The Effect of Teacher Ability on Student Test Scores in Kenya

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The Effect of Teacher Ability on Student Test Scores in Kenya

ケニアにおける教員の能力のテストの点数への影響

Abstract

The purpose of this paper is to analyze the effect of teacher ability on student's test scores in Kenya. In Kenya, the educational level is higher than that of other Sub-Saharan African countries, but the quality is not high enough, so it is necessary to improve the quality of education. And there is a need to improve the quality of teachers in order to improve the quality of education. To investigate these problems, this study used the data of SACMEQ III of Kenya in 2007 from SACMEQ to estimate the educational production function. The ordinary least squares (OLS) and the instrumental variables (IV) were used for the estimation techniques. The IV controlled for the teacher's ability. In this paper, teacher's ability is the teacher's mathematics and reading test scores. Our result show that the teacher's mathematical test score is effective to increase the student's mathematics test score. Also, the years of experience of the school head is substantially positively correlated with the students' performance, indicating that the ability of the school head is also important.

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1. Introduction

This study examines the effect of teacher ability on students' test scores, with a particular focus on primary schools in Kenya. It analyzes how teacher ability affects reading and mathematics test scores by using SACMEQ (Southern and Eastern Africa Consortium for Monitoring Educational Quality[1]) III data.

1.1 Background Information and Statement of the Problem

Access to education in Sub-Saharan Africa has improved significantly at any school level over the past decades (*Figure 1*). On the other hand, in Sab-Saharan Africa, 34.7 million primary school age children did not go to school in 2018, and this is 19.5% of primary school age population in this area (World Bank, n.d.), so out of school children is still an urgent issue. At the same time, the poor quality of education in the region is recently getting more and more attention. In Kenya, improving the quality of education is becoming a hot topic in education policy making.

Bashir, Lockheed, Ninan and Tan (2018) used the microdata from Service Delivery Indicators (SDI), and they analyzed the level of reading and mathematics skills in seven countries of Sub-Saharan Africa. It shows a seriously poor level of reading skill. In this area, about 40% of fourth grade students could not read a letter, about 70% of them could not read a sentence, and about 90% of them could not read paragraph. The mathematics results were better than reading, since only about 10% of them could not understand numbers, and about 30% of them could not add or subtract single digits. However, 95% of them could not solve math problems. Although Kenya's results are better than other African countries, it cannot be said that students have sufficient academic ability. In this country, about 10% of the fourth-grade

[1] SACMEQ (Southern and Eastern Africa Consortium for Monitoring Educational Quality) is the organization's name. They hold test every 5 or 6 years from 1995. It is carried out four times so far and is called SACMEQ I to IV each. However, the latest data is SACMEQ III which implemented from 2006 to 2011.

students could not read a letter, about 30% of them could not read a sentence, and about 70% of them could not read paragraph. In mathematics, about 10% of them could not add single digits and 90% of them could not solve math problems.

Thus, improvement of the quality of education is becoming important in Kenya. And the quality of teachers can be cited as an issue of quality of education. For example, according to Takemura (2002), education executives in Kenya said that the country has many educational problems, especially poor teacher attitudes, low quality of classes, and poor learning results. Therefore, establishing and improving the quality of the organization implementation, and system to train teachers is urgently needed.

1.2 Significance of the Study

This paper analyzes the education production function and tries to find out the impact of teacher ability on student test scores and the correlation between other school inputs and student test scores. According to Harris (2010), education production function consists of a combination of all inputs including school and family factors that produce output such as test scores and graduation rates. In economics of education, education production functions are used when measuring the impact of changes in one resource invested in school on the outcome that represents the quality of education. In this way, in the presence of various school inputs, it is possible to answer the question which school input is the most effective for improving the quality of school education (Ogawa and Nakamuro, 2009). Hanushek (2010) says the same things: the general input of the educational production function are school resources, teacher quality, and family characteristics. The outcome is not limited to the test scores but includes the students' achievement. This study provides information on how much the quality of teachers and other school inputs affect students' learning. The result showed it help policymakers to reduce waste of the budget by finding inputs that effectively improve student's test score. In addition, there is no rigorous empirical research that analyzes the topic in Kenya, so this paper can contribute to the corpus of empirical studies in economics of education and development economics.

1.3 Research Question and Hypothesis

The research question of this study is which school input improve students' test scores? And the hypothesis for this question is high quality of teacher increases students' test scores. In this paper, quality of teacher is expressed in terms of teacher's test scores, and the results of math and reading test scores are used in the analysis.

1.4 Structure of the Thesis

This paper consists of ten chapters. The first chapter explained background information and statement of the problem, significance of the study, and research question and hypothesis. The second chapter reviews literatures about education production function and the effect of school inputs. The third chapter describes the data. The fourth chapter presents the model of education production function. The fifth chapter explains educational situation and system of Kenya. The sixth chapter discusses estimation techniques. The seventh chapter explains descriptive statistics. The eighth chapter discusses findings. The ninth chapter discusses and interprets the findings. The tenth chapter is the conclusion.

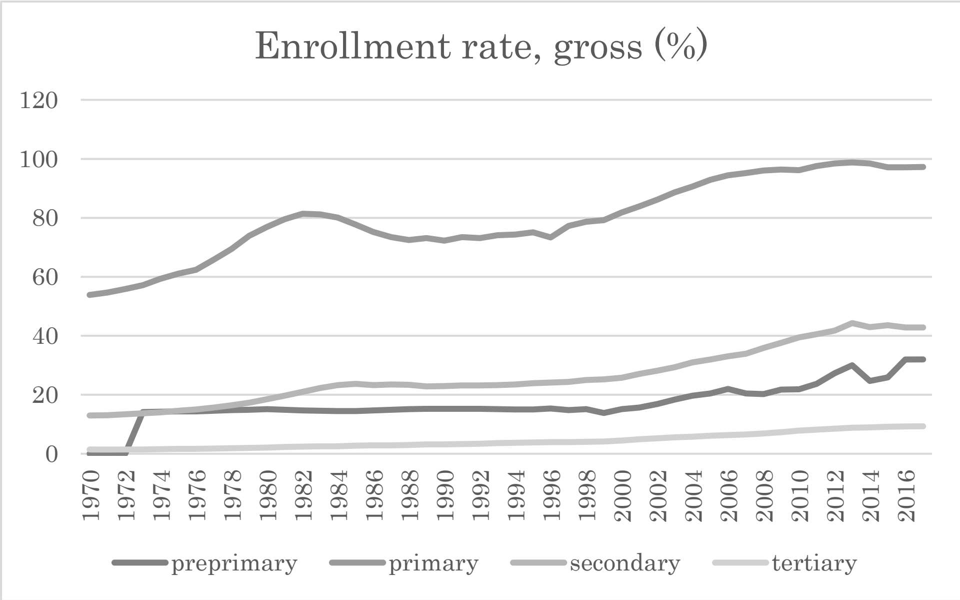

Figure 1. Gross enrollment ratio in Sub-Saharan Africa (%), 1970-2017. Data here are from World Bank (n.d.).

2. Literature Review

This chapter will introduce literature on the content of educational production functions, the effects of textbooks on students' achievement, and the effects of teachers' mathematical knowledge on students' achievement.

Ogawa and Nakamuro (2009) estimated education production function using data on Vietnam. In this report, test score is dependent variable and used to measure students' achievement. They said that the effect of toilet, library, and lab are statistically significant in infrastructure variables in the case of primary education. In addition, female teacher ratio, the ratio of teachers who have from five to ten years of experience, the ratio of teachers who have more than ten years of experience in teacher variables, class size in class variables, and burden charge of parents and local community for PTA in expenditure variables also statistically significant.

Glewwe, Kremer and Moulin (2007) analyzed the relation of school input and test score by converting test score into deviation value based on a randomized experiment. It estimated the reason that textbooks do not rise test score. They said that textbooks did not increase the deviation value for the sample of the whole students. However, textbooks raised the value among the best students. As the reason, authors mentioned that the curriculum provided by the government is too difficult for general students to understand. One of the reasons why it is difficult to understand the contents of the curriculum is that the teaching language is English, which is the third language for many students, so they cannot grasp the contents of textbooks and lessons.

Hill, Rowan and Ball (2005) estimated effects of teachers' mathematical knowledge for teaching on first and third graders' math achievement in the United States using data from a study of schools engaged in instructional improvement initiatives. They used linear mixed models. The dependent variable is student gain scores, and independent variables are about student and teacher. Student variables consist of individual information, and the examples are their family's social economic status and gender. Teacher variables consist of things can measure the ability of teachers, and the examples are years of experience and teachers' content knowledge for teaching mathematics. The result of analysis said that the family social economic status and teachers' content knowledge for teaching mathematics have a statistically significant effect on student test scores.

