe • Namibia	<b>5</b> school systems • Botswana      • Zimbabwe • Malawi • Mauritius • Namibia

**Table 4: Summary of the effects of the common pupil-level variables (Continued)**

Variable	Variable had significant effects in these models	
	Reading	Mathematics
<b>Household tasks</b> <i>(Effect: Pupils who undertook fewer household tasks did better)</i>	<b>9 school systems</b> • Botswana                      • Seychelles • Lesotho                        • South Africa • Mauritius                       • Zambia • Mozambique                   • Zanzibar • Namibia	<b>4 school systems</b> • Mauritius                       • Seychelles • Namibia                        • Tanzania
<b>Number of siblings</b> <i>(Effect: Pupils who had fewer brothers and sisters performed better)</i>	<b>8 school systems</b> • Botswana                       • Namibia • Kenya                         • Seychelles • Mauritius                       • South Africa • Mozambique                   • Swaziland	<b>6 school systems</b> • Botswana                       • Seychelles • Kenya                         • South Africa • Mauritius                       • Swaziland
<b>Learning culture (Books at home)</b> <i>(Effect: Pupils from homes with many books did better)</i>	<b>8 school systems</b> • Botswana                       • Mauritius • Kenya                         • Seychelles • Lesotho                         • South Africa • Malawi                         • Tanzania	<b>6 school systems</b> • Malawi                         • Seychelles • Mauritius                       • South Africa • Mozambique                   • Tanzania
<b>Preschool attendance</b> <i>(Effect: Pupil who attended preschool did better)</i>	<b>7 school systems</b> • Botswana                       • Seychelles • Lesotho                         • South Africa • Mauritius                       • Tanzania • Zanzibar	<b>6 school systems</b> • Botswana                       • Seychelles • Mauritius                       • South Africa • Namibia                        • Zanzibar
<b>Pupil learning materials</b> <i>(Effect: Pupils with basic learning items did better)</i>	<b>6 school systems</b> • Mauritius                       • South Africa • Namibia                         • Zambia • Seychelles                     • Zanzibar	<b>7 school systems</b> • Kenya                         • Swaziland • Mauritius                       • Uganda • Seychelles                     • Zimbabwe • South Africa
<b>Living with parents or relatives</b> <i>(Effect: Pupils who lived with biological parents or relatives performed better)</i>	<b>6 school systems</b> • Botswana                       • South Africa • Namibia                         • Zambia • Seychelles                     • Zanzibar	<b>4 school systems</b> • Malawi                         • Zanzibar • Seychelles                     • Zimbabwe
<b>Textbook ownership</b> <i>(Effect: Pupils with sole use of textbooks performed better)</i>	<b>5 school systems</b> • Botswana                       • South Africa • Mozambique                   • Swaziland • Uganda	<b>5 school systems</b> • Botswana                       • Namibia • Mauritius                       • Seychelles • Mozambique
<b>Extra tuition</b> <i>(Effect: Varied across school systems and across subject)</i> <u>Interpretation:</u> (+) Extra tuition associated with higher achievers (-) Extra tuition associated with lower achievers	<b>4 school systems</b> • Mauritius (+)                   • Seychelles (+) • Namibia (-)                   • South Africa (-)	<b>6 school systems</b> • Kenya (+)                   • South Africa (-) • Mauritius (+)                   ) • Seychelles (+)               • Tanzania (+) • Zanzibar (+)

*What were the common school-level factors contributing to the differences in pupils' scores across the 15 African school systems?*

None of the school-level variables examined in this study had significant effects in all the 15 SACMEQ school systems. However, it can be seen from the results in *Tables 2* and *3* that the variable *School resources* had significant effects in ten and seven school systems for reading and mathematics respectively, with pupils in schools that had many resources achieving better than pupils in schools with only a few or no resources. The variable *School location* had significant effects in eight school systems for reading and in seven school systems for mathematics, with pupils in schools located in large towns or cities outperforming pupils in schools located in rural and remote areas. In addition, the variable *Pupil-teacher ratio* had significant effects in five school systems for both subjects, with pupils in schools with smaller pupil-teacher ratios performing better than pupils in schools with larger pupil-teacher ratios.

The variable *Teacher score* had significant effects in five school systems for mathematics but only in three school systems in reading. In the school systems where *Teacher score* was significant, Grade 6 pupils taught by teachers who had higher subject-matter scores were estimated to perform better than pupils taught by teachers with lower subject-matter scores. It will be remembered that, in the SACMEQ III study, teachers were not tested in reading and mathematics in Mauritius.

From the results in *Tables 2* and *3*, it can also be seen that the variable *Free school meals* had significant effects in five school systems for reading and in four school systems for mathematics. In most of these school systems, pupils in schools where one or more free meals were provided per day were estimated to be of lower achievement levels than pupils in schools where no free meals were provided. However, in Kenya free school meals were associated with the better achievers in mathematics. Apart from the results for Kenya, the results from the other school systems were not surprising, because in most SACMEQ countries, free school meals are mostly provided in school serving communities that are deemed to be disadvantaged economically. Such schools are normally located in remote areas or in poor areas in towns and cities. It was not clear why this variable had a positive effect on pupil achievement in Kenya.

Other school-level variables that had significant effects in several school systems were *School community problems* (significant in five school systems for reading), and *Teacher days absent* and *School head experience as a teacher* (both variables significant in the mathematics models for four school systems). Pupils in schools in which lack of cooperation from the community was perceived by the school head as a minor problem or no problem to the school were estimated to perform better than pupils in schools where lack of community cooperation was perceived as a major problem. Pupils who were taught by teachers who were never absent (or were absent for only a few days) during the school year performed better than pupils taught by teachers who were absent for many days. Furthermore, pupils in schools where the

school heads had many years of teaching experience achieved better than pupils whose school heads had only a few years of teaching experience.

A summary of the effects of the school-level variables described above is given in *Table 5*.

