

## What Do Teachers Know and Do? Evidence from Primary Schools in Africa

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School enrollment has universally increased over the last 25 years in low income countries. Enrolling in school, however, does not guarantee that children learn. For example, after more than three years of compulsory language teaching, four out of five students in Mozambique and Nigeria cannot read a simple words of Portuguese and English, respectively. Only one in four Indian grade four student manages task – such as basic subtraction – that is part of the curriculum for the second grade and roughly half of the students in Uganda, after three years of mathematics teaching, cannot order numbers between 0-100 (Bold et al, 2017a; ASER, 2013). Not surprisingly, a large share of children in low-income countries complete their primary education lacking even basic reading, writing, and arithmetic skills (see for example Hungi et al. 2010; PASEC, 2015, ASER, 2013) – the “global learning crisis” (UNESCO 2013).

A growing body of evidence, from both the teacher value added literature and the experimental literature in development economics, shows that teacher quality, broadly defined, is a key determinant of student learning. Little is known, however, about what specific dimensions of teacher quality matter and even less about how teachers perform along these dimensions – facts that are crucial in order to guide both research and policy design. This paper reports on an ongoing research program intended to help fill this void. Using data derived from direct observations, unannounced visits, and tests, from primary schools in seven Sub-Saharan African countries—Kenya, Nigeria, Mozambique, Senegal, Tanzania, Togo, and Uganda—which together represent close to 40 percent of the region’s total population, we answer three questions: How much do teachers teach? What do teachers know? How well do teachers teach?

We proceed by first providing a brief background of the research program; the data we use to answer the aforementioned questions; and the context. We then turn the three questions posed above, and two follow-up questions: What does the pipeline to a teaching

position look like and do good teachers emerge from it? Finally, we conclude with a brief discussion of the core implications of the findings, both for education systems and education policy reform and for the experimental and quasi-experimental research agenda on ways to improve education quality.

### Measuring teacher effort, knowledge, and skills

We use data from the Service Delivery Indicators (SDI)—an ongoing Africa-wide program with the aim of collecting informative and standardized measures of what primary teachers know, what they do, and what they have to work with. The SDI program – piloted in Tanzania and Senegal in 2010 (Bold et al, 2010, 2011) – grew out of concern about poor learning outcomes observed in various student tests as well as evident shortcomings, most clearly (and perhaps most damagingly) manifested at the school level, in fast-expanding systems of education.

To date, the SDI program has collected data, including from the two pilot countries, from a total of seven countries (eight surveys): Kenya (2012), Mozambique (2014), Nigeria (2013), Senegal (2010), Tanzania (2010, 2014), Togo (2013), and Uganda (2013). In each country, representative surveys of between 150 and 760 schools were implemented using a multistage, cluster-sampling design.<sup>1</sup> Primary schools with at least one fourth-grade class formed the sampling frame. The samples were designed to provide representative estimates for teacher effort, knowledge, and skills in public primary schools, broken down by urban and rural location. For five of the six non-pilot surveys, representative data were also collected for private primary schools. Across the eight surveys, the SDI collected data on

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<sup>1</sup> In Nigeria, due to security constraints, surveys representative at the state level were implemented in four states (Anambra, Bauchi, Ekiti, and Niger).

2,600 schools, over 21,000 teachers and 24,000 students in Sub-Saharan Africa (see Bold et al., 2017a, for details of the sample).

The surveys collected a broad set of school, teacher, and student specific information, with an approach that relies as much as possible on direct observation rather than on respondent reports. Data were collected through visual inspections of fourth-grade classrooms and the school premises, direct physical verification of teacher presence by unannounced visits, and teacher and student tests. We focus here on the data on teacher behavior and knowledge.

### Education Systems in Developing Countries

The delivery of education in many low-income countries, including the countries surveyed here, is characterized by centralized, but typically weak, state control and often low-capacity, locally governed institutions for education provision. At the same time, the institutional incentives for performance are largely missing, with both career progression and financial rewards delinked from performance. Salaries and promotions are largely determined by teachers' seniority and educational qualifications, and are unrelated to effort or performance. In most settings, parents have little influence on how teachers are hired or schools are managed, and the various state and local authorities provide limited technical support or supervision.

Teacher salaries account for the largest single item in education expenditure, in countries at all income levels. In Sub-Saharan Africa, salaries for teachers and education officials account for more than 70 percent of the expenditure in education (UIS, 2011) and approximately 12 percent of total government expenditure. As a ratio to GDP per capita,

teachers in low- and middle-income countries earn about twice as much as their counterparts in high-income countries (Bruns et al., 2003).

In Africa, the public sector is the dominant actor in primary education. However, while public spending on education has increased in the last decade, so has the number of private schools. Recent data suggest that private schools—both informal and formal—account for around 20 percent of total primary school enrollment in low-income countries (Baum et al. 2014).

Enrollment overall has increased steadily from the 1960s and especially so in the last two decades, partly in response to reduced or removed formal fees for primary schooling. The increase in primary enrollment has also resulted in a huge increase in the number of teachers, which has risen from 500,000 primary school teachers in 1970 to almost 2.8 million in 2009.