Clotfelter, Ladd and Vigdor (2007) estimated the effect of teacher credentials on student achievement. They used the data from North Carolina Education Research Data Center, housed at Duke University. It is longitudinal data and includes all North Carolina students in grades 3, 4 and 5 for the years 1995-2004 and it can identify the student's math and reading teacher. They used value-added model and student's fixed effect. The dependent variables are student achievement of math and reading. The independent variables are teachers' experience, graduate degree, teacher licensure, national board certification, test scores and regular licensure. The result of the analysis shows that teachers' experience, test scores and regular licensure have positive effects on student achievement.

Ogawa and Nakamuro (2009) and Hill et al. (2005) could not solve the problem of the endogeneity of school inputs because of the omitted variables bias and reverse causality. Glewwe et al. (2007) used a randomization to control for the endogeneity of education but they did not focus on teacher quality. Clotfelter et al. (2007) used student's fixed effect to control for the endogeneity of teacher quality and other school inputs.

Ogawa and Nakamuro (2009), Hill et al. (2005), and Clotfelter et al. (2007) used teacher quality as independent variables. Ogawa and Nakamuro (2009) used pupil-teacher ratio, female teacher ratio, teacher ratio with teacher license, teacher experience, female school head ratio, the years of teaching experience of school head, and the years of school head experience as teacher variables. Hill et al. (2005) used teachers' mathematical test scores as their knowledge.

Clotfelter et al. (2007) used teacher's experience, graduate degree, teacher licensure, national board certification, test scores and regular licensure to estimate the effect of the teacher quality.

So far, there has been very little research which estimates the effect of teacher quality or ability on student achievement and controls for its endogeneity in both developing and developed countries, so this paper fills the gap.

3. Data

3-1. About SACMEQ

This study used SACMEQ III. This data is from the survey conducted by Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) that consisted of 16 Ministries of Education in Southern and Eastern Africa (SACMEQ, n.d.a). It includes the nationally representative data of around 61,000 learners, 8,000 teachers, and 2,800 school principals. This organization's work is to carry out the research and training programmes to provide educational planners and researchers with relevant technical skills (SACMEQ, n.d.c). In Kenya, the data was collected in 2007, covering 4,436 standard grade 6 pupils in 193 public and private schools, 733 teachers and 193 head teachers in Kenya's eight provinces (Wasanga, Ogle, and Wambua, 2012). The geographic coverage of the survey of SACMEQ III had 13 countries, including Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania (including Zanzibar), Uganda, and Zambia.

This survey employed a stratified two-stage sampling design. In the first stage, the schools designated the survey were sampled based on a probability-proportional-to-size (PPS) from the sampling frames submitted by each country to the SACMEQ Coordinating Centre. Larger schools were more likely to be selected than smaller schools by PPS sampling methods. In the second stage, the sample of students were selected from all the Grade 6 classes in each sampling schools using computer-generated random numbers. When the total number of them who enrolled at the data collection was over 25, the minimum cluster size (25 learners) were sampled. When the number of them was 25 or below 25 in a school, the sample included all the Grade 6 students (World Bank, 2019). The method of this data collection is face-to-face interviews (International Household Survey Network, 2019). The strengths of SACMEQ are the school level information that can be connected to student level and other individual data and includes African country's data that is not included in TIMSS and PISA.

3-2. Variables Used as Dependent / Independent Variables

This section explains the variables in the SACMEQ III dataset which are used in the study[2].

According to Table 1, dependent variables in the study are standardized test scores of mathematics and reading. The base line score is set to 500. According to Wasanga, Ogle and Wambua (2011), in this baseline, SACMEQ II and III test scores are placed on a single scale based on the average point at SACMEQ II. Test scores are standardized with the average fixed at 500 and the standard deviation at 100, so that the results can be comparable across different tests.

The dataset has school inputs and non-school inputs which will be independent variables in the analysis. School inputs consist of facility variables, teacher variables, class variables, and student variables. If the student or school has one facility, the variable's score is 1, and if they do not have, it is 0. The example of facility is table (*stable*) and chair (*chair*) (See Table 1 for the details of the facility variables). Teacher variables are pupil-teacher ratio (*stratio*), female teacher ratio (*ftratio*), and their standardized score of math and reading (*treadscore* and *tmathscore*) (See Table 1 for the details of the teacher variables). Pupil-teacher ratio (*stratio*) and female teacher ratio (*ftratio*) are calculated based on SACMEQ III data. The pupil-teacher

[2] How the variables here are used in the study will be explained in Chapter 6.

ratio (*stratio*) is calculated by dividing the number of all students enrolled in the school by the number of teachers and represents how many students a teacher has. The female-teacher ratio (*ftratio*) was calculated by adding up all permanent female teachers and temporary female teachers and dividing it by the number of all teachers. Gender and years of experience of school head (*schead* and *schdexpy*) are also included in the set of teacher variables. The dataset also has the teacher's standardized test scores (*treadscore* and *tmathscore*) which is included in the analysis as a substitute for the teachers' content knowledge for teaching mathematics and reading. Class variables consist of class size of grade 6 (*classsize6*) and school location (*lagc*). Class size (*classsize6*) is also calculated based on SACMEQ III data. This is calculated by adding up the number of 6th grade boys and girls and dividing by the number of 6th grade classes. Non-school input consists of student variables. It includes student gender (*stusex*), distance from house to school (*travel*), father's and mother's years of education (*eduyearf* and *eduyearm*), and social economic status (*zpses* and *sesindex*). Parental years of education (*eduyearf* and *eduyearm*) and social economic status (*zpses* and *sesindex*) are also calculated by SACMEQ III. The years of education is zero year for those who have never received education, four years for those who have not completed primary education, eight years for those who have completed primary education, ten years for those who have not completed secondary education, twelve years for those who completed secondary education, fourteen years for those who did not complete higher education and those who completed vocational school after secondary education, and sixteen years for those who completed four year college. In this paper, two types of social economic status are used. The original social economic status of SACMEQ III is *zpses*, but it includes parent's years of education. However, this paper will analyze the effect of parent's education separately. Thus, the variable of social economic status in the analysis need to exclude parents' years of education. The social economic status variable excluding parents' years of education is called *sesindex*. It was calculated based on the addition of dummy variables of home possessions and structural features of electricity, floor, walls, and roof when making *zpses*.

Table 1

Explanation of Variables from Based on SACMEQ III Used in This Study

Name of Variables	The Way to Make the Variables
Dependent Variables	
(1) Teat Score	
preadscore	Standardized reading test score of student
pmathscore	Standardized mathematics test score of student
Independent Variables	
(1) Facility	
stable	Student have their own table=1
chair	Student have their own chair=1
electricity	School have electricity=1
water	School have piped water / water tank / borehole / spring=1
numtoilet	The number of toilets at school
library	School have library=1
scomp	The number of computers that students can use
textr	Students have their own reading textbook=1, share with 2 / more students=0.3, share with a student=0.5, no reading textbook=0
textm	Students have their own mathematics textbook=1, share with 2 / more students=0.3, share with a student=0.5, no reading textbook=0
(2) Teacher	
treadscore	Standardized reading test score of teacher
tmathscore	Standardized mathematics test score of teacher
stratio	Pupil-teacher ratio
ftratio	Female teacher ratio
schead	School head gender (female=1. male=0)
texpy	Years of teaching experience of school head
schdexpy	Years of school head experience
readt	Reading teacher gender (female=1, male=0)
matht	Mathematics teacher gender (female=1, male=0)
hengt	Employment form of the teacher (teacher who is high educated and not hired by government=1, other=0)
(3) Class	
classsize6	Class size of grade 6
lagc	School location (school at large city=1, other area=0)
(4) Student	
stusex	Student gender (female=1, male=0)
travel	Distance from home to school (0.5km interval)
eduyearf	Years of education of father
eduyearm	Years of education of mother
zpses	Social economic status include parent's education level
sesindex	Social economic status exclude parent's education level

Note. The table here is made by the author based on the information from SACMEQ III (2007).

4. Conceptual Framework and Model

According to Glewwe and Lambert (2010), the learning processes of both cognitive and noncognitive skills include many different factors. Production function express it as a mathematical relation. Factors that determine learning can be separated into school, child, and household variables (*Figure 2*).

A simple equation of education production function is:

$$\boldsymbol{A = a(S, Q, C, H, I)} \qquad [1]$$

where A is skills learned, S is years of schooling, Q is all school and teacher characteristics, C is all child characteristics, H is all household characteristics, and I is educational inputs that parents have to pay for. Equation [1] shows how each variable affects learning. The model considers that a variable Q_j is an improvement in one factor of school quality j. Equation [1] shows how changing Q_j affects learning for given values of the other variables. However, changing Q_j leads changing household behavior, that is change S or one or more I variables. Thus, the full impact of changing Q_j cannot estimate in equation [1].

To analyze the full impact of changing school quality, it is necessary to know how changes in both the Q variables and in other variables affect S and I in equation [1]. These relationships can be expressed as:

$$S = f(Q, C, H, P) \qquad [2]$$

$$I = g(Q, C, H, P) \qquad [3]$$

where P is the prices relevant for these household decisions such as tuition, cost of school supplies, and child wages.

