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Melap Sitati,
Rosemary Murebu,
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Bringing Rigour and Evidence to Economic Policy Making in Africa

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By

Melap Sitati,

Rosemary Murebu,

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Abstract

The importance of teacher quality on early grade achievement of cognitive skills is the current policy discourse. Teacher quality is a key factor that influences learner's achievement at all levels of schooling. This paper uses a multiple regression technique on Public Expenditure Tracking (PETs) and Service Delivery Indicators survey data (2014/2015) to interrogate the impact of teacher quality in terms of qualification in teacher training and experience on early grade achievement of cognitive skills in Kenya. Although the study reveals that teacher qualification in terms of training is the single-most important attribute that impacts on learner achievement, there is no significant difference between the teacher level of training on learner performance regardless of the time taken to acquire those qualifications. Interestingly, results showed that learners taught by certificate holders in teaching performed better than the ones taught by diploma holders. Pedagogical training, which is taught at certificate level, for teaching at primary education level is significant in affecting learner performance compared to diploma, yet the latter takes more duration and resources. The evidence also shows that teacher experience significantly affects learner performance especially in reading. However, further research could investigate how different type of school interventions amplify or weaken the effects of teachers on learners' cognitive skill. The study recommends enhanced teacher professional development, more focus on in-service training on pedagogical skills acquired at the primary certificate level, equitable teacher distribution, and provision of adequate teaching and learning materials in school. It is also important to ensure that newly employed teachers have the required pedagogical skills and that they are provided with adequate pedagogical training programmes.

Keywords: *Teacher Qualification, Teacher Experience, Early Grade Achievement*

1. Introduction

Teacher quality is a key factor that influences learner's achievement at all levels of schooling (Renu and Sudipa, 2015; Hanushek, 2011; Glewwe et al., 2009; Rivkin et al., 2005; Darling-Hammond, 2000; and Fuller and Clarke, 1994). The quality of teachers is revealed through instructional competency, leadership, relationship building, classroom management skills, among others (Renu and Sudipa, 2015). Quite often, teacher quality is assessed through the level of school attainment, training qualifications, years of experience and performance in teacher's appraisals (Rivkin et al., 2005; Glewwe et al., 2009). Because of the important role that teachers play in the education system, expenditure on teacher salaries is in many countries the highest budget item in education expenditure. In Kenya, teachers' salaries accounted for 58% of the total education budget in 2022 and has consistently accounted for over half the recurrent expenditure of the last decade (Ministry of Education, 2022 Education Sector Report).

Typical observable characteristics of teacher quality that have been linked to learner performance include classroom practices, educational backgrounds, and teaching experience (Glewwe and Kremer, 2006; Lee and Lee, 2020). However, Hanushek and Rivkin (2006) argued that these observable characteristics have limited power to predict learners' academic ability, as measured by test scores, and there are unobservable characteristics of teachers that impact learner performance, such as pedagogy, classroom management skill, teaching philosophy, communication skill, motivation, individual traits and preferences (Tanaka et al., 2020). Learner performance is usually measured by test scores through structured examinations and assessments.

Acquisition of basic reading and numeracy skills in early grades of primary school helps in attaining proficiency in reading and other content areas (UNESCO, 2021; 2014; Ball, Paris and Govinda, 2014; Snow, 2002; Thorndike, 1973). Teaching children to read at a young age is the basis of enhancing educational outcomes for completion, attainment, and human capital (UNICEF, 2014). Early literacy and numeracy imply developing the ability of learners in building a strong foundation in all aspects of mathematics and a rich vocabulary, self-expression, and reading comprehension tools they need to become successful readers and lifelong learners. This has been at the centre of education policy and curriculum reforms in many countries, including Kenya. Some of the assessments that have been conducted to track early grade performance include Early Grade Reading Assessment (EGRA) and Early Grade Mathematics Assessment (EGMA), which are designed to enable countries

to measure, in a systematic way, how well children in the early grades of primary school are acquiring literacy and numeracy skills, respectively; Uwezo; Public Expenditure Tracking Surveys (PETS) and Service Delivery Indicators, Southern Africa Consortium for Monitoring Education Quality (SACMEQ); and National Assessment System for Monitoring Learner Achievement (NASMLA).

These assessments provide insights that can support research towards strengthening education systems in African countries. In addition, Kenya has been implementing projects to support early grade learning, namely Kenya Primary Math and Reading Initiative, which ran from 2011-2014; Primary Education Development (2015-2019); Tusome project (2015-2022); and the Primary Education Equity and Learning programme with the main objective of improving Early Grade Mathematics and Reading Competencies among learners. All these initiatives have a key component on teacher competencies for improving early grade reading and numeracy.

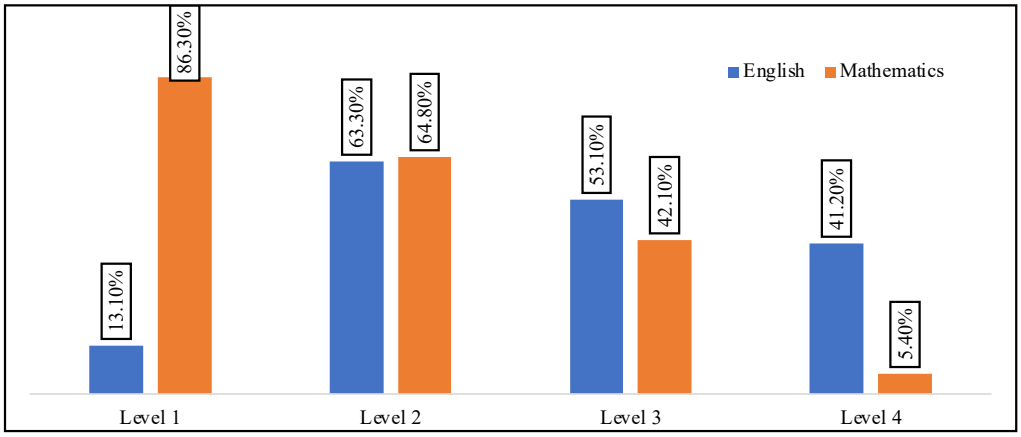
Throughout their lives, children's cognitive development is influenced by various factors such as parents, neighbourhoods, peers, teachers, school environment and the education content that they are exposed to. Quantifying the relative importance of these factors at various points in the child development process is a central question. Indeed, one of the primary goals of the Leaving No Child Behind legislation is to have a "highly qualified teacher" in every classroom (UNESCO, 2021). Evidence has shown that teachers make the greatest contribution on learner's performance (Barber and Mourshed, 2007; Glewwe et al., 2011; McEwan, 2015; Filmer et al., 2018; and UNESCO, 2021). Research supporting the important role of teachers on learner test scores and later lifelong outcomes has renewed interest in the role of teacher characteristics in the educational process, and ultimately the impact it has on skill formation as a measure of human capital (Burroughs et al., 2019; OECD, 2018; Heckman and Mosso, 2014; and Hanushek, 2011).

The Pupil-Teacher Ratio (PTR) at primary education level in Kenya is above the recommended ratio of 40 (Ministry of Education, 2022). However, staffing norms are based on class size and teacher workforce. The norm provides for placement of one teacher per classroom, plus additional teachers based on 2.5% of the total number of classrooms in a school, regardless of the enrolment in the class. Moreover, there is still uneven distribution and utilization of teachers across the country. As a measure to cope with teacher shortages, various Boards of Management for institutions have engaged teachers in public schools, some of whom may not be qualified. For instance, in 2020, twenty-two (22) counties had PTRs higher than the national average in public primary schools. Mandera had a PTR of 126 followed by Turkana with 88, Garissa at 81, Wajir at 80 and Nairobi City at 61 compared to the national PTR of 40 in the year 2020. A high PTR implies that a teacher has limited contact with individual learners, which has a negative effect on performance.

Further, there are gaps in learner achievement in terms of numeracy and literacy at early grade. The benchmark of achievement in numeracy and literacy was set at 50% score at each competency level. Poor achievement in Mathematics and English

is a major concern on the quality of education in the country. Figure 1 summarizes the proportion of pupils who attained the 50% benchmark in the different competency levels of numeracy in 2018. Statistics show that majority of learners attained below average in numeracy for level 3 and 4, whereas in reading only 13% and 5% attained the expected level in level 1 and 4, respectively. Pre-reading, a considerable proportion (87%) fell below average. Similarly, in reading for meaning, over half (59%) of the learners fell below average. A similar trend in performance is observed in Mathematical activities. In numbers, more than half (58%) were below average in translating the information presented in a sentence into one arithmetic operation.