Looking at the cross-section of schools surveyed here, pupil-teacher ratios stand at 46 students per teacher and at 34 students present in the classroom per teacher. While most students have pencil and notebooks and 80% of teachers have a functioning board to write on, this equipment is in place simultaneously in half the classrooms. One in ten classrooms are deemed too dark for students to read without straining their eyes and an average of two to three students have to share a text book. Turning to teachers, we find that twice as many teachers have entered the profession in the last ten years than in the decade before. Overall, about 15% of teachers in sub-Saharan Africa are employed on some form of non-permanent contract. In countries where contract teachers are prevalent (5 out of 7), almost a third of contract teachers are employed on short-term contracts and this share swells to 50% for teachers with less than ten years of experience.<sup>2</sup>

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<sup>2</sup> It should be noted that this is both a time and a cohort effect as many contract teachers graduate to civil service status over time

How much do teachers teach?

Being present in the classroom is a *conditio sine qua non* for teachers to exert effort at teaching. To measure the time teachers spend teaching, an extended approach of that used in Chaudhury et al (2006) was employed. Specifically, in each school, during a first announced visit, up to 10 teachers were randomly selected from the teacher roster. At least two teaching days after the initial survey, an unannounced visit was conducted, during which the enumerators were asked to identify whether the selected teachers were in the school, and if so, if they were in class teaching. Both assessments were based on directly observing the teachers and their whereabouts.

Table 1 summarizes the findings. Averaging across countries, 44 percent of teachers were absent from class, either because they were absent from school or in the school, but not in the classroom. In three of the eight surveys, more than half of the teachers were absent from the classroom, and only in one country—Nigeria—do we observe average absence below 30 percent. Being absent from school is about as common as being present in the school but absent from class. The rank correlation coefficient between the two measures is less than 0.5 at the country level, making the school absence rate at best a partial measure of teacher effort. This is most starkly illustrated in the case of Kenya and Tanzania, both of which have relatively low school absence rates (15 percent) but relatively high classroom absence rates conditional on being in school (38–39 percent).

When a large share of teachers is not teaching, unsurprisingly, a large share of classrooms will be occupied by only students. Consistent with the absenteeism findings discussed above, we find, averaging across countries, that one third of the classrooms, and almost half of the classrooms in Uganda, were “orphaned” classrooms, where students are present but there is no teacher.

Over time in these countries, the absenteeism rates appear remarkably stable. Chaudhury et al (2006) estimated a school absence rate of 27 percent in Uganda in 2002–03, which compares to our measure of 30 percent in 2013. Similarly, while absence from school fell by a third in Tanzania between 2010 and 2014, this was largely offset by an increase in absence from the classroom conditional on being in school; the net result being a small decline in absence from class between the two surveys.

What do these results imply for the amount of instruction time that students receive? To answer this, the surveys first recorded the scheduled time of a teaching day—after break times—according to school records. Averaged across schools and countries, this comes to 5 hours and 27 minutes.<sup>3</sup> We then multiply this number by the proportion of teachers absent from class. If 10 teachers are supposed to teach 5 hours and 27 minutes per day, yet 4 teachers are absent from either the school or the classroom at any one time, then the scheduled teaching time is reduced to 3 hours and 16 minutes.

Moreover, even when in the classroom, teachers may not necessarily be teaching. We address this by using the results from the classroom observation carried out as a part of the survey – an observation schedule based on recording a minute-by-minute snapshot of what the teacher was doing, for a randomly selected fourth-grade mathematics or language class.

The percentage of the lesson lost to non-teaching activities varied from 18 percent in Nigeria, the country with the lowest classroom absence rate, to 3 percent in Uganda, the country with the highest classroom absence rate. We then combine the absence-adjusted teaching time with the proportion of classroom time devoted to actual teaching activities to estimate instruction time as experienced by students.

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<sup>3</sup> For comparison, on average across the OECD countries the compulsory instructional time per school day in primary education is 4 hours and 20 minutes (OECD, 2015).

Students are taught, on average, 2 hours and 49 minutes per day, or roughly half of the scheduled time (see Table 1). Estimated instruction time varies from 3 hours and 16 minutes in Tanzania to 1 hour and 43 minutes in Mozambique. Only about ten percent of the schools provide more than 5 hours of teaching per day. About the same share provide no teaching (because none of the ten randomly selected teachers was found in the classroom). More than a quarter of schools teach less than 2 hours, and half the schools teach less than 3 hours.

What do teachers know?

For teachers to be effective, they must have the knowledge necessary for good teaching. A first necessary requirement is that they exhibit a clear understanding of the subject they teach (subject content knowledge).

To measure the subject content knowledge of primary school teachers, and specifically those teaching lower primary, all language and mathematics teachers teaching Grade 4 in the current year, or Grade 3 in the previous year, were assessed. On average, 5 teachers were tested in each school.

In contrast to other approaches to assess teachers' knowledge, where teachers take exams, teachers here were asked to mark (or "grade") mock student tests in language and in mathematics.<sup>4</sup> This method of assessment has two potential advantages. First, it aims to assess teachers in a way that was consistent with their normal activities—namely, marking student work. Second, by not testing teachers in the same way as students are tested, it recognizes teachers as professionals. In the analysis, we assess the language knowledge of

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<sup>4</sup> The subject test was designed by experts in international pedagogy and validated against 13 Sub-Saharan African primary curricula (Botswana, Ethiopia, Gambia, Kenya, Madagascar, Mauritius, Namibia, Nigeria, Rwanda, Seychelles, South Africa, Tanzania, and Uganda). See Johnson, Cunningham and Dowling (2012) for details.

those teachers who teach language, and the mathematics knowledge of those teachers who teach mathematics. Importantly, in interpreting the results one should bear in mind that all questions on the teacher test were based on common items taken from the primary curricula of each country.