By inserting [2] and [3] into [1], it is possible to make another expression for A:

$$A = b(Q, C, H, P) \qquad [4]$$

which economists call a reduced form relationship. It can express the full causal impact of school quality variables on learning. Equation [4] is more useful than [1], because it shows actual changes in A after the Q and P variables change, and how government policy affects these two sets of variables.

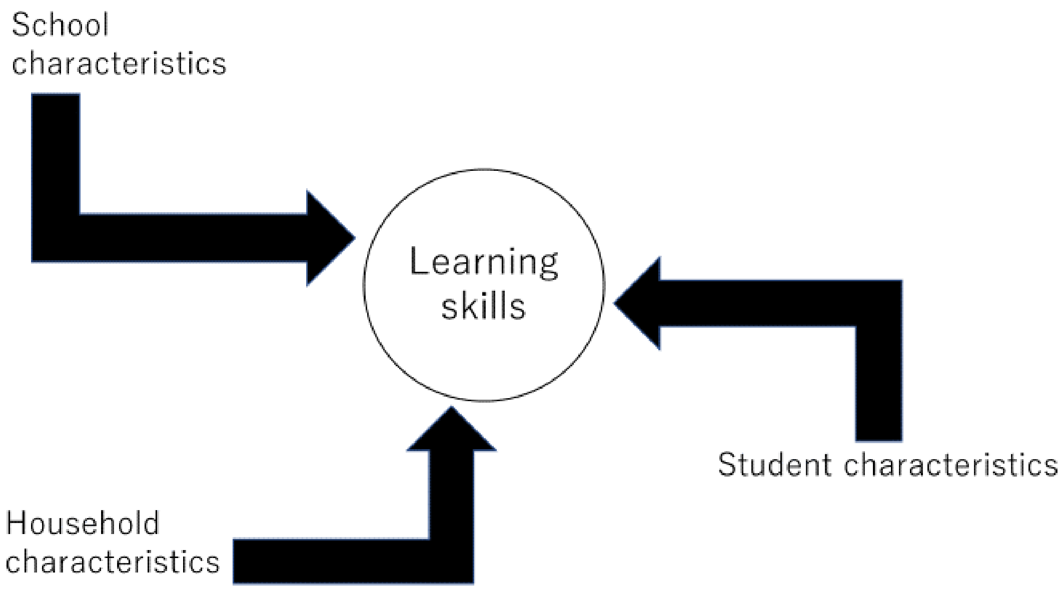

Figure 2. Conceptual framework of this analysis. The figure here is made by the author based on the information from Glewwe and Lambert (2010).

5. Context of the Country and Education Sector

This chapter explains the general economic and social status and education sector in Kenya. Table 2 shows the basic statistics on the economy and society in Kenya. The population growth rate exceeds 2%, it can be seen that the population is increasing. In addition, it can be understood that the economy is growing because the GDP growth rate is higher than the population growth rate. However, nearly 40% of people live on less than $ 1.90 per day, so there is a gap between rich and poor in the country. However, the literacy rate is about 80% and it is over 85% for young people which suggests an increase in school enrollment rates. With the increasing number of people who receive higher education and the ability to read text means that they have a wider choice of occupations, these can be expected to develop Kenya in the future.

According to SACMEQ (n.d.b), Kenya's education system has been eight years of primary school, four years of secondary, and four years of college or university since 1985. When students progress from primary to secondary and secondary to university, they have to pass the national examination for the Kenya Certificate of Primary Education (KCPE) and the Kenya Certificate of Secondary Education (KCSE), respectively. Primary education became free in 2003. Compulsory education is eight years of primary school. It starts at six years old and ends at thirteen years old.

According to *Figure 3*, Kenya's pre-primary gross enrollment rate has been increasing in the last 3 decades and was nearly 80% in 2016. In primary enrollment rate, the gross enrollment rate is over 100% and the net enrollment rate was over 80% in 2016. The primary gross enrollment has been increasing since 1994 and have been above 100%; the rates have been above 100% since 2002 (*Figure 4*). Those data shows that pre-primary and primary school are widespread throughout the country. According to *Figure 5*, in secondary education, the gross enrollment rate is over 50% and net enrollment rate was over 40% in 2009[3]. Although not as common as primary education, the enrollment rate has been increasing since 1970. Higher education has lower enrollment rate which is around 10%, but the enrollment rate has been increasing since 1980s like secondary education (*Figure 6*). Clearly, these results suggest that people have been interested in and understand the importance of education in Kenya.

Uwezo (2015) mentions the quality of education in Kenya. This paper looks at the level of English literacy, Kiswahili literacy and numeracy. Also, it compared the change of student's performance in these proportions between 2011 and 2014. According to this paper, English literacy level did not almost change during those years. It says that about 35% of the students cannot read paragraphs. Among them, about 6% of students cannot even read the alphabet. In the case of Kiswahili, the students' performance is better than English. The number of students who can read story increased by about 4% points and the number of students who cannot read a paragraph decreased by 0.8% points during those years. In the case of numeracy, the situation is not good. The level is worse than literacy both English and Kiswahili. The student who could not even count increased from 4% to 5% between 2011 and 2014. Also, about 20% of them could not even add. According to these results, in Kenya, the quantity of education is already enough for primary education, but the education quality in Kenya is still low. Thus, the next education issue is to improve the quality of education for the development of this country.

[3] The data in later years are not available.

Table 2

Basic Information of Kenya in 2018

	2018
Population, total	51,393,010
Population growth (annual %)	2.31
GDP per capita (constant 2010 US$)	1202.13
GDP growth (annual %)	6.32
Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	36.8 (2015)
Literacy rate, adult total (% of people ages 15 and above)	78.7 (2014)
Literacy rate, youth total (% of people ages 15-24)	86.5 (2014)
Unemployment rate, total (% of total labor force)	9.3
Unemployment rate, youth (% of total labor force ages 15-24)	18.5

Note. The table here is made by the author based on the information from World Bank (n.d.).

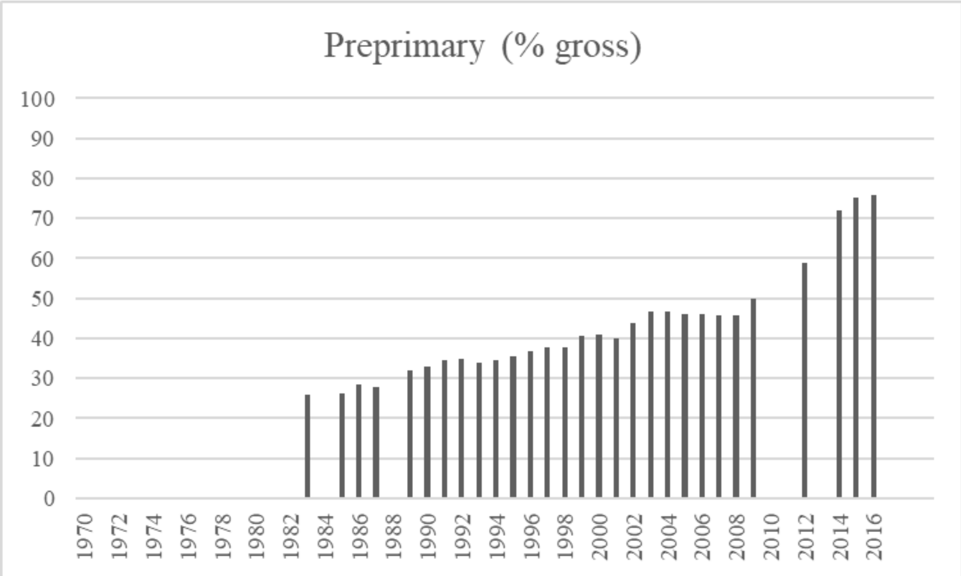

Figure 3. Pre-primary enrollment rate, 1970-2016. The figure here is made by the author based on the information from World Bank (n.d.).