**Table 5: Summary of the effects of the common school-level variables**

Variable	Variable had significant effects in these models	
	Reading	Mathematics
<b>School resources</b> <i>(Effect: Pupils in better resourced schools performed better)</i>	<b>10 school systems</b> <ul style="list-style-type: none"> <li>• Kenya</li> <li>• Lesotho</li> <li>• Malawi</li> <li>• Mauritius</li> <li>• South Africa</li> </ul>	<b>7 school systems</b> <ul style="list-style-type: none"> <li>• Swaziland</li> <li>• Uganda</li> <li>• Zambia</li> <li>• Zanzibar</li> <li>• Zimbabwe</li> </ul>
<b>School location</b> <i>(Effect: Pupils in large towns and cities performed better)</i>	<b>8 school systems</b> <ul style="list-style-type: none"> <li>• Kenya</li> <li>• Lesotho</li> <li>• Namibia</li> <li>• Swaziland</li> </ul>	<b>7 school systems</b> <ul style="list-style-type: none"> <li>• Tanzania</li> <li>• Uganda</li> <li>• Zanzibar</li> <li>• Zimbabwe</li> <li>• Botswana</li> <li>• Kenya</li> <li>• Lesotho</li> <li>• Namibia</li> <li>• Swaziland</li> <li>• Uganda</li> <li>• Zanzibar</li> </ul>
<b>Pupil-teacher ratio</b> <i>(Effect: Pupils in school with small ratios did better)</i>	<b>5 school systems</b> <ul style="list-style-type: none"> <li>• Kenya</li> <li>• Malawi</li> <li>• Mauritius</li> </ul>	<b>5 school systems</b> <ul style="list-style-type: none"> <li>• Swaziland</li> <li>• Zimbabwe</li> <li>• Botswana</li> <li>• Kenya</li> <li>• Mauritius</li> <li>• Swaziland</li> <li>• Zimbabwe</li> </ul>
<b>Teacher score</b> <i>(Effect: Pupils taught by teachers with higher scores performed better)</i>	<b>3 school systems</b> <ul style="list-style-type: none"> <li>• Namibia,</li> <li>• South Africa</li> <li>• Tanzania</li> </ul>	<b>5 school systems</b> <ul style="list-style-type: none"> <li>• Kenya</li> <li>• Namibia</li> <li>• South Africa</li> <li>• Swaziland</li> <li>• Tanzania</li> </ul>
<b>Free school meals</b> <i>(Effect: In general,, pupils in schools without free meals did better)</i>	<b>5 school systems</b> <ul style="list-style-type: none"> <li>• Botswana</li> <li>• Mauritius</li> <li>• Namibia</li> </ul>	<b>4 school systems</b> <ul style="list-style-type: none"> <li>• South Africa</li> <li>• Uganda</li> <li>• Botswana</li> <li>• Kenya</li> <li>• South Africa</li> <li>• Uganda</li> </ul>
<b>School community problems</b> <i>(Effect: Pupils in schools where community cooperation was not a problem did better)</i>	<b>5 school systems</b> <ul style="list-style-type: none"> <li>• Botswana</li> <li>• Malawi</li> <li>• Mauritius</li> </ul>	<b>1 school system</b> <ul style="list-style-type: none"> <li>• Swaziland</li> <li>• Uganda</li> <li>• Mauritius</li> </ul>
<b>Teacher days absent</b> <i>(Effect: Pupils taught by teachers who were rarely or never absent did better)</i>	<b>1 school system</b> <ul style="list-style-type: none"> <li>• Zambia</li> </ul>	<b>4 school systems</b> <ul style="list-style-type: none"> <li>• Kenya</li> <li>• Malawi</li> <li>• Mauritius</li> <li>• South Africa</li> </ul>
<b>SH teaching experience</b> <i>(Effect: Pupils with school heads who had many years of experience achieved better)</i>	<b>0 school systems</b>	<b>4 school systems</b> <ul style="list-style-type: none"> <li>• Botswana</li> <li>• Malawi</li> <li>• Mozambique</li> <li>• Uganda</li> </ul>

*What were the most important factors contributing to the differences in pupils' scores across the 15 school systems?*

The criterion of a standardized regression coefficient  $\geq |0.10|$  as an indicator of an important variable can be employed to identify the variables that were important predictors of pupil

reading and mathematics scores in these school systems from the results given in *Tables 2 and 3*. For example, based on this criterion, the most important predictors of pupil reading score in Botswana were *Pupil SES* (0.23), *Free school meals* (-0.20), *Grade repetition* (-0.17), and *Pupil age* (-0.10), while the most important predictors of pupil mathematics score in this country were again *Pupil SES* (0.18), *Grade repetition* (-0.15) and *Free school meals* (-0.15). In Zimbabwe, the most important predictors of pupil reading scores were *Grade repetition* (-0.10), *Pupil SES* (0.13), *Teacher education level* (0.10), *School resources* (0.19), and *School location* (0.18), and the most important predictors of pupil mathematics score were *Grade repetition* (-0.12), *School resources* (0.15), and *School location* (0.11).

From the results in *Table 2* (in column T2), it can be seen that *Pupil SES* emerged as a vital predictor of pupil reading achievement in 11 school systems, *Grade repetition* was an important predictor in nine school systems, *School location* in seven school systems, and *Pupil age* and *School resources* in six school systems each. Similarly, it can be seen from *Table 3* that *Pupil SES* emerged as an important predictor of pupil mathematics achievement in eight school systems, *Pupil sex* and *Grade repetition* in six school systems each, and *Pupil age* and *School resources* in four school systems each.

*What were the variations in pupil scores across the 15 SACMEQ school systems?*

*Figures 7 and 8* were plotted using the results of variance available in the null models and variance explained in the final models at the pupil level and school level given in *Appendices 2 and 3*.

From the width of the bars in *Figures 7 and 8*, it can be seen that the Seychelles, Mauritius, and South Africa had the largest total (within-school + between-school) variances in pupil reading scores, and also the largest variance in pupil mathematics scores. Malawi had the smallest total variance in reading scores, while Swaziland (followed closely by Zanzibar and Malawi) had the smallest total variance in mathematics scores. For both subjects the within-school variance was largest in the Seychelles and Mauritius, while the between-school variance was largest in South Africa.