Figure 1.1: Achievement in numeracy by competency levels



Source: Kenya National Examinations Council (2020)

Table 1.1: Definition and components of each level

	Numeracy	Literacy
Level 1	Applies single step addition or subtraction operations	Pre-reading: Matches words and pictures involving concrete concepts and everyday objects. Arranges words in alphabetical order
Level 2	Applies a two-step addition or subtraction operation involving carrying over and borrowing	Emergent reading: Spells correctly simple everyday words and recognizes missing letters in such words. Uses familiar words to complete simple everyday sentences
Level 3	Translates information presented in a sentence into one arithmetic operation	Basic reading: Uses correct punctuation in simple sentences. Infers meaning from short passages and interprets meaning by matching words and phrases. Identifies the main theme of a picture
Level 4	Translates information presented in sentences into simple arithmetic operations	Reading for meaning: Links and interprets information located in various parts of a short passage. Understands and interprets meaning of a picture and writes short sentences to describe the theme

Further, in 2021, about 46.56% of grade 3 learners attained the expected level on reading comprehension and 42.42% on writing skills, implying low performance. At the county level, the results showed that there were wide differences in pupil achievement across regions.

The Government of Kenya has since 2003 implemented the Universal Primary Education (UPE) Policy (Government of Kenya, 2003). The main objective is to enable all children to enrol and attend primary school for all the 8 years of primary school and provide quality and relevant primary education for the development of human capital. However, there is a weak balance between education quality and quantity, which has implications on human capital development in the country. In addition, with UPE, enrolment in primary schools rose drastically, from Gross Enrolment Rate of 88% in 2002 to 103% in 2003. Enrolment has been sustained for almost two decades and was 99.6% in 2019, which had an adverse effect on teaching and learning. However, the rapid increase in pupil enrolment put pressure on education infrastructure, teachers and other school inputs. This is manifested in overcrowded classrooms, and therefore inappropriate pupil-teacher ratio in certain regions. This raises concerns on the quality of primary education.

Prior to the shift in curriculum, assessment was summative, and therefore data on early grade performance was not available. At national level, the quality of schooling has been seen through summative national examinations, the Kenya Certificate of Primary Education (KCPE) administered at end of the 8th grade. However, a major concern is that the use of summative evaluation is done at the end of the primary education cycle and therefore does not allow for detection and remedy of quality gaps at earlier years, yet early years are a crucial formative period. According to Harrison et al. (2017), learning potential is not fully realized for learners whose education systems emphasize only this summative evaluation and access to schooling as measured by gross enrolment rates.

As Kenya transits from the 8-4-4 system curriculum to a new curriculum which is competency-based curriculum, there is need to rethink about teacher retooling. The shift in curriculum reforms has come with specific needs. This study is an important contribution to inform education reforms in Kenya, especially with the shift from the 8-4-4 to the 2-6-3-3-4 curriculum system, strengthening the education system and enhancing learner achievement at early grade.

Teachers are a key resource in the provision of quality of education as they provide the link between the school environment and the home environment. The availability and quality of the teaching service is therefore important in learner achievement. As of 2020, the number of primary school teachers was 222,780 compared to 218,760 in 2019 (Ministry of Education, 2021). Similarly, most teachers in public primary schools had certificate-level qualification, at 70.2% of the teachers.

It is paramount that the performance of early grade learners in reading and numeracy needed an evaluation on teacher quality since the teacher determines the quality of instruction and therefore learner performance. This focuses on teacher

quality by estimating the importance of teacher quality on learners' cognitive skills at early grade level in Kenya. The study will inform the implementation of curriculum reforms, strengthening of the education system and enhancing learner achievement at early grade. This work also expands the geographical horizons commonly considered in the literature on teacher quality and learner performance by using a representative dataset on primary schools in Kenya. It is relevant to contrast associations found in specific countries because they might depend on system-level and cultural factors.

Objectives of the study

This study focused on the contribution of teacher quality to students' performance. Specifically, the study sought to investigate the impact of teacher training qualification and experience on the performance of students in numeracy and literacy using the OLS method. The objectives of the study are as follows:

a) Analyze the factors that determine early grade learners' performance in mathematics and reading in Kenya;

b) Analyze the impact of teacher quality on learner's performance in the early grade level in Kenya; and

c) Draw implications for policy.

Research questions

The research questions are:

(i) What are the determinants of early grade learner's performance in numeracy and literacy in Kenya?

(ii) Does teacher experience and training affect early grade learners' achievement in Kenya?

2. Literature review

This section gives a review of theoretical and empirical literature on the effects of non-school environmental factors on pupil performance. It also gives a summary of the literature review, highlighting the key issues in the literature and indicates the potential contribution of this study to the existing literature in Kenya.

Theoretical literature

The link between learner achievement and their immediate environment during their years of learning has been theoretically presented and has evolved over the last century. Early on in his seminal work in 1913 on the impact of behaviourism on child development, Watson (1913), and subsequent experimental works, Watson and Morgan (1917), Watson and Rayner (1920) theorized that the environment to which a child is exposed is the key factor, together with conditioning over time, which shapes the outcome for behavioural performance even more than genetic composition. The underlying tenet of this theory was that manipulation of the learner's environment was a practical way to foster child development. Although this thinking faced wide criticism, Resee (2013)[1], Watson theory and the successive theory on operant behaviour by Skinner (1938) – that reinforced the importance of learning and environmental influences in human development – had a major impact in the design of early education systems. The Skinner theory introduced the idea of manipulating the learner environment by introducing reinforcement or rewards.

The behavioural theories were countered by cognitive development theory by Jean Piaget (1970), who argued that cognitive development in children was influenced by their cognitive abilities, processes and that these abilities developed with age and experience. The investment theory by Cattell (1957; 1963) on the influence of cognitive properties on learning further reiterates the positive link of learning to individual intelligence and age. Cognitive theories have been influential in curriculum design and methods of teaching that are aligned to the age of children. Jardine (2006)[2] Elkind (1976), Furth (1970), Furth and Wachs (1975) are some of the works that have explored the extent to which this theory has influenced education.

The socio-cognitive theory is associated with Albert Bandura (1960s) and posits that learner's performance is a culmination of socio-economic, psychological and environmental factors. Learning and teaching are social activities that affect the

performance of a learner as an interaction of the person, environment, and behaviour. These factors could be both school and non-school environmental factors (Hansen, 2000). This theory ascribes a central role to cognitive processes in which the individual can observe others and the environment, thus the learner's behaviour is regulated through the school environment. Schools envisage to produce well-educated, skilled, well-behaved students, according to the needs and requirements of the dynamically growing market through teaching and learning. However, based on the dynamics in the learner's socio-economic status and environmental factors, the learner's performance varies. Therefore, providing appropriate learning environments for students at school is an important element of ensuring equal access to education for students from diverse backgrounds.

A point of convergence for both behavioural and cognitive theories is that learner performance is influenced by both individual abilities and environmental factors that are provided in the school setting and homes. Cattell (1987) advances the idea that investment of cognitive abilities and the stimulation by the environment determines academic performance. These theoretical foundations have laid ground for school systems investment, school facilities and teachers, development of curriculum, teaching methods, teaching materials and learner assessments. This suggests that sustained and high-quality school environment and education delivery directly foster children's academic and cognitive development. In addition, the learner's environment extends to their homes and involves parents or guardians and the socio-economic status in which they live.

The theory of Lupdag (1994) suggests that numerous factors affect learner performance. These are teachers, the learners themselves and the environment. It is therefore vital that both pre-service and in-service training should equip teachers with theory and practice to enable them be effective in curriculum delivery. Further, researchers have estimated education production functions by regressing aggregate learner achievement levels on measures of teacher training and various other controls using cross-sectional data (Hanushek, 1986). In such a case, learner achievement is represented in a function as:

$$A = f(X_{1,} X_2, X_3) \quad (1)$$

Where A is pupil performance; X_1 is individual and home characteristics; X^2 is classroom level characteristics and X_3 is school inputs.

Empirical literature

In literature, several factors have been cited as the key contributors that affect learner performance and abilities. These factors have been categorized as student background, teacher factors and fiscal and other resources. Learning, therefore, is unique to the individual learner, and the quality of teachers has been demonstrated

to have a positive impact on student performance (Ahmmed et al., 2022; Goe and Stickler, 2008). Empirically, teacher factors make the greatest contribution on learner performance (Filmer et al., 2018; McEwan, 2015; Glewwe et al., 2011). A teacher plays a crucial role in the teaching-learning process while the learners carry with them variables that could influence the process and the environment that set the climate for the teaching-learning process.