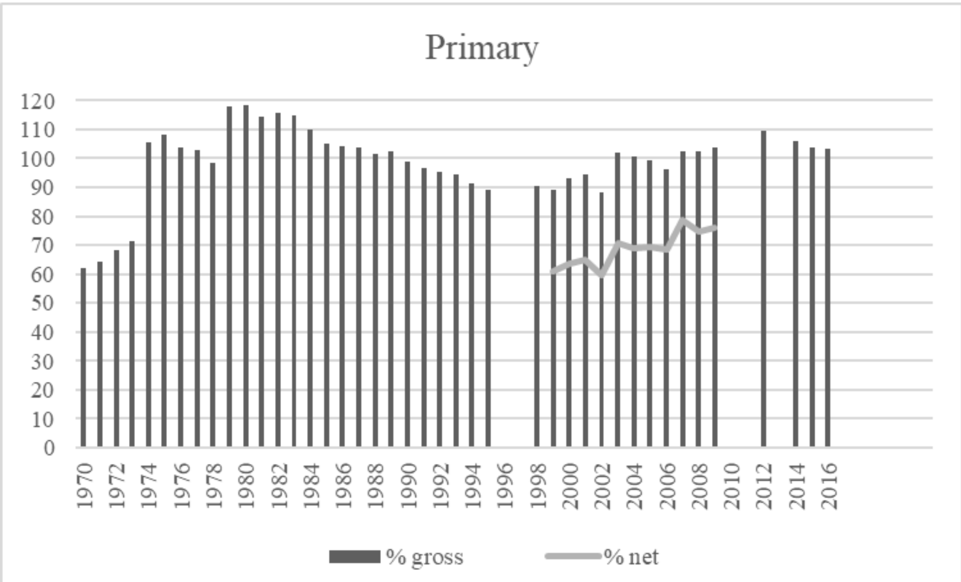

Figure 4. Primary school enrollment rate, 1970-2016. The figure here is made by the author based on the information from World Bank (n.d.).

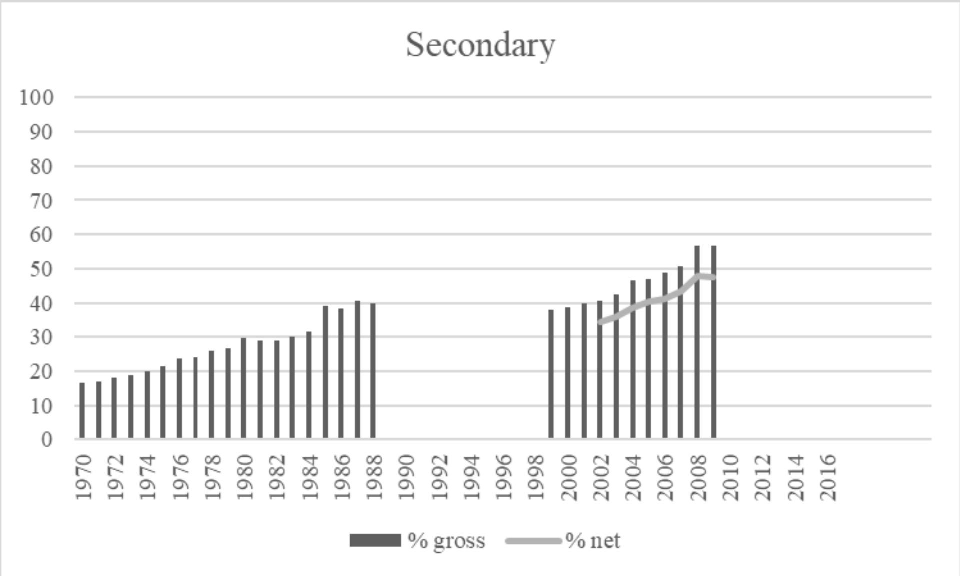

Figure 5. Secondary school enrollment rate, 1970-2016. The figure here is made by the author based on the information from World Bank (n.d.).

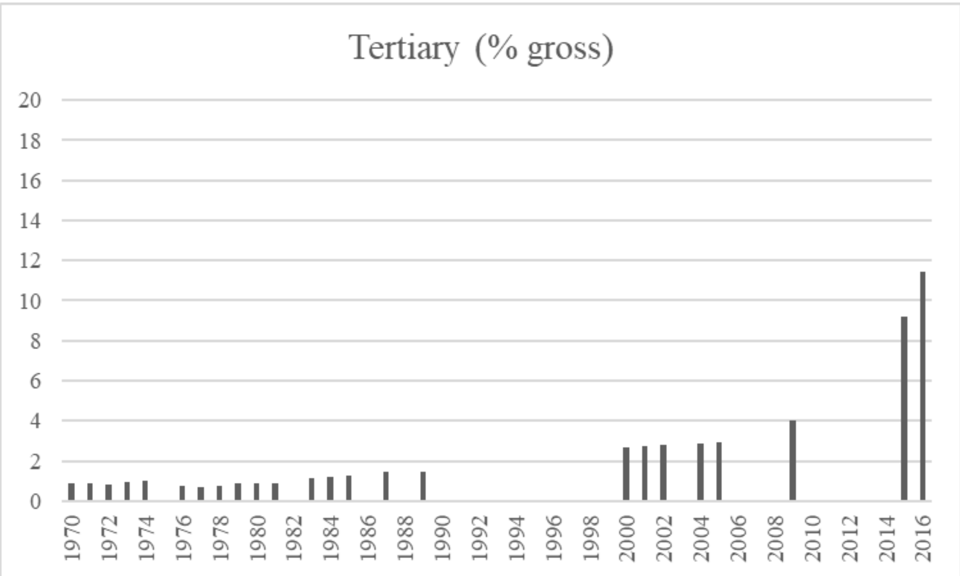

Figure 6. Tertiary school enrollment rate, 1970-2016. The figure here is made by the author based on the information from World Bank (n.d.).

6. Estimation Techniques

6.1 Ordinary Least Squares

Referring to Glewwe and Lambert (2010), the relationship between outputs and inputs in education production function can be estimated using linear regression methods. When adding squared and interaction terms to the variables in equation [1] in Chapter 4, it is assumed that the linearity is not limited. A simple linear regression equation of [1] is:

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon \qquad [5]$$

where Y is the student's standardized test score of reading or mathematics, X_1 is the teacher's standardized test score of reading or mathematics whose effect this paper wants to analyze the most[4], and X_2 to X_n are control variables. ε is an error term and it is added for several reasons according to Glewwe and Lambert (2010). The first reason is that the data does not always exist for all variables in X_1 to X_n, so ε explains all omitted variables. The second reason is that ε_i means that [5] is the only linear approximation of [1]. The third reason is that observed Y may not actually measure the student test scores but with error, and ε includes the difference between observed Y and actual Y. The fourth reason is that the variables on the right-hand-side of [5] may also contain measurement errors, and ε includes the difference between the actual value and the observed values.

Although ε may seem unimportant for not being observed, β coefficients, the causal effects of the observed variables in [5] on learning can be consistently estimated by ordinary least squares (OLS), only if ε is not correlated with all the observed explanatory variables.

6.2 Instrumental Variables

This paper uses instrumental variables to control for the endogeneity of teacher ability

[4] When Y is the student's standardized reading test score, X_1 is the teacher's standardized reading test score, and when Y is the student's standardized mathematics score, X_1 is the teacher's standardized mathematics test score.

(teacher's test scores). The instrumental variable is an interaction term of non-permanent teacher and high educated teacher. By using this, the impact of wealthy schools which have highly qualified teachers and high students' achievement are controlled for. According to Oba (2015), there are two types of employment for teachers in Kenya: teachers hired by the government and teachers hired by Board of Governors (BoG), called TSC (Teacher Service Commission) teacher and BoG teacher, respectively. In order to become a TSC teacher, obtaining a teacher's license is an absolute requirement, while some BoG teachers do not have a teacher's license. For example, BoG teachers often include university students and students who have achieved excellent results at KCSE. Kenya also suffers from a serious shortage of teachers, while teacher salaries put pressure on government finances. For this reason, even after graduating from university, there is a situation where they are not immediately employed as TSC teachers, and many BoG teachers include university graduates. In addition, BoG teachers tend to teach at schools in their hometowns which are not necessarily high performing schools. From these facts, it can be said that whether a teacher is a BoG teacher and has a high academic background or not can be used as instrumental variables because this interaction term does not correlate with other factors of school quality.

Referring to Khandker, Koolwal and Samad (2010), the equation of the educational production function using instrumental variables could be written as follows. The first-stage regression is:

$$T_i = \gamma Z_i + \phi X_i + u_i. \quad [6]$$

where T_i is a variable that indicates whether treatment has been received or not, which means teacher's test score (*treadscore* and *tmathscore*). Z_i is an instrumental variable to separate the part of the treatment variable that is independent of other unobserved characteristics affecting the outcome, which is the interaction term of being a BoG teacher and high academic background as explained above (*hengt*). X_i is control variables indicating other individual characteristics, and u_i is an error term.

The second-stage regression is:

$$Y_i = \alpha X_i + \beta T_i + \varepsilon_i. \quad [7]$$

where the IV method estimates β that is outcome of T_i. As mentioned above, T_i is a teacher's test score in either math or reading (*tmathscore* and *treadscore*). X_i is control variables indicating other individual characteristics, and ε_i is an error term. Basically, same control variables are used. In addition, the instrumental variable Z_i must satisfy the following conditions:

1. Z_i has the correlation with T_i: $cov(Z, T) \neq 0$
2. Z_i does not have the correlation with ε_i: $cov(Z, \varepsilon) = 0$

7. Descriptive Statistics

According to Table 3, comparing reading and mathematics scores (*preadscore* and *pmathscore*), mathematics scores are higher, so it can be said that Kenyan students are better at mathematics than at reading. Most students can use tables (*stable*), chairs (*chair*), and safe drinking water (*water*) at school, but a lot of schools do not have electricity (*electricity*), toilet (*numtoilet*), library (*library*), or access to computers (*scomp*). As for toilets (*numtoilet*), it includes the non flush toilets, so it can be seen that there are fewer schools that have flush toilets. Similarly, most schools do not have computers (*scomp*). When it comes to both reading and mathematics textbooks (*textr* and *textm*), more than half of the students share one textbook among three people or more (See Figure 7 and 8).