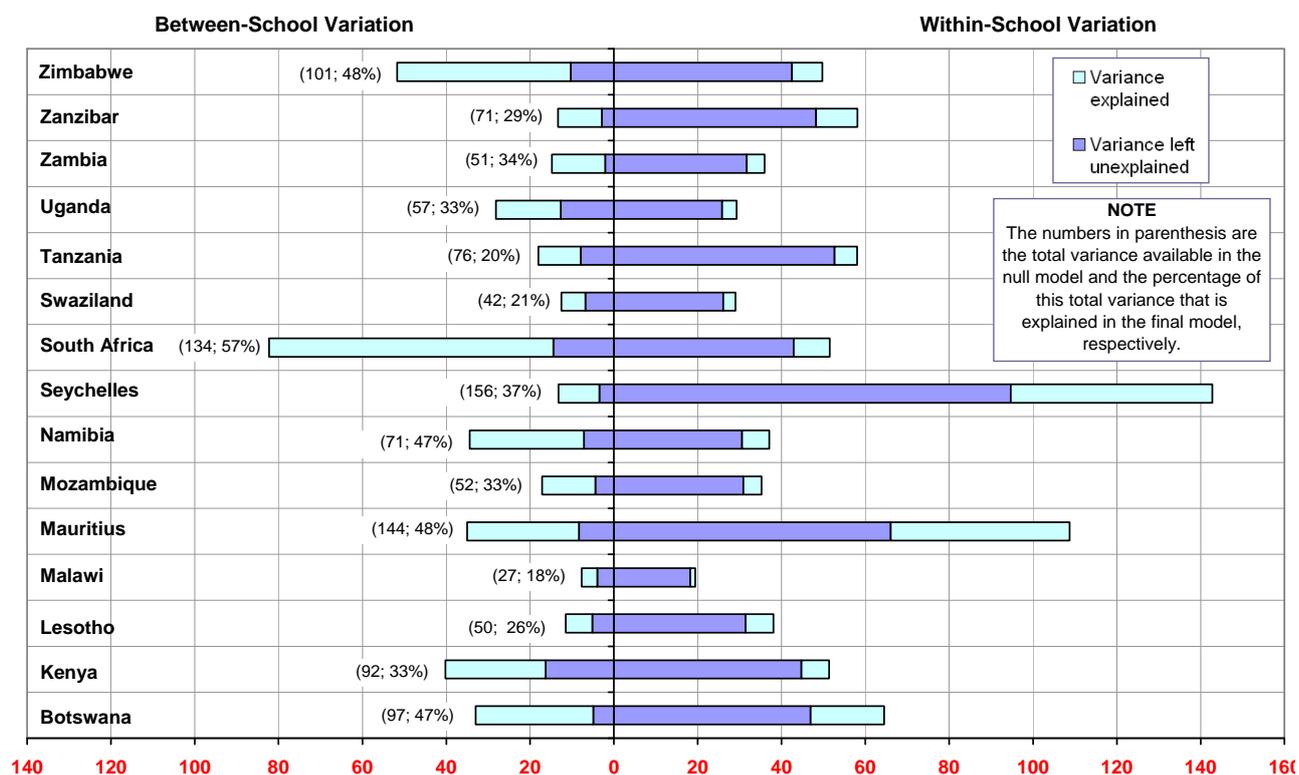


Figure 7: Variation in reading achievement

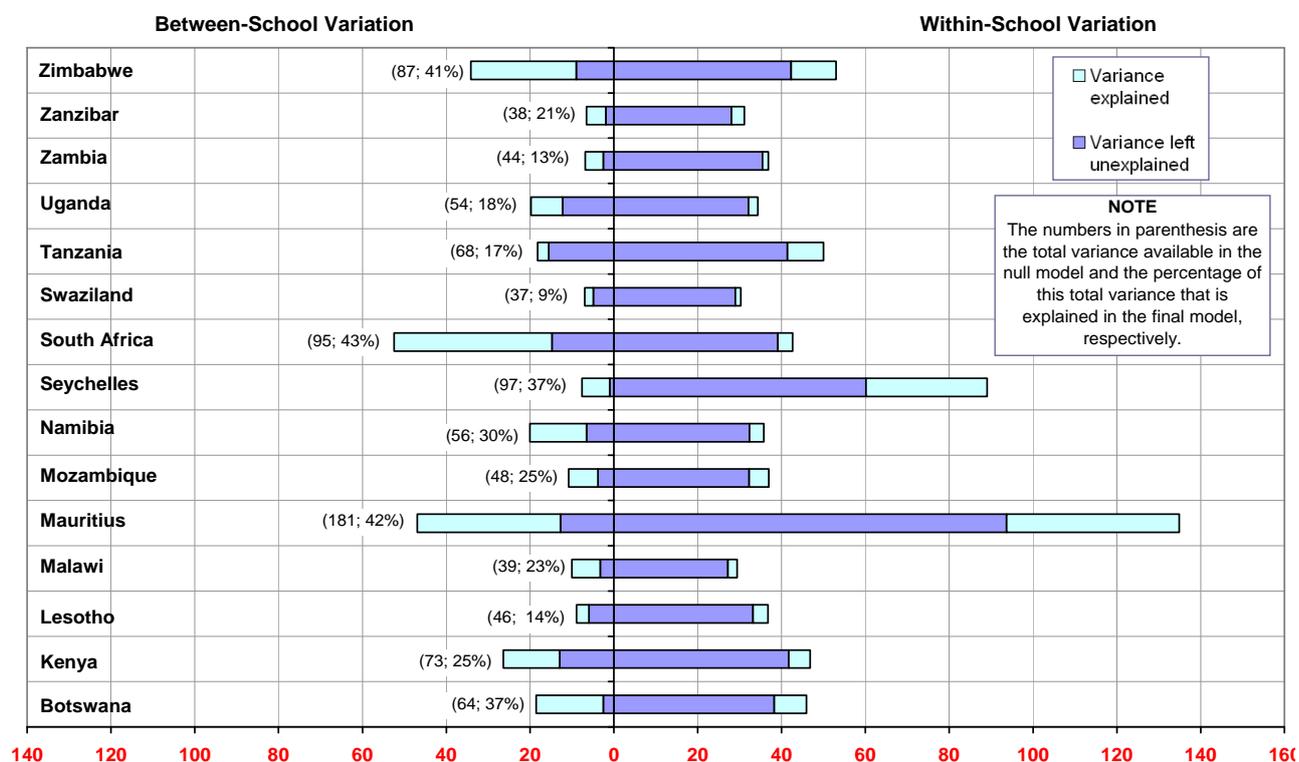


Figure 8: Variation in mathematics achievement

For the Seychelles, the large within-school variance is a consequence of streaming, which is prevalent within primary schools in the Seychelles (Leste *et al.*, 2005; Hungi and Thuku, 2010a). The same is probably the case for Mauritius, where streaming process starts after Grade 4 in preparation for the highly competitive end of primary school examination (Jahangeer and Jahangeer, 2004). On the other hand, the large between-school variances for South Africa could be attributed to the apartheid history of South Africa, where some schools were purposely well equipped and well staffed while the opposite was the case for other schools (Hungi and Thuku, 2010a).

The amount of variance available between schools is an indicator of the degree of equity in a school system, with large variance being associated with inequitable school systems (see Ferrer *et al.*, 2006: 549). Thus, South Africa had the most inequitable school system for both subjects (most between-school variation in *Figures 7* and *8*), followed by Zimbabwe for reading achievement, and by Mauritius for mathematics achievement. Nonetheless, it should be noted that most of the between-school variance in South Africa was explained by pupil background factors and school characteristics factors included in the final model for reading (50 per cent) and mathematics (40 per cent). Swaziland, Malawi, and Lesotho were among the countries that had school systems with high degrees of equity for both subjects.

For most school systems, it can be seen from *Figures 7* and *8* that the models developed in this study explained only small amounts of the within-school variance. This indicates that there are other pupil-level factors that contributed to the variation in the achievement scores, which were not included in these models. In this respect, there is a need for further investigation to examine what other important factors were left out of this study for most of the SACMEQ school systems (especially for the Seychelles and Mauritius, where large amounts of within-school variance were left unexplained).

#### *Were there substantial changes in the between-school variances over time?*

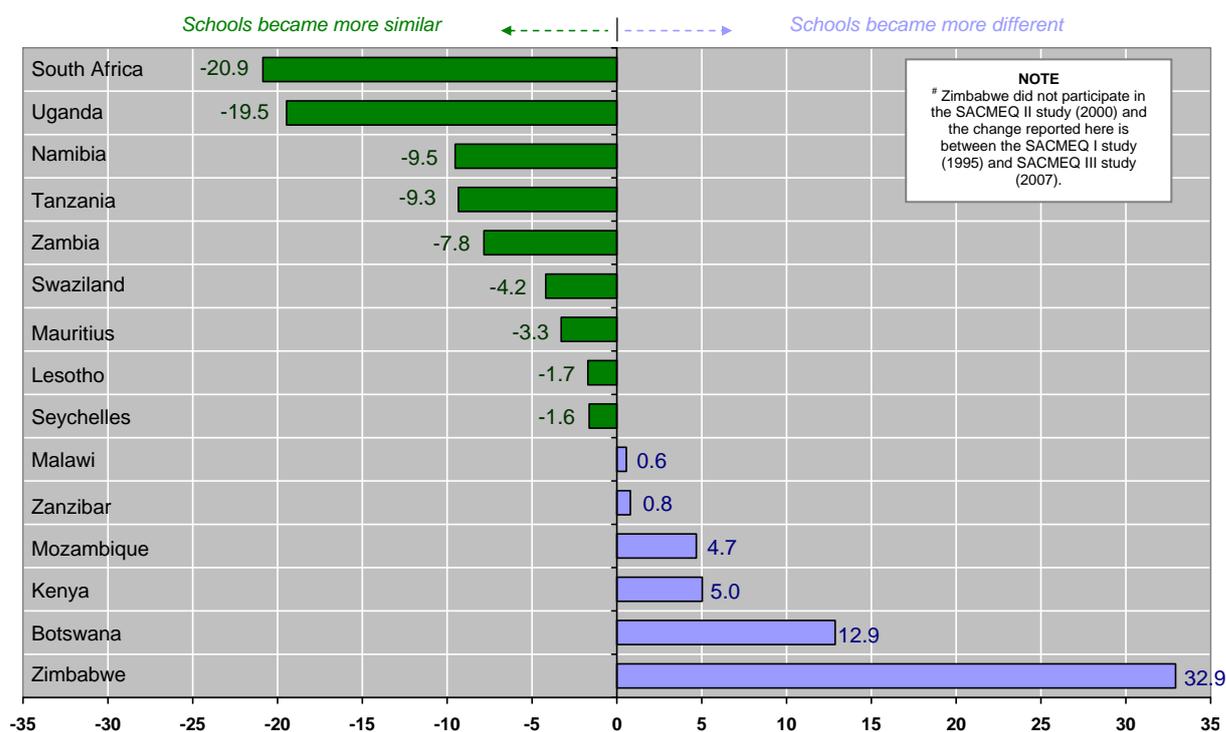
The changes in between-school variations in pupil reading scores between 2000 (SACMEQ II) and 2007 (SACMEQ III) are depicted in *Figure 9* (changes in between-school variations in pupil mathematics scores followed a similar pattern). For Zimbabwe, the change depicted in *Figure 9* is between 1995 (SACMEQ I) and 2007 because Zimbabwe did not participate in the SACMEQ II study.