Teacher training is of great importance in improving learner performance compared to those who lacked formal teaching qualifications. The higher level of training in most studies is positive and highly significant with learners' performance in numeracy and literacy. Studies have measured teacher training qualification level at pre-primary, certificate, diploma, degree and above (Shabibi, et al., 2019; Golob, 2012; Blank and De Las Alas, 2009; and Darling-Hammond et al., 2005). Contrary to this, some studies show that the level of teacher training qualifications does not matter (Barasa, 2020; Darling-Hammond et al., 2005). The findings of several studies on the impact of teacher training on student performance found mixed results, with some studies finding a positive impact and others finding no significant effect. Overall, it appears that the impact of teacher training on student performance may depend on the specific design and content of the training programme, and the skills and motivation of the teachers.

Further, comparison between professional qualification and general higher education showed significant difference in terms of learners' outcome in literacy and numeracy (Fletcher-Wood and Zuccollo, 2020; Shabibi et al., 2019; Golob, 2012). Several studies have demonstrated that when teachers have more professional knowledge, students' outcomes are also higher (Golob, 2012). Professional development of teachers has a significant role in changing teaching methods, which consequently bears a positive impact on student learning.

Professional development is necessary to support disengaged and disadvantaged students. This is in critical areas such as enhancing the relationships between teachers and students, because previous evidence suggests that students' emotional, cognitive, and behavioural engagement in class correlates with their feelings of acceptance by teachers (Shabibi et al., 2019). Shabibi et al. (2019) established that participation in the training programmes provided teachers with additional skills and active learning strategies that were focused on pupils. Teachers need opportunities for professional development, education, and support to effectively work with diverse student populations, including those who are who are ethnically, culturally, and linguistically diverse. Additionally, teachers need training and support to accommodate and adequately assist students with special needs, and to personalize learning. Overall, further research is needed to determine the most effective approaches to improving teacher training and student performance in Kenya.

Several studies on the effect of teacher experience and learner performance found that teacher experience was a significant predictor of student performance in both reading and numeracy after controlling for other relevant factors, and there was a positive association (Ondiek et al., 2019; Ayodo, 2015;; Nthepe et al., 2015). Other studies found that there were larger teacher effects on mathematics achievement

than on reading achievement in relation to teacher experience and was statistically significant only for 2nd grade reading and 3rd grade mathematics achievement. However, other studies have found that teacher experience is only of statistical significance in the early years, with a positive association on learner achievement (Podolsky and Darling, 2019; Goe and Stickler, 2008; Boyd et al., 2006; Rivkin et al., 2005; Staiger and Rockoff, 2010). However, the benefits of experience on learner performance tend to level off in later years.

Teachers' gender also influences students' performance. A study carried out in China on the role of teacher gender in education production using the Principal Component Analysis (PCA) method revealed that having a female teacher raises girls' test scores and improves both their mental status and social acclimation relative to boys (Gong et al., 2018). The findings from a study done in ten Francophone Western and Central African countries to analyze the relationship between teacher gender, student gender, and student achievement using a standardized education assessment dataset comprising over 1,800 primary schools and 31,000 grade six students revealed that being taught by a female teacher increases math and reading performance for girls but has no effect on boys (Lee et al., 2019). Based on this finding, the study suggests that hiring more female teachers in the region could reduce educational gender gaps without hurting boys.

Other studies have applied teacher value-added methodology on specific outcome variables such as reading and math test scores to measure teacher quality (Rivkin et al., 2005; Tanaka et al., 2020). Based on the theoretical literature, learner performance is influenced by both school and non-school factors. Learners' performance is measured by the Rasch model, which aligns the ability levels of pupils with the difficulty levels of test items, and to make a probabilistic linkage between a person's ability and item difficulty. Based on this approach, learners are rated on the ability to read and solve mathematical problems that are appropriate for their grade. Learners who can read and solve mathematical problems are considered to have mastered the content. Glewwe et al. (2010) using a randomized trial of a programme that rewarded Kenyan primary school teachers found that teacher-pupil ratios, cooperation between teacher and parent and teacher motivation and supervision contribute significantly to student performance in national exams.

According to Fletcher-Wood and Zuccollo (2020), a rapid review and meta-analysis on the effects of high quality professional development on teachers and students established a positive impact on student learning. The meta-analysis of 49 outcomes across 42 studies suggested an overall effect size of 0.09 on student learning. Additionally, the review reiterated other recent meta-analysis in demonstrating a positive impact of teacher professional development on student outcomes. Furthermore, the study established that professional development has the potential to bridge the gap that may exist between the efficacy of new and experienced teachers. Interestingly, the study also found that the impact of professional development on student learning is comparable to the impact of having a more experienced teacher. Notably, the effect sizes for professional development indicate a greater

improvement than estimates for the impacts of other school-based interventions, including performance-related pay and lengthening the school days. Evidence shows that learners who take breakfast or a meal in the morning perform better in class because the meal helps in their alertness, concentration and the brain's neural formation especially during formative years (Fretham et al., 2011; Chang et al., 1994; and Read, 1973). School meals are associated with education outcomes through two main pathways; first is increased access to and participation in school, measured through enrolment, attendance, and grade attainment; and the second is increased learning capabilities measured through cognitive scores and overall performance (Kristjansson et al., 2015; Gelli, 2015).

On school factors, studies have shown that school type, location and availability of quality and adequate infrastructure have a bearing on the role of teachers on performance (Tooley et al., 2007; Darling-Hammond et al. 2005; and Fuller and Clarke, 1994). Learners in private schools perform better than learners in public-based schools due to better infrastructure and resources that could contribute to better learner performance (Tooley et al., 2007; and Darling-Hammond et al., 2005). Fuller and Clarke (1994) show that developing countries lack evidence to analyze teaching behaviours and classroom factors that promote favourable student outcomes. Accessibility of electricity in schools is associated with improved performance and modern teaching methods in class. Additionally, in some instances, the availability of electricity in schools can contribute to the overall social and economic development of communities.

3. Methodology

Conceptual framework

Learner performance is measured through various approaches often characterized as summative or formative assessments. This study used data from the World Bank on Service delivery Indicators Education Survey Kenya 2014/2015 that administered proficiency tests in reading and mathematics to primary school grade 4 learners and teachers.

Numerous studies show that teacher quality is pivotal in learner performance (Rivkin et al., 2005; Darling-Hammond, 2000). The key concern arising on teacher quality is what kind of teacher attribute improves learner performance. Teacher qualities such as education background, experience, teacher workload, teacher preparedness and course work are the variables that are critical to improving student achievement. The teacher factors used in this study are highest level in teacher training qualification, teacher experience measured by years of teaching, gender of the teacher, type of employer, time taken to teach, and number of subjects a teacher teaches. The school environment factors considered are access to electricity, pupil-teacher ratio, and access to meals (Glewwe et al., 2009). Other school environment factors used in the study are location of the school and the type of school.

The home environment factors are identified as some of the key factors that impact on learner performance. Family wealth, size, level of education of household heads, distance from school, regularity of meals, if the language of the test is spoken at home, number of books at home, place where pupils stayed during the school week, socio-economic status of pupils' parents in terms of possessions, housing conditions (lighting, floor, wall, roof), and livestock and cultural factors are some of the home environmental factors that impinge on school performance (Wasanga et al., 2011). The relationship between student background and school environment points to a complex relationship that may explain variations in school achievements among learners. Learner's characteristics can be defined as individual ability factors that may affect learning activity. Cognitive theories of intelligence have argued that individual differences in cognition, memory and perception are linked to differences in test scores (Hunt et al., 1973). The effects of early environments on children at a younger age strongly affect their achievement.

The home environment and personal characteristics that have implications on learners' performance applied in this study are whether a learner had breakfast/meal, age of learner, and gender of learner.

The study analyzes the interplay between test scores, teacher qualities, school and home environments for a learner by hinging on the education production function model of skill development estimated in Cunha and Heckman (2007) and Cunha et al. (2010).

Model specification and estimation

Foremost, a general specification of the education production function model that relates to learner achievement to vectors of teacher factors (T), student and family observable inputs (L), and vector of school inputs (S) is provided. The equation is represented as:

$$A_{ij} = \alpha_1 T_{ij} + \alpha_2 L_{ij} + \alpha_3 S_{ij} + \varepsilon_i \quad (2)$$

Where the subscripts represent: (i) for individuals and (j) for school factors.