The pupil-teacher ratio (*stratio*) varies by school, and female teacher ratio (*ftratio*) for about half of the whole, with little difference between percentages of female and male teachers. However, when looking at the gender ratio of school heads, the proportion of female school heads (*schead*) is quite low, at less than 20%. Also, there is no big difference between the gender ratios for reading teachers (*readt*), but when it comes to mathematics, the proportion of female teachers (*matht*) is low, which is less than 30%. Comparing the scores of the teacher's mathematics and reading tests, the mathematics score (*tmathscore*) is much higher than reading (*treadscore*). Also, with regard to the principal, the period of teaching to the students as a teacher (*texpy*) is long, and the period of being a principal (*schdexpy*) is short. This suggests that many of them have some experience as teachers before they become principals. Class size (*classsize6*) varies between schools, and there is almost no difference in the student's gender ratios (*stusex*). With regard to school locations (*lagc*), only 15% of the schools are in the large cities. Also, the distance from home to school varies among students, and the average distance is less than 2 km.

Looking at parents' years of education, the father’s years of education (*eduyearf*) is longer than the one of mothers (*eduyearm*). The completion of primary education is more common for fathers than mothers. As to mothers’ years of education (eduyearm), there are many mothers who drop out of primary education and the average years of education is below eight years.

Table 3

Descriptive Statistics

	Mean	S.D.	Min	Max	Observations
preadscore	548.6966	100.3084	122.0835	965.6984	4,436
pmathscore	562.8786	92.93829	171.1217	1090.392	4,433
treadscore	791.0193	53.55575	613.9458	958.6404	4,191
tmathscore	898.2738	93.1466	643.1336	1204.372	4,071
stable	0.996168	0.061794	0	1	4,436
chair	0.997746	0.047431	0	1	4,436
electricity	0.271416	0.44474	0	1	4,436
water	0.862489	0.344425	0	1	4,436
numtoilet	16.55568	10.2157	0	68	4,436
library	0.385708	0.486817	0	1	4,436
scomp	1.032687	4.821136	0	44	4,436
textr	0.482597	0.28312	0	1	4,436
textm	0.464202	0.274211	0	1	4,436
stratio	43.72855	15.44908	6.285714	104.4118	4,436
ftratio	0.474503	0.224646	0	0.958333	4,436
schead	0.162534	0.368981	0	1	4,436
texpy	20.92674	6.488064	3	33	4,436
schdexpy	7.535618	5.246169	1	26	4,436
readt	0.463481	0.498721	0	1	4,436
matht	0.273445	0.445777	0	1	4,436
hengt	0.074391	0.262436	0	1	4,436
classsize6	43.75595	15.91521	5	103	4,436
lagc	0.15239	0.359439	0	1	4,436
stusex	0.481966	0.499731	0	1	4,436
travel	1.805005	1.436191	0.5	5.5	4,436
eduyearf	8.197619	5.491425	0	16	4,200
eduyearm	7.404931	5.102283	0	16	4,218
zpses	6.472949	3.004985	1	15	4,436
sesindex	12.95289	4.412117	4	27	4,436

Note. The table here is made by the author based on the information from SACMEQ III(2007). S.D. means standard deviation, Min means the minimum value, and Max means the maximum value.

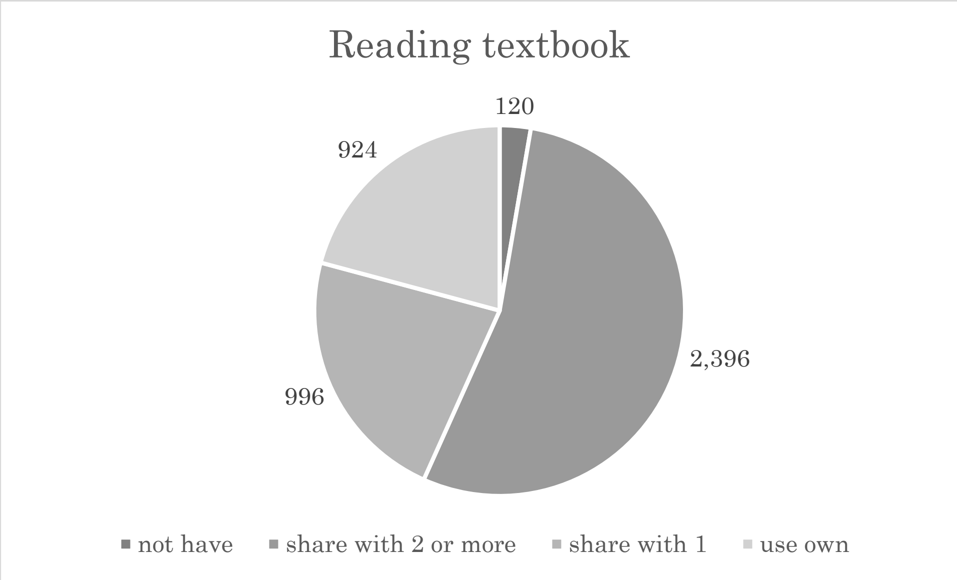

Figure 7. Reading textbook usage. The figure here is made by the author based on the information from SACMEQ III (2007).

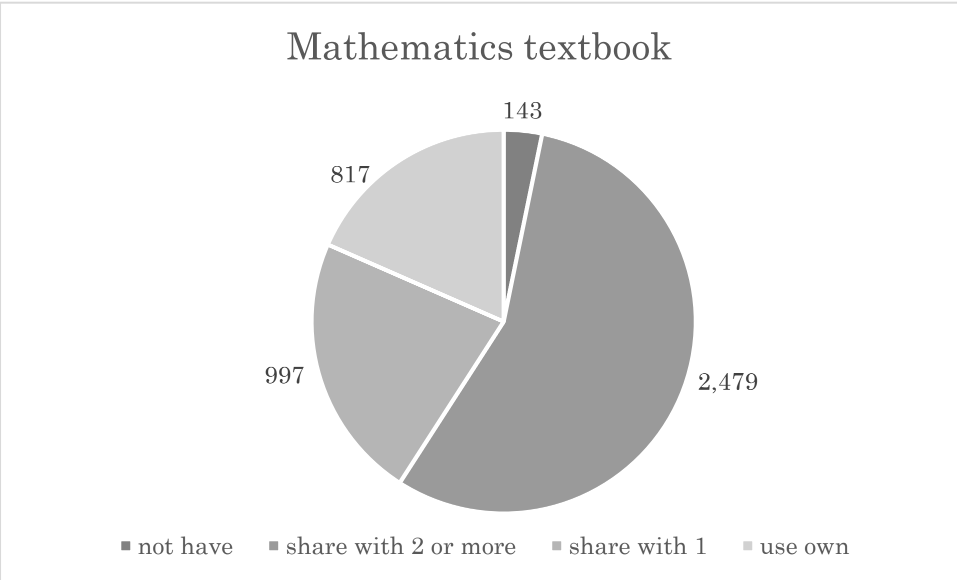

Figure 8. Mathematics textbook usage. The figure here is made by the author based on the information from SACMEQ III (2007).

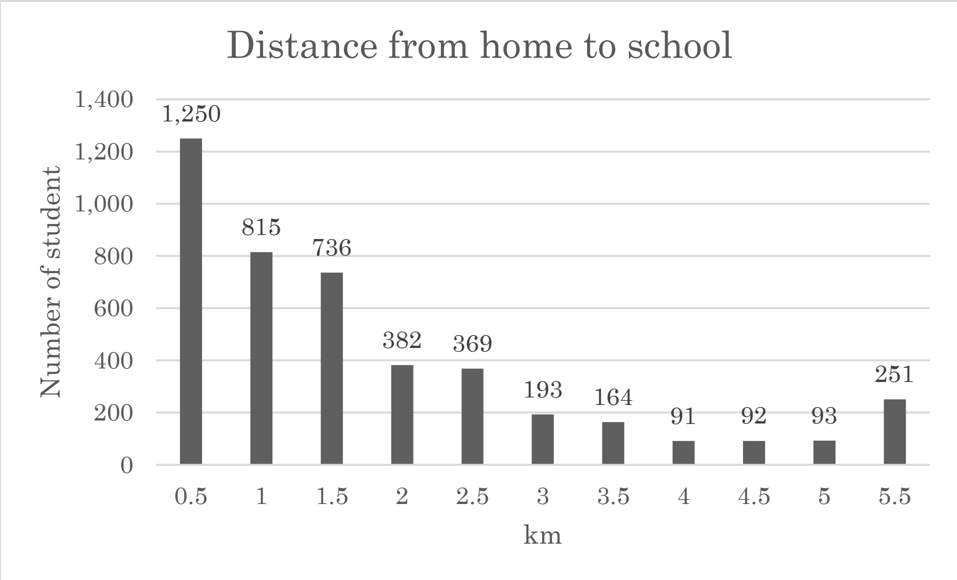

Figure 9. Distance from home to school (km). The figure here is made by the author based on the information from SACMEQ III (2007).