South Africa and Uganda recorded the largest decrease in between-school variation in pupil reading scores, while Zimbabwe and Botswana recorded the largest increase in this variation. Namibia and Tanzania also recorded a considerable decline in between-school variation. However, in most of the other school systems, this between-school variation remained roughly the same.

These results should be pleasing to the education authorities in South Africa, Uganda, Namibia, and Tanzania, because they imply that schools in these countries were becoming

more alike (equitable). On the other hand, the results should be troubling to the authorities in Zimbabwe (and to some extent Botswana), because it means that schools in these countries were becoming more dissimilar (inequitable).

It can be noted from *Figure 9* that the change in between-school variation was strikingly larger for Zimbabwe than the changes that were recorded for the other school systems. This could be partly because the time period considered for Zimbabwe is 12 years (1995 to 2007) while the time period considered for the other school systems is just seven years (2000 to 2010). It could also be partly because of the economic challenges undergone by Zimbabwe during this time period.



**Figure 9: Changes in between-school variations in pupil reading scores between 2000 and 2007**

## Summary and conclusions

The major purpose of this study was to identify the key pupil- and school-related factors that contribute to variation in reading and mathematics achievement among Grade 6 pupils in the 15 school systems that participated in the SACMEQ III study in 2007. In order to achieve this purpose, a two-level model of pupil achievement was hypothesized and analysed using multilevel procedures for each subject and for each of the 15 school systems.

At the pupil level, the results of the analyses showed that pupil socio-economic status background, pupil sex, pupil age, grade repetition, absenteeism, homework, and speaking the language of instruction at home were the common contributors to the variation in pupil

achievement in most of the 15 school systems for both subjects. These were the same variables that were previously identified by Hungi and Thuku (2010a) in their analyses of SACMEQ II data. Thus, in general, the individual-level factors influencing pupil achievement in SACMEQ school systems have not changed much over the last seven years or so.

At the school level, the common contributors to the variation in pupil achievement were identified as school resources, school location, pupil–teacher ratio, and teacher score (subject-matter knowledge). School resources and teacher score were also identified as common predictors of pupil achievement based on the SACMEQ II data (Hungi and Thuku, 2010a).

Importantly, based on the magnitudes of standardized regression coefficients of the variables in the final models, results showed that the most important contributors to variation in pupil reading and mathematics achievement across most of the 15 school systems were pupil socio-economic background, grade repetition, pupil age, and school resources. In addition, it was found that school location had a big impact on pupil reading scores in most of these school systems, and that pupil sex was an important predictor of mathematics achievement among Grade 6 pupils in these nations.

For both subjects, the results also showed that the school system with the largest between-school variation was South Africa, while the school systems with the largest within-school variation were the Seychelles and Mauritius. Large gender inequity in pupil achievement was evident in the Seychelles. Moreover, low social equity in pupil achievement in reading and mathematics was evident in South Africa, Mauritius, and Zimbabwe.

#### *What were the policy implications of the key factors influencing pupil achievement?*

The ministries of education in SACMEQ countries could consider taking actions for those variables that have been identified in this paper as important predictors of school achievement among pupils in their countries. In general, grade repetition, socio-economic status, pupil age, pupil sex, school location, and school resources were found to be important predictors of pupil achievement across most SACMEQ school systems.

For grade repetition, pupils who had never repeated grades achieved better scores than pupils who had repeated grades. On average, almost two out of every five pupils (37 per cent) in the SACMEQ III study reported that they had repeated a class at least once since starting schooling. In some countries such as Malawi and Mozambique the percentages of grade repeaters were much higher than this, and close to 60 per cent (see Hungi, 2010).

High levels of grade repetition have been blamed for increasing the overall cost of schooling because if many pupils repeat each year, school systems need to employ more teachers and build more classrooms. In most cases, pupils are made to repeat because it is believed that this will improve their academic performance. However, educational research has shown that grade repetition does not address the problems of low achievers satisfactorily, and that

potential solutions lie in early intervention, collaboration with parents, and supplementary instruction (Brophy, 2006).

As expected, pupils from richer homes and with better-educated parents outperformed pupils from poorer homes and with less-educated parents. Hungu and Thuku (2010a) proposed that, in order to minimize the effects of socio-economic background on pupil achievement in the long term, the education authorities in SACMEQ school systems may wish to consider introducing special home intervention projects. These projects would involve training teachers on how to change parental behaviour in the home so that the children receive more encouragement and support for studying. Such home intervention projects have been implemented successfully in Malaysia (see Norisah *et al.*, 1982), and were credited with raising the achievement levels of children from disadvantaged families. Such projects could reduce the large social inequity in pupil achievement found in some SACMEQ school systems, especially in Mauritius and the Seychelles, as well as reduce the problems of pupil absenteeism and grade repetition in the long term.

For *Pupil age*, being older in Grade 6 was a clear disadvantage for both reading and mathematics in most SACMEQ school systems, except in the Seychelles. As suggested by Hungu and Thuku (2010b), it is likely that older pupils feel out of place and thus less motivated to participate in school work than their younger counterparts. On average, Grade 6 pupils in most SACMEQ school systems were well above the expected age. For example, the expected age for Grade 6 pupils in Kenya, Lesotho, Malawi, and Mozambique is around 12 years, but the observed average pupil age from the SACMEQ III data for Grade 6 pupils in these countries was around 14 years. Furthermore, on average, about half (55 per cent) of the pupils in the SACMEQ III data were estimated to be over-age (at least one year older than expected), while about three-quarters of Grade 6 pupils in seven school systems (Kenya, Malawi, Mozambique, Namibia, Tanzania, Uganda, and Zanzibar) were estimated to be over-age. Incidences of over-age pupils could partly be blamed on the high levels of grade repetition discussed above. These over-age incidences could also be partly blamed on starting school late. This means that parents and education authorities in SACMEQ nations should ensure that pupils start schooling at the official age of entry and also minimize grade repetition.

For pupil sex, the direction of effect (especially for reading) varied from country to country. However, for mathematics, boys outperformed girls in almost all countries, except in the Seychelles where girls greatly outperformed boys. Ability grouping was blamed for the poor performance of boys in the Seychelles (Leste *et al.*, 2005). For the other SACMEQ school systems, the authorities concerned should consider commissioning studies to examine the reasons for the poor performance of girls (especially in mathematics) and to identify ways of correcting this problem. Hungu and Thuku (2010b), analysing data from the SACMEQ II study for Kenya, suggested that gender differences in mathematics achievement in Kenya could be linked to how mathematics is taught in Kenyan primary schools, the teaching

materials used in mathematics classes, or the Kenyan culture, which is mostly male dominated and perceives girls as not being very able in mathematics and sciences (see also studies by Lloyd *et al.*, 1998 and 2000, which investigate effects of primary school quality on pupil achievement and school internal efficiency among Kenyan pupils). Perhaps these perceptions about girls' abilities in mathematics, and teaching approaches (or teaching materials) that disadvantage or discourage girls in mathematics, are common in most SACMEQ nations.