Quality education starts with teachers; teachers must be present and engaged for learning to take place. The study analyses teacher's quality as their contribution to learner achievement, holding other inputs constant. Since we do not have longitudinal data, we consider the static version of the model (2). We estimate the following model:

$$Log(A_{ij}) = \alpha_1 T_{ij} + \alpha_2 L_i + \alpha_3 S_{ij} + \varepsilon_i \quad (3)$$

Note: Estimation of (3) includes three levels of fixed effects: Teacher effects, students and home factors and school factors.

The dependent variable is represented by grade 4 leaners' performance in Mathematics as a proxy for numeracy and English as a proxy for literacy. The covariates included in the model are described in Table 3.1.

Table 3.1: Description of variables

	Variable	Name of the variable	Description
Dependent Variable	Reading	English	English test scores
	Numeracy	Mathematics	Mathematics test score
Teacher factors (Independent Variable)	Gender of teacher	Gender of the teacher	The sex of the teacher measured (dummy 1=Male; 0 otherwise)
	Teacher qualification in teacher training	Level of qualification	This was measured as the highest level of teacher training education attainment. A categorical variable measured as 1= ECDE; 2= P1 and P2 certificate; 3=Diploma
	Teacher experience	Level of experience	Number of years in teaching (continuous)
	Teacher employer	Type of employer	Measured as type of employer of the teacher (dummy, 1=Government; 0 = Otherwise)
	Teacher in class teaching as a proxy variable for time on task	Time taken teaching	This is measured as the number of minutes teacher spent in class teaching (continuous)
	Teacher subject	Subjects taught per teacher	This will be measured as a dummy variable taking the value of 1 when a teacher teaches more than one subject and zero otherwise
School factors	Location	Urban or rural	This is dummy variable that takes the value of 1 if rural and zero if urban
	School type	Public or private	This is dummy variable that takes the value of 1 if public and 0 if private
	Pupil-teacher ratio	PTR	This is the average number of pupils per teacher. This is calculated by taking the total enrolment divided by number of teachers in a school (continuous)
	Electricity in class	Class electricity	This is dummy variable that takes the value of 1 if the classroom has electricity and 0 if otherwise

continued next page

Table 3.1 Continued

	Variable	Name of the variable	Description
Learner and Home factors (Independent Variable)	Age of learner in years	Learner age	Age of the learner (continuous)
	Gender of child	Learner gender	The sex of the child measures as a dummy variable 1 if male and 0 if female
	Learner had breakfast	BMeal	This is measured as a dummy variable 1 if the leaner had breakfast and 0 if otherwise

Data source and type

The study used the Public Expenditure Tracking (PETs) and Service Delivery Indicators survey (2014/2015), which aimed at establishing pupils' competency levels in Mathematics and Reading and the factors that influence the learning outcomes of Standard 4 pupils. The dependent variable is the test score of a student in Math or English. The test score variable in the data set is the plausible value for Math and English. We standardize the test scores so that the mean is zero and the standard deviation is one as a measure of student's attainment in Math and English (Woessmann, 2003).

Summary statistics

Table 3.2 presents detailed descriptive statistics of the sample without fixed effects. The survey used a multi-stage process, sampled 2,956 Standard 4 pupils (51% boys) from Kenyan primary schools. The main dependent variable of interest is performance in Mathematics and English for a student. Both tests were administered in English language. The Mathematics test scores a proxy for numeracy and contains a wide variety of items ranging from problem solving to simple geometry.

The learner's population is evenly distributed by sex, and the mean age is about 10.4 years. The official age for primary school entry in Kenya is 6 years for grade 1. Assuming that the pupil does not repeat subsequent classes, and with the implementation of the 100% transition policy, then by the time they are in grade 4 they should be at least 9 years old. However, from the results, the mean age of Standard 4 pupils was above the official age (9 years), an indication that some learners started school at an older age. Literature has shown that lack of regular meals may lead to lack of concentration and reduced effort and attendance to school. Therefore, the regularity of meals is among the other factors that contribute to the performance of learners in school. From the descriptive statistics, 87% of learners reported that they had breakfast.

Although there was near gender parity at the national level, there were notable differences across the counties. The results show that the average score in numeracy was 78% and 63% in literacy. Examining the learners' school factors, the average pupil teacher ratio was about 28 pupils per teacher. However, there were wide regional variabilities in PTR. Further, about 85% of the schools in the sample were public schools, and 68% were in rural areas.

On teachers' factors, about 45% of them are male from the sample, 6% had teacher training qualification at ECDE level, 11% had diploma certificate, while 61% had P1 or P2 certificate in teacher training. On average, teachers had 14 years of experience in teaching at primary school. Half of these teachers were employed by the government on permanent and pensionable basis.

Further, a teacher's average time to teach students was about 29 minutes out of the 45 minutes allocated per lesson. Also, out of the sampled teachers, about 40% taught more than one subject. The highest percentage of teachers, at 38%, had between 1-9 years of teaching experience. The next highest percentage at 25% were those with 20-29 years of experience, followed by those with 10-19 years of experience at 21%. The lowest percentages of teachers were those with no experience and those with over 30 years of experience, each accounting for only 6% and 9%, respectively.

Table 3.2: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Dependent Variable				
Numeracy (Mathematics test score)	77.7	19.34	0	100
Literacy (English test score)	63.25	13.53	0	95.56
Teacher Factors				
1. Gender of the teacher _ Male	0.45	0.5	0	1
2. Teacher training (Highest qualification)				
a) Has ECDE in teacher training	0.06	0.24	0	1
b) Holds P1 or P2 Certificate in teacher training	0.61	0.49	0	1
c) Holds Diploma in teacher training	0.11	0.3	0	1
3. Teacher Experience				
a) No experience (0 years)	0.06	0.24	0	1
b) Early years' experience (1-9 years)	0.38	0.49	0	1
c) Middle level experience (10-19 years)	0.21	0.41	0	1
d) Experienced (20-29 years)	0.25	0.43	0	1
e) Highly experienced (30 years and above)	0.09	0.29	0	1
4. Time on task	28.56	10.85	0	45
5. Teacher subject (No. of subjects per teacher)	0.40	0.49	0	1
6. Teacher employer (Government employed)	0.50	0.50	0	1

continued next page

Table 3.2 Continued

Variable	Mean	Std. Dev.	Min	Max
Learner and home factors				
8. Learner gender (Male)	0.51	0.5	0	1
9. Learner age (Years)	10.39	1.42	7	15
10. Home conditions (Learner took breakfast)	0.87	0.34	0	1
School Characteristics				
11. Pupil-teacher ratio	28.26	10.33	2.67	65.38
12. Type of school (Private school)	0.15	0.35	0	1
13. Location of School (Rural school)	0.68	0.47	0	1
14. Electricity in class	0.17	0.37	0	1

Other data patterns

Table 3.3 presents the explanatory variables used in the empirical analysis; teachers and learners' gender, type of school scores and location of school score in math and reading tests. Analysis reveals that learner's performance in math and reading differ when they are taught by female teachers and male teachers. On average, when learners are taught by a female teacher, they score significantly 3.98 points higher in math than pupils who have been taught by a male teacher. This might be due to teacher quality differences between female and male teachers, including teaching style and gender bias. Female teachers may have a teaching style that better suits the learning needs of their learners in mathematics. For example, they may be more likely to use hands-on activities or real-world examples that make math concepts easier to understand. This could lead to students being more engaged and motivated when taught by a female teacher in math.

Male learners score higher than boys in both math and reading, by 1.52 and 1.44 points, respectively. Further analysis of the data reveals that pupils from private schools score significantly higher in math and reading than those from public schools, by 6.69 and 1.75 points, respectively. This could be attributed to private schools being better equipped in terms of resources. They also have proper performance monitoring mechanisms that ensure teachers perform optimally. Panel 5 reveals that learners with access to electricity score significantly higher in numeracy and literacy compared to those from schools without electricity access, by 4.0 and 4.4 points, respectively. Similarly, learners taught by teachers who are not employed by government have a high likelihood of better performance by 3 and 1 percent points in numeracy and literacy, respectively.