8. Findings

This chapter starts with an explanation of the OLS results, which show correlation between school inputs and test scores. According to the result of mathematics test in OLS in Table 4, if teacher's test score (*treadscore*) increases by 1 point, the students' test scores (*preadscore*) increases by 0.08 point. In the case of other teacher variables, the coefficients of pupil-teacher ratio (*stratio*) and female teacher ratio (*ftratio*) were not statistically significant. The coefficients of school head gender (*schead*), years of teaching experience of school head (*texpy*), years of school head experience (*schdex/py*), reading teacher gender (*readt*), and math teacher gender (*matht*) were statistically significant. If the school head is female (*schead*), the students' test scores (*pmathscore*) increase by about 16.9 points. If years of teaching experience of school head (*texpy*) increases by 1 year, the students' test scores (*pmathscore*) decrease by about 2.6 points. If years of school head experience (*schdexpy*) increase by 1 year, the students' test scores (pmathscore) increase by about 2 points. If reading teacher is female (*readt*), the students' test scores (*pmathscore*) decrease by about 5.6 points. Also, if math teacher gender (*matht*) is female, the students' test scores (*pmathscore*) increase by about 6 points. In the case of facility variables, the effects of electricity, libraries, computers, reading textbooks, and math textbooks were statistically significant. Electricity (*electricity*), libraries (*library*), and computers (*scomp*) increase the students' test scores (*pmathscore*). Reading textbooks (*readt*) decrease the students' test scores (pmathscore). It means that when students use reading textbooks with other students, they will get higher scores. Math textbooks (*textm*) increase students' test scores (pmathscore). It means that when students use a mathematics textbooks by oneself, he or she gets higher scores. In the case of class variables, if class size (*classsize6*) increases by 1, the students' test scores (*pmathscore*) decrease by 0.48 points. It means small class size is better for students' achievement. If school is in large city (*lagc*), the students' test scores (*pmathscore*) increase by 39.1 points. In the case of student variables, the coefficients of student gender (*stusex*) and distance from home to school (*travel*) are statistically significant. Female students (*stusex*) and long distance from home to school (*travel*) decrease the students' test scores (pmathscore).

According to the result of reading test in OLS in Table 5, the coefficient of teachers' test scores (*treadscore*) were not statistically significant. In the case of other teacher variables, the coefficients of female teacher ratio (*ftratio*), school head gender (*schead*), years of teaching experience of school head (*texpy*), years of school head experience (*schdexpy*) were statistically significant. If female teacher ratio increases by 1% point, the students' test scores (*preadscore*) increase by about 51.5 points. If school head is female (*schead*), the students' test scores (*preadscore*) increase by about 17 points. If years of teaching experience of school head (*texpy*) increases by 1 year, the students' test scores (*preadscore*) decrease by about 2.3 points. If years of school head experience (*schdexpy*) increases by 1 year, the students' test scores (*preadscore*) increase by 1 point. Female reading teacher (*readt*) and female math teacher (*matht*) decrease students' test scores (*preadscore*) by about 10.4 points and 6.9 points, respectively. In the case of facility variables, the coefficients of electricity, water, computers, reading textbooks, and math textbooks were statistically significant. Electricity, water, computers increase the students' test scores (*preadscore*). Reading textbooks (*textr*) decrease the student' test scores. It means that when students use a reading textbook with other students, it increases the students' test scores (*preadscore*). Math textbooks (*textm*) decrease the students' test scores (*preadscore*). It means that students have to use a math textbook by themselves to improve their achievement. In the case of class variables, if class size (*classsize6*) increases by 1, the student's test scores (*preadscore*) decrease by about 0.5 points. When school is in large city (*lagc*), the students' test scores (*preadscore*) increase by about 40.9 points. In the case of student variables, female student (*stusex*) and long distance from home to school (*travel*) decrease the students' test scores (*preadscore*). Parental years of education (*eduyearf* and *eduyearm*) increase the student' test scores (preadscore).

Table 6 and 7 show the result of math and reading test in OLS and IV, respectively. The results of IV show the causal relationships. The effect of teachers' mathematics test scores of both OLS and IV were statistically significant. In the IV analysis, if teachers' math test scores (*tmathscore*) increase by 1 point, the students' math test scores increase by about 0.5 point (See Table 9). In the case of reading test, the coefficients of OLS were not statistically significant, but the effect of IV with *zpses* and *sesindex* were statistically significant at 10% level. If teachers' reading test scores (*treadscore*) increase by 1 point, the students' reading test scores decrease by about 2.9 points. In the IV estimations, tests of the exogeneity of the teachers' test scores are conducted. The p values from the Durbin-Wu-Hausman chi-sq tests are 0.000 or 0.001 in all IV estimations for mathematics and reading, indicating that we can reject the exogeneity.

Table 4

Result of OLS Analysis (Mathematics)

	(1)	(2)	(3)
	OLS No SES	OLS zpses	OLS sesindex
tmathscore	0.084*** (0.015)	0.076*** (0.014)	0.080*** (0.015)
stable	-36.977 (51.195)	-42.658 (50.376)	-39.219 (50.492)
chair	81.208 (73.476)	125.378** (49.082)	94.022 (75.401)
electricity	23.357*** (4.493)	19.017*** (4.292)	19.109*** (4.498)
water	-0.527 (3.864)	-0.074 (3.621)	-1.156 (3.872)
numtoilet	0.242 (0.188)	0.080 (0.176)	0.157 (0.186)
library	7.110** (2.952)	7.090** (2.783)	7.070** (2.946)
scomp	0.903** (0.431)	0.889** (0.395)	0.717* (0.420)
textr	-13.215** (6.637)	-11.790* (6.381)	-14.713** (6.617)
textm	27.307*** (6.995)	22.167*** (6.711)	25.795*** (6.986)
stratio	-0.128 (0.135)	-0.068 (0.126)	-0.073 (0.133)
ftratio	11.593 (9.858)	11.852 (9.130)	9.843 (9.821)
schead	18.018*** (4.360)	16.870*** (4.167)	16.873*** (4.390)
texpy	-2.619*** (0.274)	-2.763*** (0.260)	-2.550*** (0.273)
schdexpy	2.001*** (0.356)	2.000*** (0.334)	1.905*** (0.355)
readt	-5.194 (3.164)	-4.612 (2.947)	-5.644* (3.138)
matht	6.417* (3.489)	5.606* (3.297)	6.095* (3.488)
classsize6	-0.453*** (0.115)	-0.465*** (0.108)	-0.477*** (0.115)
lagc	44.820*** (6.422)	35.976*** (6.194)	39.075*** (6.552)
stusex	-26.691*** (2.737)	-26.967*** (2.566)	-26.918*** (2.721)
travel	-2.801*** (1.073)	-2.850*** (0.998)	-2.847*** (1.067)
eduyearf	0.809** (0.347)		0.519 (0.343)
eduyearm	0.816** (0.395)		0.386 (0.393)
zpses	No	Yes	No
sesindex	No	No	Yes
Observations	3,687	4,068	3,687
R-squared	0.188	0.197	0.195

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively.