*School location* and *School resources* were the other factors that were found to be important in a vast majority of the SACMEQ school systems. Pupils in schools located in urban areas performed better than pupils in schools located in rural areas, while pupils in schools with more resources did better than pupils in schools with fewer resources. Thus, the education authorities in SACMEQ nations should endeavor to provide more resources to all schools, especially those located in isolated areas and villages.

*What are the policy implications of the within-school and between-school variations?*

Large within-school variation in pupil achievement indicates huge inequity between pupils in the same school. Hungi and Thuku (2010a), using the SACMEQ II data (collected in 2000), found that the within-school variations in pupil achievement in the Seychelles and Mauritius were much larger than these variations in other SACMEQ school systems. In the current study, the within-school variations were also found to be largest in the Seychelles and Mauritius, showing that this inequity still persists in these two countries. Hungi and his colleague suggested that this inequity could be linked to the streaming practiced in these two school systems. They argued that this kind of inequity should be discouraged by the governments by introducing policies against streaming and for the promotion of mixed-ability teaching in primary schools.

Between-school variations were found to be largest in South Africa and Zimbabwe (especially in reading), and this indicates considerable inequity between the qualities of education offered in primary schools in these two school systems. Thus, the ministries of education in South Africa and Zimbabwe need to take actions to facilitate the improvement of low-performing schools with an aim of minimizing the variance between primary schools in their countries. Nevertheless, the authorities in South Africa should be pleased because their country recorded the largest decrease in between-school variation between 2000 and 2007, which indicates that schools in South Africa were becoming more alike. Uganda and Namibia were the other countries that recorded impressive reductions in the between-school variations, meaning that whatever actions the authorities in those countries were carrying out in their efforts to minimize between-school variation were paying dividends. This is encouraging.

On the other hand, Zimbabwe recorded the largest increase in between-school variation, but this could be partly because the change in between-school variation in Zimbabwe was over a 12-year period (1995 to 2007) while in other countries this change was over a seven-year

period (2000 to 2007). Nonetheless, this means that schools in Zimbabwe were becoming more dissimilar (inequitable), and therefore the authorities in Zimbabwe may wish to consider taking action to arrest this trend.

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# APPENDICES

## Appendix 1: Variables tested in the two-level models for reading and mathematics

### LEVEL 1 (PUPIL) VARIABLES

#### *Pupil individual characteristics*

**Pupil age**

**Pupil sex**

(0=boy; 1=girl)

**Grade repetition**

(0=never; 1=repeated once; 2=repeated twice; 3=repeated three times or more)

**Days absent**

**Speaking language of instruction**

(0=never, 1=sometimes; 2=most of the time; 3=all the time)

#### *Personalized learning support*

**Preschool attendance**

(0=never; 0.5=a few months; 1=one year; 2=two years; 3=three years or more)

**Pupil learning materials**

Sum of possession of at least one of each of eight important learning materials: an exercise book, a notebook, a pencil, a sharpener, an eraser, a ruler, a pen, and a file.

(0= no learning materials; 1=at least one; . . . 8=at least one of each item)

**Homework factor**

(0=no homework given; 1=homework given some days but never corrected nor explained; . . . 9=homework given most days, and always corrected and explained)

**Homework help at home**

Two version of this variable were considered:

*Version 1:* (0=no homework/never; 1=sometimes; 2=most of the time).

*Version 2:* (0=no homework/never; 1=sometimes/most of the time).

**Extra tuition**

(0=no extra tuition in this subject; 1=extra tuition in this subject)

**Working place factor**

(0=has no sitting nor writing place; 1=has either sitting or writing place; 2=has both sitting and writing places)

**Textbook ownership**

(0=no textbook; 1=share with 2 or more pupils; 2=share with one pupil; 3=sole use)

**Travel distance to school**

#### *Home environment*

**Socio-economic status factor**

Rasch score involving items on home possessions, parental education, home quality, source of lighting at home, etc. (see Dolata, 2005)

**Number of siblings**

Number of brothers and sisters (plus step- and half- brothers and sisters) living with pupil at home.

**Meals per week**

Total number of meals (breakfast, lunch, and supper) taken by pupil a week.

**Household tasks factor**

Sum of the involvement of pupil in various household activities such as laundry, fetching water, collecting firewood, livestock duties.

**Learning culture at home**

Number of books at home

**Parents alive**

(0=no parent alive; 1=one parent alive; 2=both parents alive)

**Living with parents/relatives**

(0=living with non-relatives; 1=living with parents or relatives)

## Appendix 1: Continued.

**LEVEL 2 (SCHOOL & CLASS) VARIABLES***Teacher characteristics***Teacher sex**

(0=male; 1=female)

**Teacher age****Permanent teacher**

(0=temporary teacher; 1=permanent teacher)

**Teacher education level**

(0=primary; 1=junior secondary; 2=senior secondary; 3=A-level; 4=university graduate)

**Teacher years of professional training**

(0=no training; 0.5=less than one year; 1=one year; 2=two years; 3=three years; 4=more than three years)

**Teacher years of experience****Teaching hours per week****Teacher in-service training**

Number of short in-service courses attended during the last three years

**Teacher visits to education resource centre**

(0=no educ. resource centre/not visited; 1=has visited educ. resource centre during this school year)

**Teacher subject matter knowledge**

Teacher score on a reading test (for the reading models).

Teacher score on a mathematics test (for the mathematics models).

**Teacher frequency of meeting parents**

(0=never; 1=once a year; 2=once a term; 3=once or more per month)

**Teacher hours of preparation per week****Teacher housing condition**

(0=poor state; 1=require major repairs; 2=requires minor repairs; 3=good condition)

**Teacher trained to teach subject**

(0=not trained to teach subject; 1=trained to teach subject)

**Teacher days absent**

Number of days absent during this school year.

**Report on subject**(0=school report for each pupil has no specific section for comments on the subject;

1=school report for each pupil has a specific section for comment on the subject)

**School head advice teacher**

(0=never; 1=once a year; 2=once a term; 3=once or more a month)

*Classroom environment***Class size**

Number of pupils in the class.

**Classroom resources factor**

Sum of the existence of the following eight items in the classroom: writing board, chalk/marker, wall chart, cupboard, bookshelves, classroom library or book corner, teacher table, and teacher chair.

**Parents sign homework**(0=parents not asked to sign homework; 1=parents asked to sign homework)**Frequency of tests**

(0=no tests; 1=once a year; 2=once per term; 3=two or three times per term;

4= two or three times per month; 5=at least once per week)

## Appendix 1: Continued

### LEVEL 2 VARIABLES (Continued)

#### *School head characteristics*

**School head sex**

(0=male; 1=female)

**School head age****School head years of professional training**

(0=no training; 0.5=less than one year; 1=one year; 2=two years; 3=three years; 4=more than three years)

**School head education level**

(0=primary; 1=junior secondary; 2=senior secondary; 3=A-level; 4=university graduate)

**School head years of experience as a head****School head years of teaching experience****School head management course**

(0=no training on school management; 1=has received training on school management)

**School head teaching hours per week**

#### *School environment*

**Condition of school buildings**

(0=poor state; 1=require major repairs; 2=require minor repairs; 3=good condition)

**School resources factor**

Two versions of this variable were considered:

*Version 1:* Sum of the existence of 22 school resource items in the school including a school library, school meeting hall, staff room, separate office for school head, sports area, water, electricity, telephone, fax machine, overhead projector, radio, TV set, photocopier, and computer.