Table 3.3: Difference in mean test scores

Panel 1: Teacher			
	Male Teacher	**Female Teacher**	**Difference in mean**
Numeracy (Math test score)	74.87	78.85	-3.98***
Reading test score	63.71	63.45	0.26***
Panel 2: Learner			
	Male Learner	**Female Learner**	**Difference in mean**
Numeracy (Math test score)	77.75	76.23	1.52***
Reading test score	64.3	62.86	1.44***
Panel 3: Type of School			
	Private School	**Public School**	**Difference in mean**
Numeracy (Math test score)	83.53	76.85	6.69***
Reading test score	64.38	62.64	1.75***
Panel 4: Location of School			
	Urban	**Rural**	**Difference in mean**
Numeracy (Math test score)	74.85	79.29	-4.45***
Reading test score	63.49	62.88	0.61***
Panel 5: Electricity			
	With	**Without**	**Difference in mean**
Numeracy (Math test score)	80.73	76.71	4.02***
Reading test score	66.08	62.53	3.55***
Panel 6: Type of Employer			
	Not Government	**Government**	**Difference in mean**
Numeracy (Math test score)	79.71	76.40	3.31***
Reading test score	63.74	62.67	1.07***
Panel 7: Availability of Breakfast/Meal			
	Had a breakfast	**No Breakfast**	**Difference in mean**
Numeracy (Math test score)	77.35	76.86	0.49***
Reading test score	63.07	62.75	0.32***

Panel 1 investigates the difference in average score when learners are taught by female and male teachers. Panel 2 displays average test score in math and reading among learners disaggregated by gender. Panel 3 and 4 address learners' performances by the type of their schools (public vs private) and location (rural vs urban), respectively. Panel 5 presents average test score in math and reading among learners if their schools have electricity or not; panel 6 shows type of employer; and panel 7 whether learner had breakfast at home.

*** $p<0.01$

A t-test to compare the mean test scores for the trained teachers and those without training confirms that this difference is statistically significant at 5 per cent level. The findings show that learners who are taught with teachers who have professional training have better performance compared to those taught by teachers without any form of training. The results are in line with literature, which shows that training has a positive and significant influence on learners' performance. Further, the findings show that teacher training impacted learner performance positively on literacy compared to numeracy.

Table 3.4: Results on teacher training qualifications

Group	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
Without teacher training	4.095771	0.012702	0.2492353	4.070796 4.120746
With teacher training	4.137781	0.004746	0.2345168	4.128475 4.147087
Combined	4.13206	0.004457	0.2369681	4.123321 4.140799
diff	-0.04201	0.012972		-0.08402
diff = mean(Without) – mean (With Training) Ho: diff =0 t = -3.2384 degrees of freedom = 2,825				
Ha: diff < 0 Pr(T < t) = 0.0006		Ha: diff != 0 Pr(T > t) = 0.0012		Ha: diff > 0 Pr(T > t) = 0.9994

4. Empirical results

This section discusses and presents the results of the study. The foremost determinants of early grade learners' performance in mathematics and reading are discussed. Next, the study analyses the impact of teacher training qualification and experience on learners' performance. The study presents the adjusted R-squared values from a series of regressions of the different dependent variables (math test score and reading test score) on a learner, school and teacher characteristics. The first column for each dependent variable is based on a specification with only learner factors; the second column adds school factors; and third column adds teacher factors as presented in Table 4.1 and 4.2 below. Comparing columns (2) and (3), the inclusion of teacher factors increases the explanatory power by 3.6 percentage points for reading test score, and 2.8 percentage points for mathematics test score. This indicates that significant variations in teacher quality exists within schools.

Table 4.1: Determinants of learners performance in reading

Variables	(1)	(2)	(3)	(4)
	Learner Factors	School Level Factors	Teacher Factors	Full Model
Gender of the teacher			0.0131	0.0112
			(0.0101)	(0.0108)
Teacher employed by government			-0.0400***	-0.0240*
			(0.0104)	(0.0124)
Teacher training_P1 and P2 Certificate			0.0435**	0.0466**
			(0.0187)	(0.0204)
Teacher training_ Diploma			0.0344	0.0375
			(0.0223)	(0.0237)

continued next page

Table 4.1 Continued

Variables	(1)	(2)	(3)	(4)
	Learner Factors	School Level Factors	Teacher Factors	Full Model
Teacher Experience				
a. Experience of the teacher (1-9 yrs)			0.00337	-0.0293
			(0.0330)	(0.0363)
b. Experience of the teacher (10-19 yrs)			-0.0154	-0.0358
			(0.0340)	(0.0371)
c. Experience of the teacher (20-29 yrs)			-0.0820**	-0.100***
			(0.0345)	(0.0377)
d. Experience of the teacher (above 30 yrs)			-0.0895**	-0.114***
			(0.0368)	(0.0399)
Subject (s) taught per teacher			-0.00159	-0.00322
			(0.00971)	(0.0100)
Time on task in minutes			0.0001	0.0001
			(0.0005)	(0.0005)
Location of school- school is rural		0.00516		0.0177
		(0.00970)		(0.0109)
School type _ Private		0.00146		-0.0242
		(0.0148)		(0.0179)
Electricity in class		0.0555***		0.0666***
		(0.0146)		(0.0171)
Pupil-teacher ratio		-0.000989**		-0.00132**
		(0.000482)		(0.000579)
Gender of the learner _Male	0.025***			0.0180*
	(0.008)			(0.00988)
Age of the learner	-0.005*			0.000624
	(0.028)			(0.00334)
Learner had breakfast	-0.026			-0.0115
	(0.0113)			(0.0128)
Constant	4.177***	4.147***	4.148***	4.170***
	(0.0321)	(0.0163)	(0.0393)	(0.0649)
R-squared	0.003	0.009	0.045	0.047

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.2: Determinants of learners performance in mathematics

Variables	(1)	(2)	(3)	(4)
	Learner Factors	School Level Factors	Teacher Factors	Full Model
Gender of the teacher			-0.0384***	-0.0368**
			(0.0140)	(0.0144)
Teacher employed by government			-0.0110	-0.0134
			(0.0134)	(0.0161)
Teacher training_ P1 and P2 Certificate			0.0415*	0.0417*
			(0.0218)	(0.0230)
Teacher training _Diploma			0.0426	0.0531*
			(0.0308)	(0.0320)
Teacher Experience				
a. Experience of the teacher (1-9 yrs)			0.0568	-0.0359
			(0.0606)	(0.0238)
b. Experience of the teacher (10-19 yrs)			0.0103***	-0.0779***
			(0.0619)	(0.0275)
c. Experience of the teacher (20-29 yrs)			-0.0789	-0.180***
			(0.0622)	(0.0303)
d. Experience of the teacher (above 30 yrs)			-0.108*	-0.208***
			(0.0650)	(0.0346)
Subject (s) taught per teacher			-0.0126	-0.0106
			(0.0145)	(0.0155)
Time on task in minutes			-0.0002	-0.0000
			(0.0005)	(0.0005)
Location of school- school is rural		0.0475***		0.0366**
		(0.0152)		(0.0167)
School_ type _private		0.0899***		0.0102
		(0.0151)		(0.0259)
Electricity in class		0.0570***		0.0720***
		(0.0152)		(0.0194)
Pupil-teacher ratio		0.00186***		0.00194**
		(0.000612)		(0.000777)
Gender of the learner _Male	0.0155			0.00957
	(0.0117)			(0.0143)
Age of the learner	-0.00327			0.00227
	(0.00392)			(0.00488)

continued next page

Table 4.2 Continued

Variables	(1)	(2)	(3)	(4)
	Learner Factors	School Level Factors	Teacher Factors	Full Model
Learner had breakfast	0.0305*			0.0458**
	(0.0180)			(0.0229)
Constant	4.334***	4.224***	4.329***	4.257***
	(0.0455)	(0.0220)	(0.0636)	(0.0777)
R-squared	0.002	0.017	0.045	0.062

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
NB: The findings presented below are only for the variables that had a significant effect (positive or otherwise) on the dependent variable in question.

Learners factor

Considering learner's factors, the results show that gender had no significant impact on performance in numeracy. However, a male student is likely to perform 2 percentage points better in literacy at 10 per cent significance level. Also, a student who had breakfast or a meal at home is likely to perform 5 percentage points better in numeracy at 5 per cent significance level. Home breakfast had no significant effect on student performance in literacy. Age of the learner had no significant effect on performance in both numeracy and literacy.