Table 5

Result of OLS Analysis (Reading)

	(1)	(2)	(3)
	OLS No SES	OLS zpses	OLS sesindex
treadscore	-0.032 (0.028)	-0.037 (0.027)	-0.040 (0.028)
stable	8.458 (28.226)	-5.032 (26.027)	2.681 (25.331)
chair	49.413 (45.010)	90.169** (36.778)	68.639 (41.925)
electricity	35.989*** (4.435)	27.051*** (4.156)	28.315*** (4.338)
water	8.063** (4.080)	6.263* (3.802)	6.640* (4.036)
numtoilet	0.409** (0.187)	0.282 (0.176)	0.294 (0.185)
library	3.395 (3.007)	2.264 (2.837)	3.379 (2.981)
scomp	1.441*** (0.445)	1.152*** (0.413)	1.094** (0.433)
textr	-14.189** (6.948)	-13.462** (6.590)	-16.557** (6.882)
textm	24.124*** (7.220)	17.568** (6.892)	22.410*** (7.159)
stratio	-0.157 (0.132)	-0.135 (0.125)	-0.085 (0.130)
ftratio	55.653*** (9.517)	49.581*** (8.860)	51.489*** (9.409)
schead	19.034*** (4.310)	19.020*** (4.136)	16.996*** (4.318)
texpy	-2.471*** (0.270)	-2.552*** (0.254)	-2.349*** (0.269)
schdexpy	1.145*** (0.359)	1.084*** (0.334)	0.982*** (0.354)
readt	-10.087*** (3.212)	-7.564** (2.997)	-10.391*** (3.173)
matht	-6.606* (3.651)	-6.184* (3.441)	-6.859* (3.627)
classsize6	-0.454*** (0.112)	-0.484*** (0.106)	-0.504*** (0.112)
lagc	48.014*** (5.812)	38.033*** (5.596)	40.901*** (5.893)
stusex	-6.185** (2.813)	-7.010*** (2.639)	-6.613** (2.780)
travel	-1.915* (1.031)	-1.781* (0.960)	-1.950* (1.016)
eduyearf	1.021*** (0.335)		0.557* (0.333)
eduyearm	1.473*** (0.376)		0.816** (0.376)
zpses	No	Yes	No
sesindex	No	No	Yes
Observations	3,804	4,191	3,804
R-squared	0.235	0.248	0.251

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively.

Table 6

Result of IV Analysis (Mathematics)

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS No SES	OLS zpses	OLS sesindex	IV No SES	IV zpses	IV sesindex
tmathscore	0.084*** (0.015)	0.076*** (0.014)	0.080*** (0.015)	0.578*** (0.087)	0.525*** (0.087)	0.543*** (0.087)
zpses	No	Yes	No	No	Yes	No
sesindex	No	No	Yes	No	No	Yes
Observations	3,687	4,068	3,687	3,687	4,068	3,687
R-squared	0.188	0.197	0.195	.	0.012	0.005
Durbin-Wu-Hausman chi-sq test (p-value)				0.000	0.000	0.000

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively. Durbin-Wu-Hausman chi-sq test (p-value) shows the result of the test to determine whether endogenous regressors in the model are in fact exogenous.

Table 7

Result of IV Analysis (Reading)

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS No SES	OLS zpses	OLS sesindex	IV No SES	IV zpses	IV sesindex
treadscore	-0.032 (0.028)	-0.037 (0.027)	-0.040 (0.028)	-4.114 (2.623)	-2.990* (1.811)	-2.881* (1.715)
zpses	No	Yes	No	No	Yes	No
sesindex	No	No	Yes	No	No	Yes
Observations	3,804	4,191	3,804	3,804	4,191	3,804
R-squared	0.235	0.248	0.251	.	.	.
Durbin-Wu-Hausman chi-sq test (p-value)				0.000	0.001	0.001

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively. Durbin-Wu-Hausman chi-sq test (p-value) shows the result of the test to determine whether endogenous regressors in the model are in fact exogenous.

9. Discussion

According to Chapter 8, it is clear that the teacher’s ability has the causal relationship with student’s test scores. Mathematics teachers’ test scores increase students’ mathematics test scores. However, reading teachers’ test scores have the opposite effect on students’ achievement. It is not clear why reading teachers’ test scores decrease students’ reading test scores. But, according to Commeyras and Inyega (2007), Muthwii (2004) said that if the students do not understand the content of the lessons taught in English, the teachers use Kiswahili and other local languages instead of English as teaching language. In this way, it is recognized that using multiple languages in class is practical to deepen students' understanding. However, students need to read and answer in English during the test, so even if they understand the content of the lesson in Kiswahili or other local languages, it may not be reflected in the test results. Also, only teachers capable of translating English into Kiswahili can use this method, so students who were taught by teachers with high test scores may have lower test scores. In addition, even if a teacher's ability is high, the teaching method of the teacher is not necessarily good.

Also, there are important variables to increase students’ test scores. It is school head characteristics. The experience as a school head may affect students test scores more than the teacher's ability. According to the results of OLS analysis, it is suggested that a good school head has short teaching experience and long school head experience. It is thought that high skilled teachers get ahead of other teachers earlier than other teachers, and that such teachers have a positive influence on students by becoming principals. The same thing may be true for female school heads. Being a female school head is positively correlated with both the students’ math and reading test scores. According to the descriptive statistics, it is clear that most of the school heads are male. It can be said that a female teacher who has enough ability to assume a role in a male society has become a school head, and their ability has a great influence on the students’ performance.

Other control variables are as follows. It becomes clear that textbooks should be used in a different way or teachers have to change the way to teach depending on the subject. In the case of mathematics, using a textbook alone improves student test scores. However, in the case of reading, using a textbook with other students improve the test scores. This is the same as Glewwe et al. (2007), and it seems that the curriculum of conducting classes in English is difficult for students. If students share one textbook, they can teach each other what they don't understand, which may lead to an increase to the test scores. Mathematics can be understood by looking at the equation even if they do not understand part of the textbook. Thus, the test scores increase if they use it alone.

Electricity and access to computers seem to be effective for improving both mathematics and reading. Library is effective for only mathematics and safe drinking water is effective for only reading. These results show just correlation, but it is thought that in the better learning environment, the students are more likely to concentrate on the lesson. Thus, it can be said that it is desirable to install electricity that seems to be highly effective.

The class size has a negative correlation with test scores, so it can be said that the smaller class size is better to improve the students' achievement.

Schools in large cities increase student test scores. The possible reason is that test scores are influenced by the socio economic status of the students' family. It is thought that schools in large cities have more students from wealthy families than schools in other areas. Students in wealthy families have higher test scores, because their parents can afford to pay for education, so they can go to a well-equipped private school or study in classes outside school.

Female students have lower test scores than male students, especially in mathematics. It is not clear what causes this situation directly, but the fact that mother's years of education increase reading test scores more than the ones of father could be related to this gender difference, that is female is good at reading than mathematics.

Long distance from home to school decreases student test scores, so it can be suggested that the shorter the distance from home to the school, the longer the study time and the higher the scores on tests.

10. Conclusion

The results of this paper suggest several ways to improve student performance. The first is to establish and improve training institutions for mathematics teachers and school heads. A highly skilled mathematical teacher has a positive causal relationship with students' mathematics test scores. It is necessary to train mathematics teachers for the development of Kenya because it is thought that increasing mathematics skills will have a major impact on the social life of students. Also, the high skilled school head seems to increase the students' test scores in both reading and mathematics although the study only shows the correlation, not causation. From this result, if the quality of school head becomes high, it is expected that the students' grades will improve regardless of the subject. Although we could not find the positive effect of teachers' reading test scores on students' reading scores, so it cannot be said that the training of reading teachers is not necessary, because if the teachers change the way to teach, students' grades may increase.

Subsequent policy recommendations are based on correlation, considering the influence of student's social economic status. The next policy recommendation is installation of physical school inputs, especially library and electricity. To make a library at school requires collecting a large number of books and requires a large budget, but the cost and benefit of books is good because it can be used for a long time. Moreover, it is expected that students spend more time to study by taking books home and use them. If the study time increases, students' grades will increase, so the library should be set up. In the case of electricity, if electricity is introduced, teachers will be able to incorporate video teaching materials into their classes and will be able to open the school until late, so it can also be used for classes for students who cannot attend school during the day and for adult education. Then, the education can be expanded more than now. Computers also improve the student's achievement, but it cannot be used without electricity and the cost is expensive. Therefore, setting up the computers should be after installing other facilities.

The last policy recommendation is to create a system to eliminate student economic disparities. If there is a difference in the quality of education depending on the economic status of the family, there will be a negative chain that children in poor families will become increasingly poor, so government must make the way to solve this.

The future studies can analyze the causal relationship between other school inputs and test scores. For example, it is important to find an instrumental variable that controls for the quality of the school heads and analyze its causal effect on test scores.