*Version 2:* Rasch score involving school resources items (e.g. school library, staff room, water, electricity, and computer) as well as classroom resource items such as teacher table, teacher chair, sitting places, cupboard, and bookshelves (see Saito, 2005).

**Borrowing books from school**

(0=no library/not allowed to borrow books; 1=pupils allowed to borrow books)

**Proportion of female teachers****School days lost**

Number of school days lost in the last school year because of factors beyond school head control such as natural calamities, strikes, and social unrest.

**School location**

(0=isolated; 1=rural; 2=small town; large town or city)

**School inspections**

Two version of this variable were considered:

*version 1:* The number of times the school has been visited by a school inspector or quality assurance office during the last two school years.

*version 2:* The number of years since the school had a full inspection.

**School community contribution factor**

Sum of the presence of community contributions towards nine school activities including construction and maintenance of school buildings, construction and repair of school furniture, provision of school meals, buying of textbooks, stationery and supplies, payment of teacher salaries, and extra-curriculum activities.

**School community problems**

The extent to which lack of cooperation from community is a problem to the school.

(0=no problem; 1=minor problem; 2=major problem).

**Appendix 1: Continued****LEVEL 2 VARIABLES (Continued)****Pupils' behaviour problems factor**

Sum of existence of behavioural problems among pupils (e.g. lateness, skipping classes, classroom disturbance, cheating, use of abusive language, theft, fighting, and vandalism)

**Teachers' behaviour problems factor**

Sum of existence of behavioural problems among teachers (e.g. lateness, absenteeism, skipping classes, use of abusive language, drug abuse, and alcohol abuse)

**Pupil–teacher ratio****Pupil–toilet ratio****Private school**

(0=government school; 1=private school)

**Free school meals**

(0=no free school meals; 1=one free school meal a day; 2=two or more free school meals a day)

**School size**

Total number of pupils in the schools' biggest shift.

***School environment (aggregated variables)*****Mean pupil age****Proportion of girls****Mean grade repetition****Mean days absent****Mean speaking language of instruction****Mean preschool attendance****Mean learning materials****Mean homework (given, corrected, and explained)****Mean homework help****Mean extra tuition****Mean working place****Mean textbook ownership****Mean travel distance to school****Mean socio-economic status****Mean number of siblings****Mean meals per week****Mean household tasks****Mean learning culture****Mean parents alive****Mean living with parents/relatives**

## Appendix 2: Final models for reading achievement

**Table A6: Pupil-level models for reading**

Variable	Botswana		Kenya		Lesotho		Malawi		Mauritius		Mozambique		Namibia		Seychelles	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Pupil age	-9.04	1.52	-10.01	0.99	-5.17	0.68	-2.15	0.58			-1.45	0.61	-6.56	0.60	18.59	8.95
Pupil sex	16.25	2.47	-11.73	2.30			-12.42	1.89	7.93	3.43	-12.80	2.22	5.30	1.71	48.40	6.57
Grade repetition	-26.70	2.16	-12.81	1.65	-8.64	1.35	-4.59	1.15	-49.90	3.94	-6.20	1.34	-15.48	1.35	-27.54	10.12
Days absent	-2.24	0.96	-1.89	0.53	-1.43	0.45	-1.81	0.44	-7.34	0.81	-1.44	0.57	-0.97	0.46	-4.15	1.30
Preschool attendance	6.15	1.34			2.46	0.97			9.26	2.40					18.64	7.83
Speaking language of instruction	13.72	2.18							35.84	3.67	4.25	1.44	8.14	1.39	50.97	6.47
Socio-economic status	0.24	0.02	0.06	0.03	0.12	0.02	0.05	0.02	0.29	0.03	0.10	0.02	0.09	0.02	0.24	0.06
Number of siblings	-1.14	0.52	-1.16	0.47					-4.30	1.19	-1.25	0.45	-1.17	0.19	-9.87	2.24
Meals per week	0.82	0.31			1.11	0.32			1.29	0.54	0.83	0.32	0.65	0.19		
Household tasks	-2.18	0.67			-1.71	0.69			-4.12	0.87	-1.63	0.78	-1.98	0.50	-6.53	1.70
Homework help at home	14.90	5.95									4.54	2.26				
Parents alive	4.52	2.10							12.67	6.18						
Living with parents/relatives	11.46	5.18											5.83	2.47	28.36	6.67
Learning culture (books at home)	0.05	0.03	0.09	0.02	0.05	0.02	0.04	0.02	0.08	0.02					0.25	0.05
Pupil learning materials									3.51	0.76			1.32	0.51	14.90	2.95
Reading textbook ownership	10.54	1.74									5.92	1.28				
Homework	2.88	0.73	4.44	0.57	1.58	0.77			4.55	0.98	2.39	0.71	1.34	0.57		
Extra tuition in reading									32.15	4.95			-9.42	4.02	19.71	8.09
Travel distance to school			-2.64	0.83	-2.06	0.68			-3.21	1.00						
Working place																
<b>Within-school variation</b>																
Null model ( $\delta^2$ , %variance available)	64.5	66.1%	51.4	56.1%	38.1	76.8%	19.4	71.7%	108.7	75.6%	35.2	67.3%	37.1	51.9%	142.8	91.5%
Final model ( $\delta^2$ , %variance explained)	46.9	18.0%	44.8	7.2%	31.4	13.5%	18.2	4.4%	66.0	29.7%	30.9	8.3%	30.6	9.1%	94.7	30.8%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

**Table A6: Pupil-level models for reading (Continued)**

Variable	South Africa		Swaziland		Tanzania		Uganda		Zambia		Zanzibar		Zimbabwe	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Pupil age	-5.12	0.76	-4.50	0.63			-4.91	0.71	-1.31	0.62			-4.18	1.97
Pupil sex	10.81	1.70			-17.64	3.05	-9.51	1.77	-9.07	3.01				
Grade repetition	-15.00	1.25	-9.53	1.28	-23.96	2.66	-4.74	1.13	-8.86	1.56	-26.14	4.43	-14.25	2.54
Days absent					-3.29	0.42	-1.02	0.33	-1.34	0.43	-3.00	0.52	-1.69	0.57
Preschool attendance	2.84	0.83			5.13	2.18					3.99	1.77		
Speaking language of instruction	14.69	1.66	3.86	1.61					10.75	2.31			8.49	2.33
Socio-economic status	0.20	0.02	0.08	0.01	0.18	0.03			0.12	0.03	0.19	0.04	0.16	0.04
Number of siblings	-0.90	0.30	-1.15	0.28										
Meals per week	0.63	0.20			xxx	xxx	0.56	0.21	0.55	0.27			1.26	0.33
Household tasks	-1.54	0.46							-1.81	0.79	-2.72	1.07		
Homework help at home											7.13	3.36		
Parents alive														
Living with parents/relatives	8.64	3.23							6.66	3.23	46.45	11.01		
Learning culture (books at home)	0.08	0.01			0.80	0.25								
Pupil learning materials	1.53	0.54							1.66	0.72	3.53	1.16		
Reading textbook ownership	2.81	1.11	20.12	7.34			3.31	1.11						
Homework (given, corrected, and explained)	2.02	0.48			1.74	0.62	3.22	0.51	1.82	0.80	4.47	0.88	3.87	0.92
Extra tuition in reading	-12.98	5.10												
Travel distance to school													-2.18	1.03
Working place	18.17	7.66			26.45	8.99							16.97	3.87
<b>Within-school variation</b>														
Null model ( $\delta^2$ , %variance available)	51.5	38.5%	29.0	69.9%	58.0	76.3%	29.3	51.0%	36.0	70.9%	58.1	81.3%	49.8	49.0%
Final model ( $\delta^2$ , %variance explained)	42.9	6.5%	26.1	7.1%	52.6	7.1%	25.9	6.0%	31.7	8.5%	48.3	13.8%	42.5	7.2%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