We start by assessing whether teachers master their students' curriculum in language. For this, we focus on tasks on the teacher test that covered the (roughly) third and fourth year of primary school curriculum—specifically, spelling and simple grammar exercises. To allow for some margin of error, we count a teacher as mastering the student curriculum if he or she marked 80 percent or more of the spelling and grammar questions correctly.

Two thirds of teachers make it over this low bar, though there is wide variation across countries (Table 2). While over 90 percent of teachers in Kenya and Uganda master the knowledge that their students are supposed to learn, only a quarter of Nigerian teachers do.

Possessing knowledge equivalent to the fourth grade curriculum is, of course, not sufficient to teach language in lower primary, because language teaching is “monolithic.” That is to say, teaching a student how to compose even a simple text requires knowledge that goes well beyond the curriculum.

We therefore deem a language teacher in Grade 4 to have minimum subject content knowledge if he or she can confidently correct children's work in such aspects of literacy as reading comprehension, vocabulary, and formal correctness (grammar, spelling, syntax, and punctuation), all of which are competencies a teacher in lower primary would routinely be required to teach. To this end, the language test contained (in addition to the spelling and grammar exercises) Cloze passages to assess vocabulary and reading comprehension, and a letter written to a friend describing the student's school, which the teacher had to mark and correct.

We formally define “minimum knowledge in language” as marking at least 80 percent of the items on the language test correctly. Only 7 percent of the language teachers meet this minimum subject knowledge, with the level uniformly low across the eight countries: in Kenya, 34 percent of language teachers have minimum subject knowledge, and no teachers in Togo, Mozambique, Tanzania, or Nigeria meet the threshold (Table 2).

Which areas of language teaching are especially problematic? First, some teachers are weak in all areas of the curriculum: 14 percent could not spell a simple word (“traffic,” for example), and a similar share could not correctly answer a grammar exercise that asked them to identify the option, out of three, that would complete a sentence such as “[ \_\_\_\_\_ ] [Who, How much, How many] oranges do you have?” Second, most teachers struggled with those tasks that required at least some knowledge beyond the lower primary curriculum to mark. Less than half of the items in the Cloze passage were marked correctly, which included “student” responses such as “[Where ] do I have to go to the market?” (the correct answer being “Why or When”) (see Table 3). Teachers corrected only a quarter of the spelling, grammar, syntax, and punctuation mistakes in a child’s letter that included segments such as “I went to tell you that my new school is better the oldone I have a lot of thing to tell you about my new school in Dar es Salaam.”

In mathematics, we classify a teacher as having minimum subject content knowledge if he or she can accurately correct children’s work in such aspects of numeracy as manipulating numbers using whole number operations. This requirement amounts to correctly scoring 80 percent or more of the questions on the lower primary portion of the mathematics test. In essence, the test thus measures whether the math teacher masters his or her students’ curriculum, allowing for 20 percent points margin of error. Fewer than 70 percent of mathematics teachers have minimum knowledge according to this definition (Table 2), although there is again wide variation across countries, with less than half of the

mathematics teachers in Togo deemed to have minimum knowledge. Looking at specific tasks in mathematics, almost a quarter of the teachers cannot subtract double digit numbers and one-third of the teachers cannot multiply double digit numbers (Table 3).

Given the design of the mathematics test, it is possible to map each teacher's (and student's) knowledge onto the lower primary curriculum. In Figure 1, we graph teacher and student knowledge on a common scale, namely years of curriculum knowledge, exploiting the fact that a subset of items straddling grade 1 to 4 were included on both tests. Consistent with two thirds of teachers displaying minimum knowledge, we find that about a third of teachers do not master the grade 4 curriculum. Strikingly, one in five do not master the grade one curriculum. On the student side, we find exceedingly few grade four students, 1 in 20, who have knowledge commensurate with their grade level. About 50% lag two grades behind in their knowledge, and one third have not progressed beyond grade 1. Comparing teacher and student knowledge, we see that one in four students managed to subtract double digits, a task on the grade 3 curriculum which the same share of teachers failed to solve.

That the two measures of teacher knowledge – knowing the students' curriculum and minimum knowledge for teaching – coincide for mathematics but not for language teaching, is a consequence of the subject's modular nature. In other words, it is possible, in principle, to teach fourth graders how to divide two numbers without having a deeper knowledge of algebra. As a consequence, the number of teachers considered to master their students' curriculum is very similar for language and mathematics, while there is a large difference in the number of teachers considered to have minimum knowledge for teaching between the two subjects.

Of course, we would expect a competent math teacher to have knowledge beyond that of his or her students, and the mathematics test, therefore, also included questions one would only encounter in upper primary school. Many mathematics teachers struggled with these

tasks: only a minority of teachers, and in some countries very few, could interpret information in a Venn diagram and/or a graph (see Table 3). As we will see below, this low competence in interpreting data has implications for teachers' ability to monitor their students' progress. Finally, only a few teachers could solve a more advanced math story problem, and only one third could solve a logic puzzle.

How well do teachers teach?

Knowing one's subject is a necessary, but not sufficient, condition for good teaching. Teachers must also know how to translate their subject knowledge into effective pedagogy and then apply this in the classroom. There is broad agreement that for teaching to be effective, lessons must be well-designed and well-structured. Teachers must also know how to assess student capabilities and react appropriately, for example, by asking questions that require various types of responses and by giving feedback on those responses, commonly referred to as knowledge of the context of learning (see Johnson, 2006; Coe, Aloisi, Higgins and Major, 2014; Ko and Sammons, 2013, Mujis et al., 2014; Vieluf et al., 2012).