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Appendix

Table 1

Result of the First Stage of Instrumental Variables (Mathematics)

	(4)	(5)	(6)
	IV No SES	IV zpses	IV sesindex
stable	26.843 (18.130)	26.928 (18.622)	26.197 (18.016)
chair	-40.333 (30.039)	-39.792 (25.562)	-37.560 (30.748)
electricity	17.183*** (4.095)	17.545*** (4.137)	16.216*** (4.245)
water	45.543*** (3.846)	43.811*** (3.739)	45.340*** (3.850)
numtoilet	1.306*** (0.212)	1.291*** (0.201)	1.285*** (0.211)
library	0.992 (3.175)	-0.347 (3.043)	0.959 (3.177)
scomp	-0.977** (0.410)	-0.938** (0.383)	-1.005** (0.411)
textr	8.592 (7.024)	6.229 (6.783)	8.332 (7.026)
textm	1.705 (7.017)	-0.127 (6.753)	1.393 (7.021)
stratio	-0.159 (0.139)	-0.217 (0.134)	-0.150 (0.138)
ftratio	-0.570 (9.354)	-3.564 (9.037)	-0.980 (9.359)
schead	23.816*** (4.065)	23.825*** (3.914)	23.550*** (4.064)
texpy	0.467** (0.239)	0.459** (0.227)	0.477** (0.238)
schdexpy	-1.400*** (0.321)	-1.389*** (0.313)	-1.417*** (0.323)
readt	-8.025** (3.365)	-8.304*** (3.227)	-8.079** (3.364)
matht	-23.342*** (3.451)	-22.764*** (3.304)	-23.390*** (3.453)
classsize6	0.402*** (0.129)	0.453*** (0.123)	0.396*** (0.129)
lagc	-45.901*** (5.411)	-45.306*** (5.292)	-47.046*** (5.422)
stusex	2.173 (2.884)	1.167 (2.773)	2.114 (2.887)
travel	-1.011 (1.022)	-0.270 (0.993)	-1.022 (1.022)
eduyearf	-0.581* (0.347)		-0.642* (0.351)
eduyearm	1.211*** (0.403)		1.116*** (0.411)
hengt	79.527*** (5.743)	73.948*** (5.423)	78.752*** (5.713)
zpses	No	Yes	No
sesindex	No	No	Yes
Observations	3,687	4,068	3,687
Adj R-squared	0.134	0.124	0.135

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively. Adj R-squared means Adjusted R-squared.

Table 2

Result of the First Stage of Instrumental Variables (Reading)

	(4)	(5)	(6)
	IV No SES	IV zpses	IV sesindex
stable	7.679 (14.075)	8.716 (13.703)	6.702 (13.590)
chair	6.687 (15.985)	6.053 (13.814)	9.537 (16.293)
electricity	-15.767*** (2.375)	-16.594*** (2.333)	-16.882*** (2.405)
water	1.603 (2.268)	1.214 (2.158)	1.363 (2.263)
numtoilet	0.197* (0.107)	0.270*** (0.103)	0.178* (0.108)
library	10.045*** (1.643)	10.102*** (1.562)	10.008*** (1.642)
scomp	-0.342 (0.241)	-0.498** (0.230)	-0.379 (0.241)
textr	19.009*** (3.963)	18.299*** (3.735)	18.704*** (3.960)
textm	-1.871 (4.036)	-1.752 (3.831)	-2.111 (4.039)
stratio	-0.880*** (0.058)	-0.868*** (0.056)	-0.871*** (0.058)
ftratio	-23.093*** (4.987)	-22.969*** (4.710)	-23.687*** (4.991)
schead	13.854*** (2.277)	14.405*** (2.186)	13.545*** (2.279)
texpy	-0.445*** (0.154)	-0.519*** (0.145)	-0.433*** (0.154)
schdexpy	1.438*** (0.186)	1.476*** (0.178)	1.416*** (0.186)
readt	1.706 (1.706)	1.075 (1.617)	1.687 (1.703)
matht	-2.237 (1.895)	-3.965** (1.817)	-2.276 (1.893)
classsize6	0.078 (0.066)	0.061 (0.063)	0.071 (0.066)
lagc	37.512*** (3.193)	38.410*** (3.091)	36.467*** (3.245)
stusex	-1.836 (1.628)	-1.660 (1.547)	-1.902 (1.628)
travel	1.555*** (0.554)	1.531*** (0.528)	1.543*** (0.554)
eduyearf	-0.323* (0.187)		-0.389** (0.189)
eduyearm	0.267 (0.213)		0.170 (0.219)
hengt	-5.813* (3.332)	-6.308** (3.173)	-6.577** (3.323)
zpses	No	Yes	No
sesindex	No	No	Yes
Observations	3,804	4,191	3,804
Adj R-squared	0.144	0.148	0.145

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively. Adj R-squared means Adjusted R-squared.

Table 3

Result of the Second Stage of Instrumental Variables for the Details (Mathematics)

	(4)	(5)	(6)
	IV No SES	IV zpses	IV sesindex
tmathscore	0.578*** (0.087)	0.525*** (0.087)	0.543*** (0.087)
stable	-42.852 (59.932)	-48.128 (58.663)	-44.242 (58.814)
chair	104.604* (63.290)	151.460*** (45.484)	113.209* (65.066)
electricity	16.201*** (5.149)	12.681*** (4.887)	13.310*** (5.086)
water	-21.474*** (5.735)	-18.140*** (5.319)	-20.604*** (5.643)
numtoilet	-0.321 (0.234)	-0.422* (0.220)	-0.351 (0.230)
library	7.941** (3.391)	8.284*** (3.149)	7.856** (3.333)
scomp	0.750* (0.441)	0.792** (0.404)	0.613 (0.432)
textr	-21.584*** (7.534)	-17.896** (7.090)	-22.223*** (7.424)
textm	25.298*** (7.612)	21.610*** (7.214)	24.233*** (7.521)
stratio	0.092 (0.155)	0.139 (0.145)	0.122 (0.152)
ftratio	13.380 (10.687)	15.097 (9.802)	11.880 (10.540)
schead	6.052 (5.327)	6.013 (5.042)	5.928 (5.265)
texpy	-2.547*** (0.294)	-2.715*** (0.275)	-2.497*** (0.291)
schdexpy	2.562*** (0.387)	2.514*** (0.362)	2.450*** (0.383)
readt	-3.304 (3.577)	-2.531 (3.298)	-3.783 (3.505)
matht	17.756*** (4.345)	15.668*** (4.085)	16.762*** (4.286)
classsize6	-0.665*** (0.138)	-0.677*** (0.129)	-0.670*** (0.135)
lagc	63.424*** (7.655)	53.369*** (7.463)	57.667*** (7.835)
stusex	-27.330*** (3.094)	-27.264*** (2.856)	-27.468*** (3.037)
travel	-2.171* (1.170)	-2.653** (1.076)	-2.249* (1.153)
eduyearf	0.952** (0.385)		0.713* (0.379)
eduyearm	0.201 (0.454)		-0.098 (0.445)
zpses	No	Yes	No
sesindex	No	No	Yes
Observations	3,687	4,068	3,687
R-squared	.	0.012	0.005
Durbin-Wu-Hausman chi-sq test (p-value)	0.000	0.000	0.000

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively. Durbin-Wu-Hausman chi-sq test (p-value) shows the result of the test to determine whether endogenous regressors in the model are in fact exogenous.

Table 4

Result of the Second Stage of Instrumental Variables for the Details (Reading)

	(4)	(5)	(6)
	IV No SES	IV zpses	IV sesindex
treadscore	-4.114 (2.623)	-2.990* (1.811)	-2.881* (1.715)
stable	43.324 (78.982)	22.940 (59.713)	24.683 (56.067)
chair	76.129 (81.054)	110.415* (64.605)	94.636 (64.660)
electricity	-28.321 (43.412)	-21.658 (31.370)	-19.350 (30.475)
water	15.446 (10.681)	10.648 (7.740)	11.222 (7.937)
numtoilet	1.274* (0.730)	1.128* (0.630)	0.850* (0.488)
library	45.102 (27.915)	32.596* (19.378)	32.362* (18.391)
scomp	-0.357 (1.541)	-0.622 (1.325)	-0.290 (1.129)
textr	61.283 (51.014)	38.937 (34.144)	34.986 (33.475)
textm	16.136 (18.915)	12.308 (13.789)	16.196 (14.222)
stratio	-3.668 (2.285)	-2.639* (1.557)	-2.498* (1.478)
ftratio	-38.358 (64.756)	-17.783 (44.676)	-15.463 (44.114)
schead	75.331** (37.154)	61.348** (26.795)	55.338** (24.142)
texpy	-4.073*** (1.301)	-3.916*** (1.021)	-3.415*** (0.863)
schdexpy	6.889* (3.857)	5.346* (2.739)	4.911** (2.501)
readt	-3.989 (8.500)	-5.028 (5.774)	-6.270 (6.215)
matht	-15.572 (9.800)	-17.769* (9.089)	-13.189* (7.180)
classsize6	-0.157 (0.360)	-0.318 (0.243)	-0.317 (0.252)
lagc	199.533** (99.607)	150.405** (70.382)	143.468** (63.702)
stusex	-13.536 (8.550)	-11.867** (6.000)	-11.887* (6.205)
travel	4.553 (4.844)	2.813 (3.373)	2.531 (3.282)
eduyearf	-0.387 (1.229)		-0.601 (0.942)
eduyearm	2.562** (1.171)		1.319* (0.791)
zpses	No	Yes	No
sesindex	No	No	Yes
Observations	3,804	4,191	3,804
R-squared	.	.	.
Durbin-Wu-Hausman chi-sq test (p-value)	0.000	0.001	0.001

Note. Robust standard errors are in parentheses. *, **, and *** signify statistical significance at the 10, 5, and 1 percent level, respectively. Durbin-Wu-Hausman chi-sq test (p-value) shows the result of the test to determine whether endogenous regressors in the model are in fact exogenous.