xxx - There were some technical issues with Meals per week for Tanzania

**Table A7: School-level models for reading**

Variable	Botswana		Kenya		Lesotho		Malawi		Mauritius		Mozambique		Namibia		Seychelles	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Grade mean	502.94	7.40	548.99	3.65	463.96	2.07	439.21	2.26	538.60	5.09	479.47	2.32	489.81	3.16	526.10	8.52
Teacher age					-0.49	0.18							-0.55	0.23		
Permanent teacher					32.26	6.71										
Teacher yrs of prof. training							8.40	3.19								
Teacher in-service training			3.12	1.42	0.66	0.25										
Teacher subject matter knowledge									xxx	xxx			0.06	0.02		
Teacher freq. of meeting parents			8.57	3.38												
Frequency of reading tests					-5.27	2.20										
Proportion of female teachers			0.44	0.17			0.26	0.10								
Class size							-0.30	0.08								
SH sex			18.92	8.56												
SH age			-2.10	0.63												
SH experience as a head							1.34	0.44								
SH management course									15.76	6.95						
School resources			3.57	1.65	2.08	0.90	2.66	1.12	0.12	0.05						
School location			13.99	5.55	8.23	3.08							21.41	3.18		
School inspections													2.70	0.94		
School community contribution											3.94	1.37				
School community problems	-6.53	3.25					-9.02	3.01	-14.35	3.84						
Pupil-teacher ratio			-0.54	0.27			-0.12	0.05	-1.38	0.65						
Free school meals	-64.38	7.33							-17.00	6.44			-14.08	4.34		
School size									0.04	0.01					-0.05	0.01
Pupils' behaviour problems							0.67	0.30								
Mean days absent													-23.94	6.81		
Mean preschool attendance											58.17	18.58				
Mean sp. language of instruction					51.45	19.46										
Mean socioeconomic status											0.41	0.08				
Mean meals per week	13.85	5.23														
Mean reading textbook ownership													3.72	1.85		
Mean homework											1.93	0.87				
Mean extra tuition in reading	74.82	27.23														
Mean working place													15.54	4.34		
<b>Between-school variation</b>																
Null model ( $\tau$ , %var. available)	33.0	33.9%	40.2	43.9%	11.5	23.2%	7.7	28.3%	35.0	24.4%	17.1	32.7%	34.4	48.1%	13.2	8.5%
Final model ( $\tau$ , %var. explained)	4.9	28.8%	16.3	26.1%	5.2	12.7%	4.0	13.7%	8.3	18.6%	4.4	24.3%	7.2	38.1%	3.4	6.3%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

xxx - Teachers were not tested in Mauritius

**Table A7: School-level models for reading (Continued)**

Variables	South Africa		Swaziland		Tanzania		Uganda		Zambia		Zanzibar		Zimbabwe		
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	
Grade mean	485.01	3.83	548.62	2.23	586.02	2.79	478.94	2.65	429.20	3.04	489.47	11.19	505.25	3.38	
Teacher education level													1.20	0.44	
Teacher teaching hours per week			-0.80	0.34											
Teacher visits to educ. res. centre					12.31	4.35									
Teacher subject matter knowledge	0.10	0.04			0.12	0.04									
Teacher hours of prep. per week			0.77	0.34											
Teacher housing condition	6.97	2.52													
Frequency of reading tests	9.24	3.20													
Teacher days absent									-0.14	0.06					
Teachers' behaviour problems	-1.58	0.69									xxx	xxx			
Class size									-0.29	0.12					
SH professional training	8.43	2.87													
SH education level			6.30	2.77											
SH teaching hours per week					-0.68	0.29									
Condition of school buildings					4.42	1.89									
School resources	2.57	0.64	2.16	0.75			4.64	0.97	0.06	0.03	2.09	0.87	0.21	0.06	
Pupils allowed to borrow books	27.69	6.51													
School location			13.10	2.68	16.41	2.81	21.26	4.16			8.84	2.56	20.70	6.18	
School community problems			-8.03	3.29			-9.31	3.61							
Pupil-teacher ratio			-1.23	0.37					xxx	xxx			-0.76	0.36	
Private school							31.27	9.23							
Free school meals	-36.24	6.18					-22.44	4.77							
Mean pupil age					49.89	9.17									
Mean socio-economic status	0.31	0.09													
Mean household tasks							-33.20	12.70							
Mean learning materials									7.03	3.18	18.87	6.41			
Mean extra tuition in reading					60.22	27.49									
<b>Between-school variation</b>															
Null model ( $\tau$ , %var. available)	82.2	61.5%	12.5	30.1%	18.0	23.7%	28.2	49.0%	14.8	29.1%	13.3	18.7%	51.7	51.0%	
Final model ( $\tau$ , %var. explained)	14.5	50.7%	6.8	13.8%	7.9	13.2%	12.7	27.0%	2.1	25.1%	2.8	14.7%	10.3	40.8%	

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

xxx - There were some technical issues with Teachers' behaviour problems for Zanzibar and Pupil-teacher ratio for Zambia

## Appendix 3: Final models for mathematics achievement

**Table A8: Pupil-level models for mathematics**

Variable	Botswana		Kenya		Lesotho		Malawi		Mauritius		Mozambique		Namibia		Seychelles	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Pupil age	-6.12	1.16	-7.32	0.84	-4.75	0.78	-1.90	0.69					-4.94	0.62		
Pupil sex			-27.73	2.53	-5.95	2.40	-12.75	2.78	-8.08	3.90	-13.85	2.61	-8.32	1.66	19.14	3.72
Grade repetition	-18.39	1.91	-6.32	1.82	-7.37	1.33			-45.21	3.98	-4.96	1.55	-11.32	1.33		
Days absent	-1.87	0.83	-1.34	0.46	-1.61	0.49	-1.19	0.53	-6.95	0.90			-1.08	0.47	-2.39	1.01
Preschool attendance	4.19	1.25							11.72	2.87			2.01	0.99	10.83	5.38
Speaking language of instruction	9.07	2.07					5.91	1.83	27.80	3.79	2.97	1.33	5.52	1.45	36.60	4.33
Socioeconomic status	0.15	0.02	0.06	0.03	0.11	0.02			0.37	0.02	0.07	0.02	0.09	0.02	0.21	0.05
Number of siblings	-1.61	0.51	-0.96	0.44					-4.05	1.27					-6.72	2.00
Meals per week	0.59	0.26					1.08	0.40	1.52	0.50			0.48	0.16		
Household tasks									-3.20	1.00			-1.80	0.53	-3.56	1.02
Homework help at home	15.48	4.88									4.56	2.16				
Parents alive	4.32	1.95														
Living with parents/relatives							14.46	5.70							26.94	7.40
Learning culture (books at home)							0.04	0.02	0.07	0.02	0.11	0.05			0.21	0.04
Pupil learning materials			1.77	0.85					4.97	1.14					10.42	2.45
Mathematics textbook ownership	7.50	1.58							10.19	3.03	2.93	1.28	2.74	1.10	17.79	6.14
Homework	1.66	0.59	2.22	0.63	2.16	0.90			4.62	1.16	2.27	0.71				
Extra tuition in mathematics			9.73	3.62					36.93	5.14					18.97	6.43
Travel distance to school			-3.43	1.02	-1.87	0.73			-3.94	1.26						
Working place																
<b>Within-school variation</b>																
Null model ( $\delta^2$ , %variance available)	45.9	71.3%	46.8	64.0%	36.8	80.5%	29.4	74.6%	134.9	74.2%	37.0	77.3%	35.8	64.1%	89.1	92.1%
Final model ( $\delta^2$ , %variance explained)	38.3	11.9%	41.7	7.0%	33.2	7.9%	27.2	5.5%	93.7	22.6%	32.2	9.9%	32.4	6.1%	60.1	30.0%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