School factor

In relation to school factors, the availability of electricity in school is highly significant and positively correlated with student performance in numeracy and literacy by 7.2 percentage points and 6.6 percentage points, respectively, at 1 per cent significance level. This could be attributed to the presence of electricity and lighting in classes to facilitate early morning or late evening classes, while also enabling the use of modern media tools such as the Internet and television in the classroom. Additionally, schools that have access to electricity tend to have better staff retention rates and outperform non-electrified schools on important educational measures. Further, the performance of students in literacy is not affected by the school setting, rural or otherwise. Interestingly, students from rural schools are likely to perform 4 percentage points better in numeracy at 5 per cent significance level compared to their peers attending schools in urban areas. Pupil-teacher ratio is significant and negatively correlated with student performance in literacy and significant and positively correlated with student performance in numeracy. Although pupil-teacher ratio was significant at 5 per cent significance level, it had a negligible effect on performance in both literacy and numeracy at 0.1 percentage points and 0.2 percentage points, respectively.

Teacher factors

Teacher characteristics

Regarding gender, male teachers have a negative effect on student performance in numeracy by 4 percentage points at 5 per cent significance level, but no effect on performance in literacy. Female teachers would be beneficial for students to increase their math score.

Teacher employer

Teachers employed on a permanent basis by the government are likely to have a negative impact on student performance in literacy by 2.4 percentage points at 10 per cent significance level. This could be because teachers employed on permanent basis may feel more secure in their jobs and become complacent, leading to a decline in the quality of instruction they provide to learners.

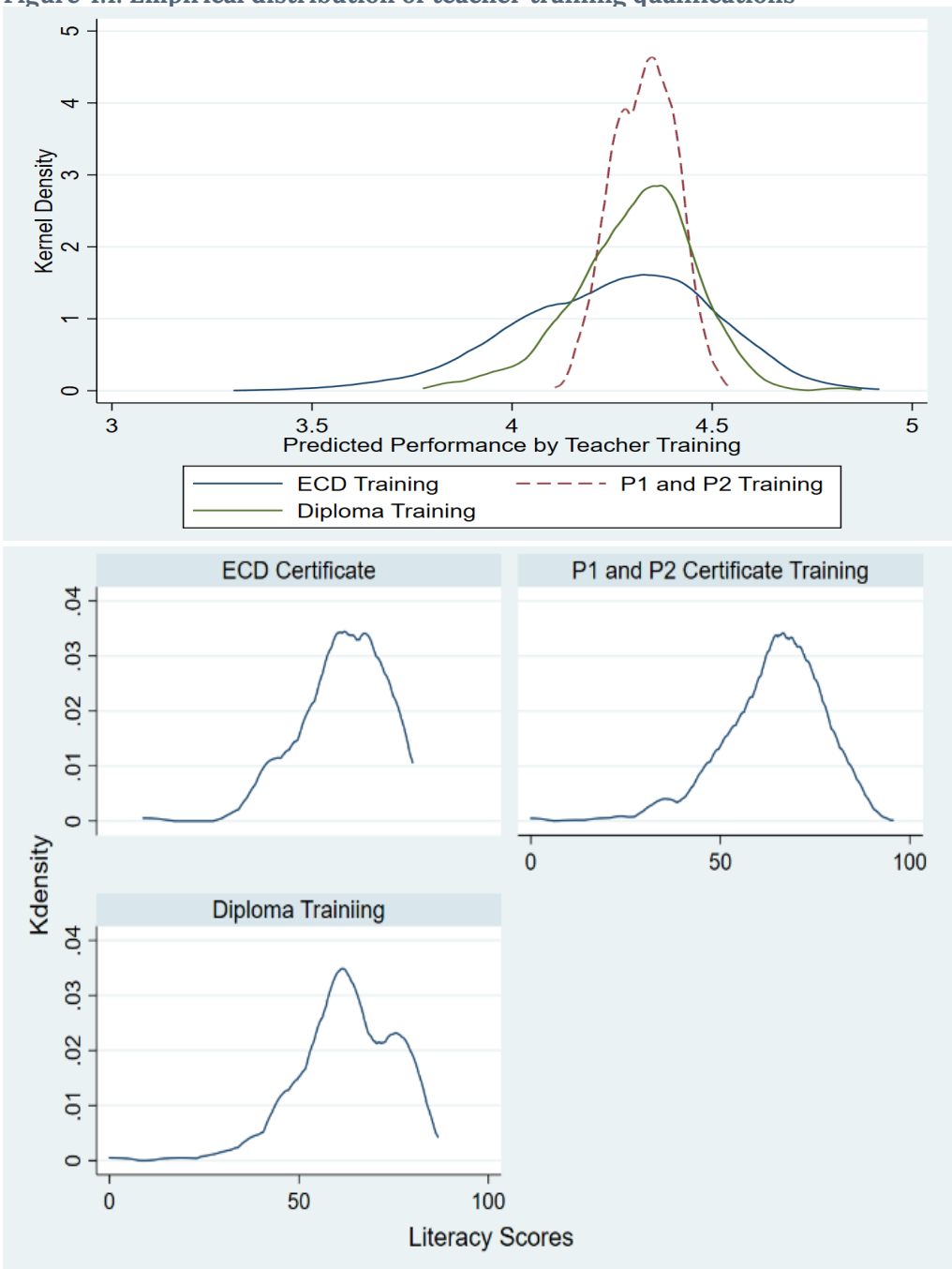
Teacher qualification

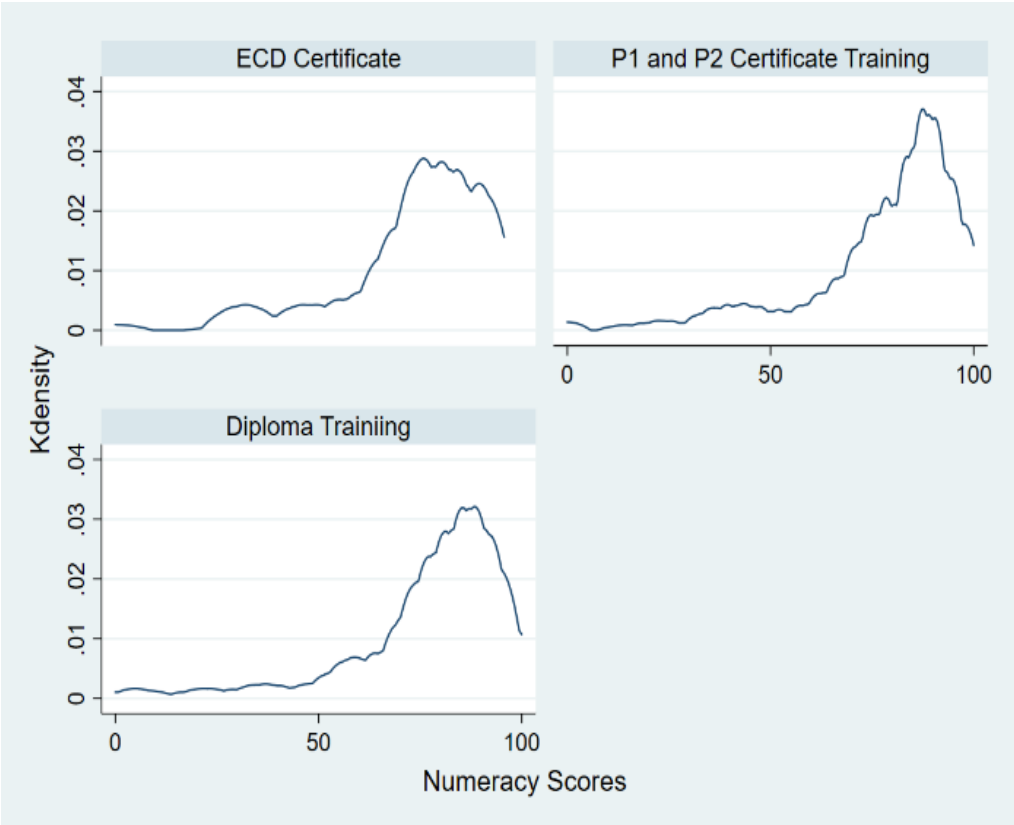
The variable on teacher qualification helps us to answer the question: does level of teachers' certification and training matter in learner's performance? Teacher training is considered as one of the most critical investments in supporting teacher quality. It also comes at a large cost and takes between two to four years depending on the level of training. On qualification, both certificate and diploma training positively impact student performance in numeracy and literacy. However, having only a primary certificate in teacher training has a significant effect on student performance in literacy by 5 per cent whereas having diploma in teacher training has no effect on literacy scores.