Related to this, a recent review (Mujis et. al 2014) identifies the following elements as key when it comes to behavior in the classroom: (i) designing and structuring lessons, and in particular, introducing topics and learning outcomes at the start of the lesson and reviewing them at the end; (ii) frequently checking for student understanding by asking questions, and allowing time for students to review and practice what they learned, either individually or in groups; (iii) varying the cognitive level of questions by mixing lower and higher order questions; and (iv) providing substantive feedback to students by acknowledging correct answers in a positive fashion and correcting wrong answers, as skills and practices that are consistently associated with gains in student learning.

We broadly follow the education literature and first measure teachers' pedagogical knowledge; then, we examine how well teachers can assess students and monitor their progress; and finally, we gauge the extent to which teachers apply that knowledge in the classroom.

To measure general pedagogical knowledge, the survey asked teachers to read and extract information from a factual text (general content knowledge) and to prepare a lesson, including learning aims and outcomes based on their reading (pedagogical content knowledge). Both these tasks are consistent with professional tasks normally expected of teachers, and we therefore consider a teacher to have minimum general pedagogy knowledge if he or she scores 80 percent or more on this portion of the test.

To measure teachers' ability to assess students' learning and give feedback (which we shorten here to "assessing students"), teachers were asked to prepare questions that required students to recall what was learned (lower order) and questions that asked students to apply the material to new contexts (higher order) on the basis of their reading of the factual text. In a second task, teachers were asked to use a marking scheme to give feedback on strengths and weaknesses in students' writing and to distinguish weak and strong learners. In a third task, teachers were provided with a list of students' grades; they were then asked to turn the raw scores into averages and to comment on the learning progression of individuals and groups of students with the help of a bar chart. We define a teacher as having "minimum knowledge in assessing students" if he or she could answer 80 percent of the items in the three tasks correctly.

To quantify teaching practices, a modified Stallings (1980) classroom observation snapshot module recorded which activities from a pre-determined list the teacher performed during each minute of a lesson.

As reported in Table 4, Panel A, only 10 percent of teachers reached the threshold for minimum general pedagogy knowledge. In four countries, fewer than 5 percent of teachers met the threshold. While teachers could usually read and understand the factual text, they were typically not able to translate this information into teaching, as they struggled to prepare a lesson plan (average score 31 percent on this task) and formulate lesson aims and learning outcomes based on their reading (average score of 22 percent on this task).

Poor knowledge of general pedagogy translated into poor skills in the classroom: less than half of the teachers explained the topic of the lesson at the start and summarized what was learned at the end, and almost 40 percent of lessons seemed unplanned to the observers (Table 4, Panel C).

As with general pedagogical knowledge, few teachers demonstrated an ability to assess student learning and respond to that assessment (Panel B). Very few could formulate questions that checked basic understanding based on what they had read, and fewer still could formulate a question that asked students to apply what they had learned to other contexts.

During their lessons, many teachers asked questions that required students to recall information or to practice what was learned, but significantly fewer asked questions that required higher order skills and encouraged students to apply what was learned to different contexts and be creative. Overall, 31 percent of teachers mixed lower and higher order questions in their class—ranging from 14 percent of teachers in Mozambique to 44 percent of teachers in Uganda (Panel C).

Eighteen percent of teachers could give feedback on strengths and weaknesses in students' writing using a marking scheme (Panel B)—ranging from 8 percent in Nigeria to 32 percent in Kenya. Furthermore, just over 12 percent could monitor and comment on the learning progression of students—ranging from 5 percent in Nigeria to 26 percent in Kenya.

This was mirrored in the classroom: in response to students' answers, just over half the teachers consistently gave positive feedback and corrected mistakes without scolding students, with a low of 32 percent in Mozambique and a high of 75 percent in Uganda (Panel C).

In summary, general pedagogical knowledge and the ability to assess students' learning and respond to that assessment is poor across the seven countries, with less than 1 in 10 teachers being classified as having minimum knowledge in general pedagogy or student assessment. When it comes to classroom practice, many teachers deploy some of the teaching practices identified in the literature as promoting learning, but very few (less than one in ten) apply the full set of beneficial skills, i.e. structuring, planning, asking questions and giving feedback, in their lessons.

What does the pipeline to a teaching position look like?

So far we have shown that teacher quality, as measured by their knowledge, attendance and practices in the classroom, is very low in the seven countries we have surveyed. At a general level, these findings strongly suggest that systems employed to select, train and motivate teachers are de facto dysfunctional.<sup>5</sup>

Research on high-performing education systems consistently points to the importance of making teacher recruitment more selective, ensuring that the quality of the teaching program is high, and putting in place effective screening mechanisms at the point of hiring,

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<sup>5</sup> This section draws on the SABER country reports for Kenya, Nigeria and Uganda, on the Uganda, Senegal and Tanzania country summaries prepared by the Centre for International Education (CIE) at the University of Sussex ([www.sussex.ac.uk/cie/projects/completed/tpa](http://www.sussex.ac.uk/cie/projects/completed/tpa)), information provided by the Ministry of Public Services in Senegal [http://www.servicepublic.gouv.sn/index.php/demarche\\_administrative/demarche/1/58](http://www.servicepublic.gouv.sn/index.php/demarche_administrative/demarche/1/58), Nordstrum (2015), as well as findings from the data.

for example through national teacher standards that ensure minimum standards for what a teacher should know and be able to do (Bruns and Luque, 2014).