**Table A8: Pupil-level models for mathematics (Continued)**

Variables	South Africa		Swaziland		Tanzania		Uganda		Zambia		Zanzibar		Zimbabwe	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Pupil age	-4.27	0.76	-3.66	0.69			-1.85	0.73					-5.46	2.40
Pupil sex			-14.50	2.00	-31.16	3.49	-14.10	2.04	-12.30	2.73	-8.55	2.58	-8.00	3.47
Grade repetition	-10.40	1.12	-4.72	1.25	-17.36	2.18	-3.32	1.22	-8.43	1.57	-9.06	3.42	-16.14	2.92
Days absent					-2.75	0.35	-0.74	0.36	-0.95	0.42			-1.44	0.50
Preschool attendance	2.71	0.82									3.05	1.45		
Speaking language of instruction	7.29	1.48							6.63	2.73			7.79	2.52
Socio-economic status	0.13	0.01	0.03	0.01	0.13	0.03			0.09	0.03	0.09	0.03	0.11	0.04
Number of siblings	-0.56	0.26	-0.94	0.29										
Meals per week					xxx	xxx							1.31	0.35
Household tasks					-1.48	0.71								
Homework help at home													20.25	4.09
Parents alive														
Living with parents/relatives											20.17	8.93	7.84	3.45
Learning culture (books at home)	0.10	0.02			0.77	0.30								
Pupil learning materials	1.24	0.55	2.61	1.15			1.37	0.50					1.88	0.78
Mathematics textbook ownership														
Homework (given, corrected, and explained)	1.95	0.44	2.04	1.01	1.61	0.62	2.81	0.56			1.37	0.60	1.89	0.93
Extra tuition in mathematics	-10.18	4.08			9.63	4.24					22.63	6.11		
Travel distance to school													-2.70	1.04
Working place					16.94	7.33	18.59	3.89			5.09	2.14	11.54	4.29
<b>Within-school variation</b>														
Null model ( $\delta^2$ , %variance available)	42.6	44.8%	30.3	81.3%	50.0	73.3%	34.4	63.5%	36.8	84.3%	31.1	82.6%	53.0	60.8%
Final model ( $\delta^2$ , %variance explained)	39.1	3.7%	29.0	3.5%	41.4	12.7%	32.1	4.2%	35.4	3.2%	28.0	8.3%	42.3	12.3%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

xxx - There were some technical issues with Meals per week for Tanzania.

**Table A9: School-level models for mathematics**

Variable	Botswana		Kenya		Lesotho		Malawi		Mauritius		Mozambique		Namibia		Seychelles	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Grade mean	505.98	4.96	561.49	3.98	477.09	2.54	440.81	5.64	589.10	5.87	487.09	2.47	474.92	2.14	512.08	7.69
Teacher sex											11.52	4.64				
Teacher teaching hours per week									-1.47	0.61						
Teacher subject matter knowledge			0.07	0.03					xxx	xxx			0.07	0.02		
Teacher days absent			-0.70	0.30					-0.42	0.19						
Report on mathematics					22.50	5.77										
SH advice teacher									4.24	1.91						
Teachers' behaviour problems					-1.36	0.58										
Proportion of female teachers	-0.39	0.16														
Class size									-0.35	0.10			-0.47	0.16		
Classroom resources									3.65	1.65						
SH experience as a teacher	0.47	0.21							4.97	1.08	0.83	0.32				
SH teaching hours per week									-0.64	0.28						
School resources					2.48	1.00							0.06	0.02	0.26	0.06
School days lost									-4.34	1.71						
School location	4.35	2.16	11.55	3.77	7.11	2.81							11.31	3.28		
School community contribution	3.67	1.20														
School community problems									-16.31	4.77						
Pupil-teacher ratio	-0.86	0.43	-0.55	0.24					-2.54	0.78						
Private school			43.18	15.70												
Free school meals	-41.23	9.03	20.15	6.28												
School size									0.07	0.02					-0.04	0.01
Mean socio-economic status											0.28	0.05				
Mean meals per week															45.98	18.78
Mean learning materials					27.04	11.06										
Mean extra tuition in mathematics	66.80	17.26														
<b>Between-school variation</b>																
Null model ( $\tau$ , %var. available)	18.5	28.7%	26.4	36.0%	8.9	19.5%	10.0	25.4%	46.9	25.8%	10.8	22.7%	20.0	35.9%	7.6	7.9%
Final model ( $\tau$ , %var. explained)	2.5	24.8%	12.9	18.4%	5.9	6.5%	3.3	17.0%	12.7	18.8%	3.8	14.7%	6.5	24.2%	1.0	6.9%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

xxx - Teachers were not tested in Mauritius.

**Table A9: School-level models for mathematics (Continued)**

Variable	South Africa		Swaziland		Tanzania		Uganda		Zambia		Zanzibar		Zimbabwe	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Grade mean	495.68	2.25	548.00	2.32	563.26	3.78	487.22	2.81	438.94	2.61	472.82	9.10	498.01	5.77
Teacher age					-0.80	0.30								
Teacher education level					9.98	4.44								
Teacher teaching hours per week			-0.51	0.24										
Teacher subject matter knowledge	0.09	0.02	0.04	0.02	0.10	0.04								
Teacher days absent	-0.43	0.15												
Class size									-0.24	0.11				
SH professional training	8.24	2.83												
SH experience as a head					0.84	0.40								
SH experience as a teacher							0.95	0.39						
School resources	2.11	0.62	0.09	0.03			2.73	1.08					0.16	0.04
Pupils allowed to borrow books	17.31	5.81												
School location			6.28	2.34			15.83	3.46					12.62	4.63
School inspections			2.03	1.01	1.86	0.89	1.62	0.50	xxx	xxx				
School community contribution	2.71	1.22												
Pupil–teacher ratio			-0.69	0.34					xxx	xxx			-0.92	0.29
Private school							33.40	7.97			48.19	8.37		
Free school meals	-35.82	6.25					-14.69	4.68						
School size	-0.02	0.01												
Mean socio-economic status	0.19	0.09												
Mean meals per week					xxx	xxx					8.92	2.66		
Mean household tasks									-9.07	3.66				
Mean learning materials									7.47	2.45				
<b>Between-school variation</b>														
Null model ( $\tau$ , %var. available)	52.4	55.2%	7.0	18.7%	18.2	26.7%	19.8	36.5%	6.8	15.7%	6.5	17.4%	34.1	39.2%
Final model ( $\tau$ , %var. explained)	14.8	39.6%	4.9	5.6%	15.6	3.9%	12.3	13.9%	2.6	9.8%	1.9	12.3%	9.0	28.9%

**NOTE:** All coefficients are unstandardized and are significant at  $p \leq 0.05$ .

xxx - There were some technical issues with School inspections and Teacher–pupil ratio for Zambia, and Meals per week for Tanzania.

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