Though the study found that teacher training has a positive impact on learner performance, there is no significant difference between the teacher level of qualification on learner performance regardless of the time taken to acquire those qualifications. Deeper analysis on teacher qualification and student performance revealed interesting results. Contrary to conventional knowledge that teacher training qualification level has a positive effect on learner performance in Mathematics and English in Kenya (Darling et al., 2005; Barasa, 2020), the study found that teachers' level of qualification had no influence on students' performance regardless of the time taken to acquire those qualifications. In fact, learners who are taught by teachers with pre-primary certificate perform the same as those learners whose teachers have diploma training. Teachers with primary certificate qualifications had students performing better compared to students taught by teachers with a diploma, yet the latter demands more years of study to acquire the qualification. This is an indication that the duration of teacher training programmes has little impact on learner performance. Probably, the

acquisition of teaching skills is what matters most in improving teacher effectiveness. Learners who are taught by teachers trained at P1 and P2 certificate level where they acquire pedagogical skills have a higher likelihood of performing better compared to those who are taught by diploma teachers or higher level certificates.

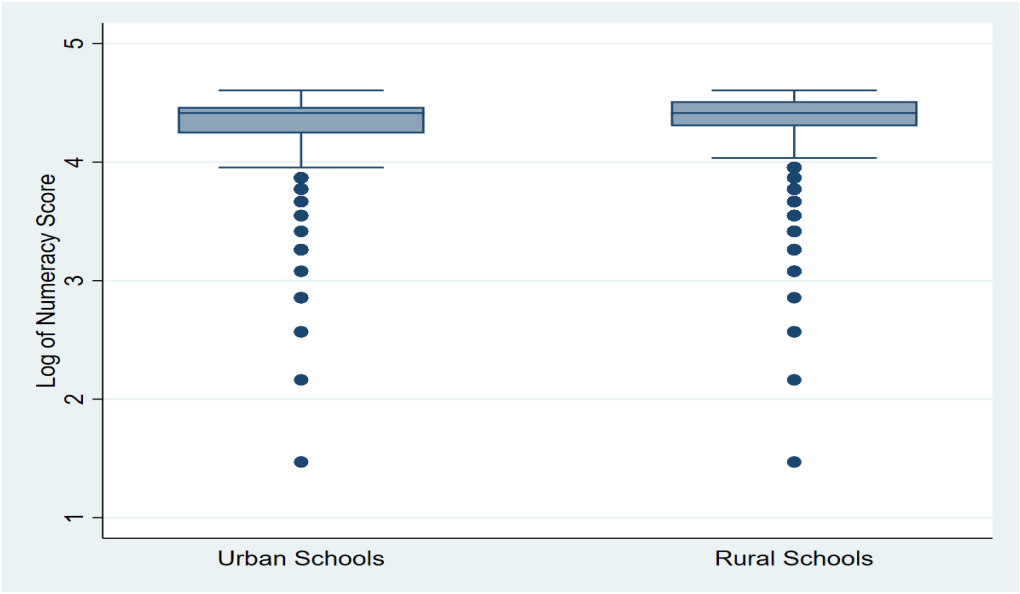
Figure 4.1: Empirical distribution of teacher training qualifications





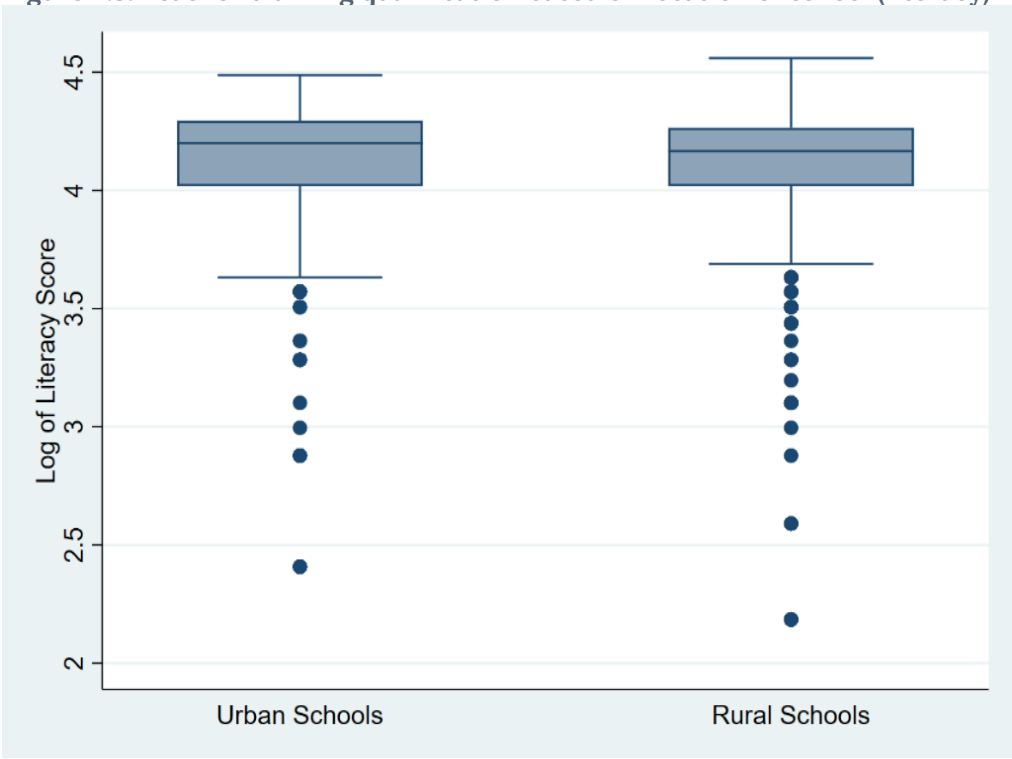
The study undertook further analysis to show the interactions between teacher training and school characteristics. Foremost, the study analyses trained teacher qualification and examines how they differ across rural and urban schools in respect to learner performance. We also conduct a t-test to test whether the differences are statistically significant. A multivariate regression analysis suggests that, in relation to numeracy, learners performed better in rural areas compared to their urban counterparts.

Figure 4.2: Teacher training qualification based on location of school (numeracy)



The opposite is true for learners' performance in literacy. This could be due to first language spoken at home. In urban areas, most of the families use English and Kiswahili as their first language. The two languages are used for instruction in schools, which makes it easier for learners to comprehend. This gives learners from urban areas an upper hand, since they also use the same language at home, as opposed to rural areas where mother tongue is used as a first language, yet over 40 indigenous languages are spoken in various parts of Kenya.

Figure 4.3: Teacher training qualification based on location of school (literacy)



Further, with a view to analyzing and evaluating their performance in a more elaborate way, we compare the distribution of test scores between learners in private versus public schools against teacher qualifications (Figure 4.4). We find strong evidence from the data that students in private schools are achieving better results, both in numeracy and literacy, compared with their counterparts in public schools. The two kernel density functions of numeracy scores in private and public schools show that not only the mean, but the whole distribution of test scores in private schools is to the right-hand side of the distribution pertaining to public schools, suggesting strong evidence that learners from private schools score significantly higher in math and reading than those from public schools. This suggests that quality teachers should be complemented by learning resources to guarantee performance. Furthermore, there is need to ensure equitable distribution of teachers and provision of adequate teaching and learning materials in school. In addition, this difference in performance could be due to teacher management, quality of school inputs and performance appraisal mechanisms.

Figure 4.4: Teacher training qualification by school type

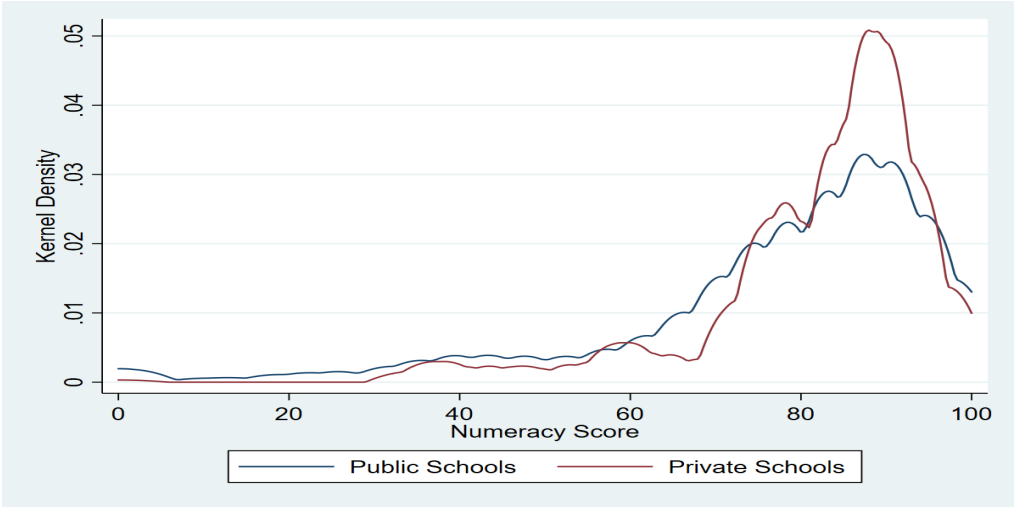


Table 4.3 shows a summary of the results after interacting qualification in teacher training and the gender of the teacher. Male teachers have a negative impact on learner performance in both literacy and numeracy, irrespective of teacher training qualification. The analysis shows that male teachers with teacher training qualification at ECDE level, P1 and P2 certificate level and at diploma level, reduces the test score in numeracy and literacy by 31, 25 and 10 percentage points, respectively (significant at one per cent) as opposed to female teachers with the same qualifications. A similar trend is observed in literacy as male teachers with teacher training at ECDE, certificate and diploma reduce learner performance in literacy by 9, 7 and 6 percentage points, respectively. This implies that learners at early grade level are better off being taught by female teachers, which could be attributed to their nurturing nature and ability to understand learners mental and emotional needs particularly at an early age of schooling.