On the face of it, there are established systems to qualify teachers with a certificate in all seven countries we surveyed. Using the survey data, for example, we find that almost 90% of teachers have such a qualification, which confers training at or below the level of post-secondary, non-tertiary education. Ten percent of teachers hold (in addition to their certificate) a bachelor or master's degree in education. A more thorough review of teacher-training systems in sub-Saharan Africa, however, reveals that the pipeline to a teaching position falls short on the core dimensions of selectivity, quality and screening.<sup>6</sup>

First, standards for entry into teacher training are low: completing lower secondary education is often enough to enter. In fact, of the teachers in the survey with a national certificate for teaching, just under 50% do not have education above lower secondary. The majority of the remainder have either completed upper secondary education (28%) or post-secondary, non-tertiary education (18%).

This low academic attainment of students entering teacher training is compounded further by the inadequacy of the programs themselves. Specifically, there is a disconnect between the needs of candidates, who, having gone through their country's primary and secondary education system, arrive with poor subject matter knowledge and curricula that focus on teaching methods and pedagogy theory. For example, the Nigerian curriculum devotes more than twice the amount of time to pedagogy (theory) than to Maths, English and Science, and even the time spent on subjects is mostly devoted to subject-specific learning methods. In the case of Kenya, all qualified teachers are expected to teach mathematics at

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<sup>6</sup> Raising teacher quality likely requires more than making recruitment more selective and providing future teachers with high quality training, including putting in place effective schemes that ensure continued high effort and continued upgrading of knowledge for teachers in schools. As stressed in section 2, the education system in the countries we surveyed, and in fact in many education system across the globe, fail to ensure these crucial elements also.

primary level, but mathematics is not a compulsory subject during their training. In addition, while research suggests that pre-service training that focusses on the work teachers face in classrooms produces more effective teachers and higher learning for students (Boyd et al., 2009), little time is devoted to actual classroom practice, which can be as low as six weeks in Kenya, for example.

The length of teacher training courses varies among countries, ranging from two years in the case of Kenya, Tanzania and Uganda down to de facto a few months in the case of Senegal. Trainers are typically not trained instructors, but former teachers, and just as in the primary schools we surveyed, absenteeism among trainers is anecdotally high, resulting in a de facto large reduction in effective teaching.

In Table 5 we explore the extent to which educational qualifications correlate with better observed quality teaching in government primary schools. Specifically, we estimate subject and pedagogy knowledge, classroom skills, and effort conditional on a teacher's highest education level and whether they hold a degree in education.<sup>7</sup> We also investigate whether variation in other observable teacher characteristics, such as gender, age, experience, and position in the school, can help explain which teachers are absent less often, are more knowledgeable and have better skills in the classroom.

When it comes to a teacher's subject knowledge (measured as percentage of correct questions on the subject test), education matters at least to some extent (column 1). Relative to those with primary or no education, teachers with lower secondary education score four percentage points higher (or 8 percent higher) while teachers with upper secondary education score five percentage points higher (or 10 percent higher). A teacher with professional education – a Degree in Education – and with post-secondary education, answers 12

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<sup>7</sup> We do not control separately for whether the teacher holds a training certificate since this qualification is near universal.

percentage points, or 24% more questions correctly. Interestingly, contract teachers, conditional on education level, tend to do have better subject knowledge, and do not do worse on the test in an unconditional comparison, which takes into account that contract teachers have less education and training than regular teachers. Finally, there is no relationship between age, experience, gender and subject knowledge.

When it comes to pedagogy knowledge and skills in the classroom (measured as percentage of correct questions on the pedagogy test and percentage of four classroom skills observed), education matters also, but only at higher levels, and professional training becomes ever more important (columns 2-3). Teachers who have completed lower secondary education are indistinguishable from those with primary education in terms of their pedagogy score and classroom skills and teachers with upper secondary education behave the same in the classroom as those who have less education.

Beyond education, we find that younger teachers do better on the pedagogy portion of the test and this remains true even unconditionally, when allowing for the fact that younger cohorts are less educated. Contract teachers perform significantly worse on the pedagogy part, but have the same classroom practices as regular teachers. Finally, women and men have the same pedagogy knowledge, but women display much better classroom practices.

A priori, it is less clear how teacher education and training correlates with teacher effort. However, looking at column (4) a clear pattern emerges. Teachers who are more educated tend to be absent from the classroom more often. Contract teachers are absent less often, but significantly so only in an unconditional comparison which takes into account that these teachers are less educated. Finally, female teachers are absent significantly less often, and the effect is relatively large.

The pattern of coefficients across the different dimensions of teacher quality is consistent between knowledge and skills on the one hand and effort on the other, with

characteristics – in particular education – that predict higher performance on one dimension predicting lower performance on the other. Looking at knowledge and skills only, the results are in line with the qualitative evidence we presented above, which showed that professional education is geared towards pedagogy theory rather than subject knowledge, and that overall education and training is inadequate to prepare teachers for their job: even a teacher with post-secondary education, a training certificate and an education degree would get just over 60% of the subject knowledge questions correct and less than 50% of the pedagogy questions. Finally, it is interesting to note that neither age nor experience, the most significant predictors of teacher salaries, are strongly correlated with the quality of teaching.

Taken together, it is easy to see how a vicious circle is created in which today's teachers have gone through an education system that does not prepare them adequately, through a training system with low entry requirements that does not compensate for the flaws in the education system, or through no training at all, to be sent into school where they struggle to teach the next generation of students.

## Discussion

In this paper we report on what primary school teachers in Africa know and do using unique data from seven African countries. The findings provide a concerning picture of teacher effort, knowledge, and skill, although there is significant variation in teacher quality, both within and across countries. Even taking this variation into account, however, if “adequate” teaching is defined by students that during most of their scheduled time are being taught by teachers with at least basic pedagogical knowledge and minimum subject knowledge in language and mathematics, then essentially no public primary school students, in the countries we surveyed, benefit from adequate quality education.

In Bold et al (2017b) we show that this lack of quality education can help explain why so many students learn little and complete their primary education lacking even basic reading, writing, and arithmetic skills. Potential human capital for cohorts of students is consequently lost. Specifically, Bold et al (2017b) estimate that after four years of primary schooling, students have acquired only one and a half years of effective human capital. More than a quarter of the students are deemed to have less than one year of human capital and only 10 percent of the students have acquired three years of effective human capital and a mere 1 percent are deemed to manage what they are expected to according to the language and mathematics curriculum for grade 4.

We use data from representative surveys from seven countries representing a substantial proportion of the population of sub-Saharan Africa. Evidence from other studies, however, suggest that the problem of low quality teachers is not specific to sub-Saharan Africa. Chaudhury et al. (2006) present results from a multi-country study spanning Asia, Africa and Latin America, where enumerators made unannounced visits to public schools to measure teacher presence in schools. Pooling data across countries, they find an average teacher absence rate of 19%, which is similar to the 23% absence rate we report in Table 1. Further, in India, Kremer et al. (2005) report that not only were 25% of teachers absent from work, but another 25% were in school but not teaching and thus only about half of the teachers were found to be actually engaged in teaching, again a result strikingly close to what we document across the seven countries we surveyed.

There are few direct studies outside of Africa about how much teachers know about the subjects they teach and how they perform in the classroom, but those available show very low results. Bruns and Luque (2014) report findings from a national evaluation of teachers (and students) by the Ministry of Education in Peru. More than eight of ten sixth-grade teachers scored below level 2 on a 2006 test where level 3 meant mastery of sixth-grade math

skills and performance below level 2 implied the “teachers were unable to establish mathematical relationships and adapt routine and simple mathematical procedures and strategies”. Bruns and Luque (2014) further document, drawing on data from a large sample of classrooms in seven Latin American and the Caribbean countries, that teachers only spend 52-85% of class time on academic activities, implying a loss of potential instructional time equivalent of one less day of instruction per week. Consistent with the findings we report here, they also show that in every Latin American and the Caribbean country studied, teachers in classrooms spend about 10 percent of time completely “off-task”.

At a general level, given the results presented here, it is easy to list what governments “should” do to improve service performance in the education sector, assuming they have the capacity and commitment to do so. Specifically, the results highlight the importance of developing teacher training programs that attract talented candidates and prepare them to teach the curriculum effectively. The results also highlight the need to put in place effective schemes that ensure high effort and continued upgrading of knowledge and skills. Our results, however, do not speak to what exact policies and reforms should be implemented and this, we believe, is an important area for future policy analysis and research.

Importantly, reforms aimed at systematically raising the quality of the teaching body along the lines stressed above should be viewed as more of a longer run solution. In fact, the huge improvement in the delivery of high quality education in countries such as South Korea and Singapore resulted from system-wide efforts over several decades (Murnane and Ganimian, 2014). Unfortunately, millions of children in low income countries, even after several years of schooling, still lack basic literacy and numeracy skills and cannot afford to wait for system wide reforms to be identified and implemented.

Fortunately, the findings from the large experimental literature on education provide evidence of strategies to raise, in particular, foundational literacy and numeracy skills (see

reviews in Kremer et al, 2013; Murnane and Ganimian, 2014; Glewwe and Muralidharan, 2015; and Evans and Popova, 2016). More recent evidence also shows that some of these interventions can effectively be brought to scale (cf. Banerjee, et al, 2016). Our findings can also help guide this literature moving forward, especially when the objective is to go beyond provision of basic skills. The main message of the paper is that teachers perform poorly in several, likely complementary, dimensions. They teach too little and they lack the necessary skills and knowledge to teach effectively when they actually teach. It is difficult to think of any intervention in education that would dramatically push countries towards a reasonable level of student learning if it does not simultaneously address all of these dimensions of teacher quality.

For example, there is by now strong evidence that teacher effort, broadly defined, can be raised, leading to improved learning outcomes which can be substantial, especially in settings with very low student achievement and high teacher absenteeism (cf. Muralidharan and Sundararaman, 2011). Such incentive schemes are, however, bound to run up against the constraint of teachers' limited knowledge and skills, given that many teachers do not even master their students' curriculum, thus highlighting the challenge of also incorporating components that have the potential to improve teachers' knowledge and practice.