Table 4.3: Empirical results on interactions between gender and training

Variables	Numeracy	Literacy
	Full Model	Full Model
Gender of the teacher	0.198***	0.0853**
	(0.0672)	(0.0334)
Teacher employed by government	0.00520	-0.0106
	(0.0168)	(0.0130)
Teacher Training_P1 and P2 Certificate	-0.0128	0.0253
	(0.0235)	(0.0308)
Teacher Training_ Diploma	0.0185	-0.00590
	(0.0374)	(0.0362)
Teacher Experience		
1. Experience of the teacher (1-9 years)	0.0454	-0.0231
	(0.0381)	(0.0316)
2. Experience of the teacher (10-19 years)	-0.0184	-0.0186
	(0.0379)	(0.0314)
3. Experience of the teacher (20-29 years)	-0.0718*	-0.0773***
	(0.0399)	(0.0299)
4. Experience of the teacher (above 30 years)	-0.451**	-0.0768
	(0.183)	(0.0470)
Interactions teacher training and experience		
Teacher training at P1, P2 certificate and No experience	0.112***	-0.0169
	(0.0408)	(0.0500)
Teacher training at Diploma and no experience	0.131***	
	(0.0196)	
Teacher training at ECDE and high experience	0.390*	0.0363
	(0.211)	(0.0788)
Teacher training at P1, P2 certificate and high experience	0.367**	-0.0543
	(0.182)	(0.0489)
Teacher training at Diploma and high experience	0.409**	-0.114
	(0.185)	(0.0943)

continued next page

Table 4.3 Continued

Variables	Numeracy	Literacy
	Full Model	Full Model
Gender of teacher_ Male and qualifications at ECDE	-0.313***	-0.0959*
	(0.0784)	(0.0515)
Gender of teacher _Male and qualifications at P1, P2 certificate	-0.254***	-0.0723**
	(0.0691)	(0.0353)
Gender of teacher _Male_ qualifications at Diploma level	-0.260***	-0.0594*
	(0.0638)	(0.0331)
Teaching subject (number of subjects)	-0.00549	-0.0243**
	(0.0141)	(0.0114)
Time in class teaching	0.000343	-0.0001
	(0.0005)	(0.0005)
Location of school - school is rural	-0.0001	0.0153
	(0.0144)	(0.0126)
School type _ Private	0.0603***	-0.0291
	(0.0220)	(0.0180)
Electricity in class	0.0580***	0.110***
	(0.0180)	(0.0156)
Pupil-teacher ratio	0.0028***	-0.0009*
	(0.000778)	(0.0006)
Gender of the learner_ Male	-0.000466	0.00921
	(0.0135)	(0.0105)
Age of the learner	-0.00049	0.00175
	(0.00493)	(0.00344)
Learner had breakfast	0.0247	-0.00549
	(0.0226)	(0.0161)
Constant	4.266***	4.157***
	(0.0719)	(0.0582)
Observations	2,108	2,123
R-squared	0.072	0.055

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Teacher experience

Teacher experience is highly significant and negatively correlated with student performance in numeracy and literacy, with the impact increasing with an increase in the level of experience. Notably, early experience (0-19 years) has a positive significant effect on student performance in numeracy and literacy. According to several studies (Boyd et al. 2006; Rivkin et al., 2005; Staiger and Rockoff, 2010), having experience is crucial for teachers in the beginning of their career. However, in later years, there seems to be minimal to no further benefits. Podolsky et al. (2019) established a positive correlation between a teacher's level of experience and the academic performance of their students. This literature is consistent with our findings.

Table 4.4: Impact of teacher experience on performance

Teacher experience	**Mean**	**Std. Dev.**	**Freq.**		
No experience	81.9843	15.3047	188		
Early years' experience (1-9 years)	81.3665	15.0315	1,169		
Middle level experience (10-19 years)	79.4548	16.3456	579		
Experienced (20-29 years)	72.2587	24.3141	728		
Highly experienced (30yrs and above)	72.0667	21.4781	292		
Total	77.8696	19.0985	2,956		
Analysis of Variance					
Source	**SS**	**df**	**MS**	**F**	**Prob > F**
Between groups	51684.07	4	12921.02	37.16	0
Within groups	1026162.09	2951	347.74		
Total	1077846.17	2955	364.75		
Bartlett's test for equal variances: $chi^2(4) = 261.4534$			$Prob>chi^2 = 0.000$		

The study interacted teacher training at various levels with teacher experience (Table 4.3 above). From the analysis, there is no impact on literacy performance for learners when taught by trained and experienced or no experienced teachers. However, teacher training and experience has a significant impact on learners in mathematics test scores. Having a teacher with P1 and P2 qualification who is highly experienced (over 30 years of teaching) raises the mathematics test score by 37 percentage points, and a highly experienced teacher with diploma qualification raises the score by 40 percentage points. In comparison, having a teacher with only P1 and

P2 certificate or diploma qualification and no experience raises mathematics scores for learners at 11% and 13%, respectively. This implies that teaching methods and mastery of content is important for performance in mathematics test scores. This is very significant for policy makers, considering that experience comes with teaching methods whereas teacher training relates to mastery of content. This raises questions regarding the quality of pre-service and in-service training for teachers in Mathematics and subjects that have numeracy as an important policy intervention.

5. Conclusion and recommendations

The aim of the study was to establish the effect of teacher attributes and training on the learner performance. The results revealed that pedagogical training, which is taught at certificate level for teaching at primary education level is significant and important in influencing learner performance compared to diploma, yet the latter takes more duration and resources. The evidence also shows that teacher experience significantly affects learner performance. Also, female teachers have a higher likelihood of raising learner performance compared to their male counterparts. Learners from private schools recorded higher achievement compared to those in public schools. This suggests that quality teachers should be complemented by quality school environments and adequate learning resources to guarantee performance.

The study recommends that teacher training be tailored towards content, and in pedagogical in-service training. Further, the Teachers Service Commission could enhance the quality of teachers through in-service training and other teacher professional development programmes, teacher motivation and equitable teacher distribution. Having specific training for mathematics teachers and in subjects that have numeracy is an important policy intervention. The Ministry of Education could ensure the provision of adequate teaching and learning materials in all public schools. The study recommends that newly employed teachers be required to have pedagogical skills or else these skills are imparted through induction programmes and apprenticeship. Policies designed to enhance pedagogical training will also need to be designed and implemented.

If teacher qualification levels do not have a significant impact on student performance, it may be worth considering other factors in teacher recruitment and selection, such as diversity in terms of gender, ethnicity, and socio-economic background. This could help ensure that all learners have access to high-quality teaching and diverse role models.

However, further research could investigate how different types of school interventions amplify or weaken the effects of teachers on pupils' cognitive skills. Further, one could also ask whether different types of teacher quality are more effective in helping different types of students.

Notes

1. Reese (2013) provides a detailed review of the influences of Watson's behaviourism on child psychology, including subsequent works on this subject. https://www.redalyc.org/pdf/593/59335808004.pdf

2. See Piaget and Education Primer by Jardine, David W. (2006).

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Consortium pour la Recherche Economique en Afrique
Middle East Bank Towers,
3rd Floor, Jakaya Kikwete Road
Nairobi 00200, Kenya
Tel: +254 (0) 20 273 4150
communications@aercafrica.org