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**Table 1: Teacher Absence**

	All	Min	Max
Absence from class (%)	44	23 (NGA)	57 (UGA)
Absence from school (%)	23	15 (KEN)	45 (MOZ)
No. of teachers	16,543		
Scheduled teaching time (h min)	5h 27m	4h 21m (MOZ)	7h 13m (UGA)
Time spent teaching (h min)	2h 49m	1h 43m (MOZ)	3h 16m (TZA)
No. of schools	2,001		
Orphaned classrooms (%)	33	24 (TGO)	45 (UGA)
No. of schools	1,647		

**Notes:** The table reports the absence rate for all teachers, the scheduled teaching time, actual teaching time and number of orphaned classrooms for all government schools. All individual country statistics are calculated using country-specific sampling weights. The average for all countries, reported under the heading “All”, is taken by averaging over the country averages. The ISO 3-digit alphabetic codes of the countries with the lowest and highest score for each item are given in brackets. Teachers are marked as absent from school if during the second unannounced visit, they are not found anywhere on the school premises. Otherwise, they are marked as present. Teachers are marked as absent from class if during the second unannounced visit, they are absent from school or present at school but absent from the classroom. Otherwise, they are marked as present. The scheduled teaching time is the length of the school day minus break time. Time spent teaching adjusts the length of the school day by the share of teachers who are present in the classroom, on average, and the time the teacher spends teaching while in the classroom. The orphaned classrooms measure is the ratio of the classrooms with students but no teacher to the number of classrooms with students with or without a teacher (not collected for the pilot countries). ISO 3-digit alphabetic codes are: KEN (Kenya), MOZ (Mozambique), NGA (Nigeria), SEN (Senegal), TZA I (Tanzania I, pilot), TZA (Tanzania II), TGO (Togo), UGA (Uganda). For country-specific estimates, see Bold et al (2017).

**Table 2:** Teachers' content knowledge: Minimum thresholds

Percentage (%) of teachers with ...	All	Min	Max
<i>Subject knowledge: Language</i>			
80% of knowledge equivalent to a 4 <sup>th</sup> grader	66	26 [NGA]	94 [KEN]
Minimum knowledge	7	0 <sup>a</sup>	34 [KEN]
No. of teachers	3,741		
<i>Subject knowledge: Mathematics</i>			
Minimum knowledge	68	49 [TGO]	93 [KEN]
No. of teachers	3,922		

**Notes:** The table reports minimum content knowledge indicators for teachers in grade 4 or who taught grade 3 in the previous year in government schools. Language knowledge is computed for teachers teaching language and mathematics knowledge is computed for teachers teaching mathematics. All individual country statistics are calculated using country-specific sampling weights. The average for all countries, reported under the heading "All", is taken by averaging over the country averages. The ISO 3-digit alphabetic codes (see table 1 for details) of the countries with the lowest (Min) and highest (Max) score for each item are given in brackets. A language teacher is defined as having 80% of knowledge equivalent to a fourth grader in language if he/she score at least 80% on the tasks covered in the 4<sup>th</sup> grade curriculum. A language teacher is defined as minimum knowledge if he/she score at least 80% on the grammar, Cloze test and correcting a student's composition task of the language assessment. A mathematics teacher is defined as having minimum knowledge (=80% of knowledge equivalent to a 4<sup>th</sup> grader) if he/she score at least 80% on the tasks covered in the curriculum up the grade 4. (a) MOZ, NGA, TZA I, TGO. For country-specific estimates, see Bold et al (2017a).

**Table 3:** Teachers’ performance on specific item groups of knowledge

	All	Min	Max
<b>Language</b>			
Spelling task, score out of 100	86	86 [TZA I]	86 [TZA I]
Grammar task, score out of 100	79	58 [NGA]	92 [KEN]
Cloze task, score out of 100	44	27 [TGO]	66 [KEN]
Correct composition task, score out of 100	26	9 [MOZ]	50 [KEN]
No. of teachers	3,770		
<b>Math</b>			
Can add double digits (%)	91	75 [TGO]	98 [KEN]
Can subtract double digits (%)	77	59 [NGA]	94 [SEN]
Can multiply double digits (%)	68	44 [MOZ]	89 [SEN]
Can solve simple math story problem (%)	55	17 [MOZ]	91 [SEN]
Understands a Venn diagram (%)	41	19 [TGO]	70 [KEN]
Can interpret data in a graph (%)	25	12 [TGO]	62 [KEN]
Can solve algebra (%)	35	3 [MOZ]	74 [KEN]
Can solve difficult math story problem (%) <sup>a</sup>	15	7 [SEN]	22 [TZA]
No. of teachers	3957		

**Notes:** The table presents scores on specific tasks for teachers in government schools in grade 4 or who have previously taught grade 3. Language knowledge is computed for teachers teaching language and mathematics knowledge is computed for teachers teaching mathematics. All individual country statistics are calculated using country-specific sampling weights. The average for all countries, reported under the heading “All”, is taken by averaging over the country averages. The ISO 3-digit alphabetic codes (see table 1 for details) of the countries with the lowest (Min) and highest (Max) score for each item are given in brackets. (a) Question was asked only in Tanzania (2010). For country-specific estimates, see Bold et al (2017a).

**Table 4:** Pedagogical knowledge and skills

	All	Min	Max
<i>Panel A: Pedagogical knowledge</i>			
Minimum general pedagogy knowledge (%)	9	1 (NGA)	36 (TZA)
Factual text comprehension (0-100)	42	23 (MOZ)	78 (TZA)
Preparing a lesson plan (0-100)	31	15 (NGA)	58 (TZA)
Formulate aims and learning outcomes (0-100)	22	11 (NGA)	41 (TZA)
No. of teachers	5,181		
<i>Panel B: Assessing students</i>			
Minimum knowledge assessing students (%)	0*	0	0
Formulate questions to check understanding (0-100)	17	5 (NGA)	52 (TZA)
Formulate questions to apply to other contexts (0-100)	7	3 (NGA)	15 (TZA)
Assessing students' abilities	18	8 (NGA)	32 (KEN)
Evaluating students' progress	12	5 (NGA)	26 (KEN)
No. of teachers	5,181		
<i>Panel C: Skills and practices in the classroom</i>			
Introduce and summarize topic of the lesson (%)	41	16 (MOZ)	62 (KEN)
Lesson appears planned to enumerator (%)	64	37 (UGA)	75 (KEN)
Ask a mix of lower and higher order questions (%)	31	14 (MOZ)	44 (UGA)
Give positive feedback, praise, corrects mistakes (%)	52	32 (MOZ)	75 (UGA)
Engages in all of the above practices (%)	8	1 (MOZ)	17 (KEN)
No. of teachers (classrooms)	1,558		

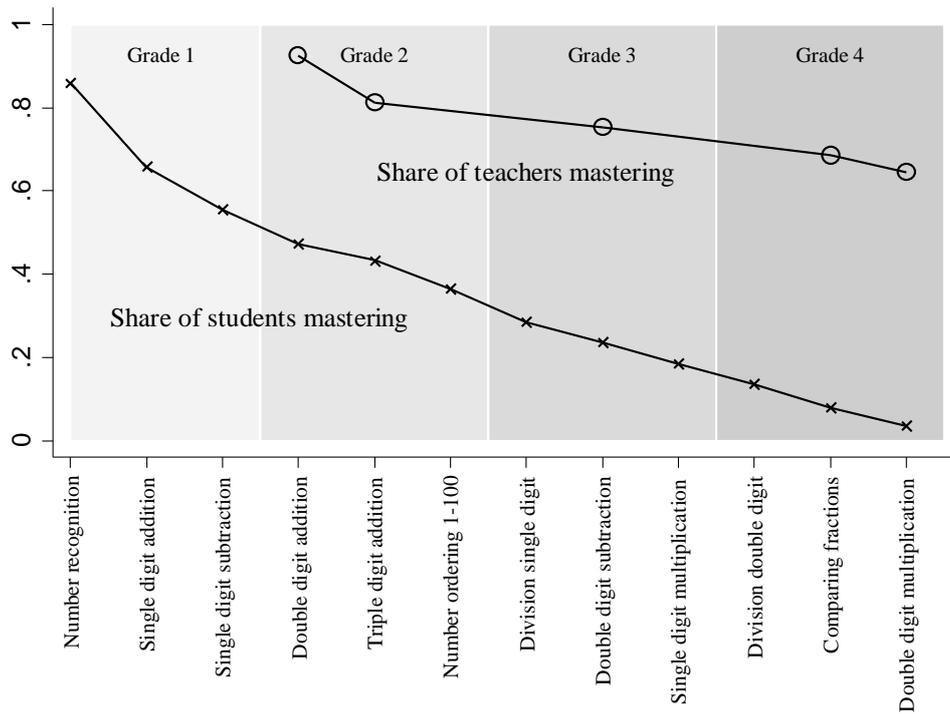
**Notes:** Panel A reports minimum general pedagogical knowledge and scores on specific pedagogical tasks for teachers in government schools in grade 4 or who have previously taught grade 3. A teacher is defined as having minimum knowledge of general pedagogy if they score least 80% on the tasks that relate to general pedagogy (factual text comprehension and being able to formulate learning outcomes and lesson aims). Panel B reports minimum pedagogical knowledge in assessing students and monitor their progress and scores on specific pedagogical tasks for teachers in government schools in grade 4 or who have previously taught grade 3. A teacher in any subject is defined as having minimum knowledge assessing students if they score least 80% on the tasks that relate to assessment (comparing students' writing and monitoring progress among a group of students). Panel C presents teacher practices in the classroom in government schools in grade 4. The information is not available for Senegal and Tanzania (1st survey). All individual country statistics are calculated using country-specific sampling weights. The average for all countries, reported under the heading "All", is taken by averaging over the country averages. The ISO 3-digit alphabetic codes (see table 1 for details) of the countries with the lowest (Min) and highest (Max) score for each item are given in brackets. All scores are computed for teachers teaching either subject. (\*) No teacher assessed had minimum knowledge to assess students. For country-specific estimates, see Bold et al (2017a).

**Table 5:** Teacher characteristics and teacher quality

	(1)	(2)	(3)	(4)
	Content knowledge	Pedagogical knowledge	Pedagogical skills	Absence (effort)
Female	-0.01 (0.005)	-0.00 (0.004)	0.07*** (0.015)	-0.08*** (0.010)
Experience	-0.00 (0.003)	0.00 (0.002)	-0.00 (0.007)	-0.01*** (0.004)
Age	0.00 (0.003)	-0.01*** (0.002)	0.01 (0.007)	0.00 (0.005)
Lower secondary	0.04*** (0.014)	0.02 (0.011)	0.03 (0.039)	0.06** (0.028)
Upper secondary	0.05*** (0.015)	0.05*** (0.011)	0.02 (0.039)	0.05* (0.031)
Post_secondary	0.07*** (0.014)	0.06*** (0.011)	0.08** (0.040)	0.06** (0.032)
Degree in Education	0.05*** (0.007)	0.05*** (0.006)	0.06*** (0.022)	0.00 (0.013)
Contract Teacher	0.02** (0.009)	-0.02*** (0.008)	0.02 (0.026)	-0.02 (0.020)
Head Teacher				0.18*** (0.015)
Constant	0.50*** (0.079)	0.35*** (0.055)	0.73*** (0.106)	0.15* (0.090)
Schools	1,563	1,563	1,623	1,724
Observations	6,916	7,042	1,623	13,336

**Notes:** The table presents estimates from multivariate regressions, one regression for each column, with the dependent variables listed in the top row, the independent variables listed in the left column, and controlling for country and day and month of survey fixed effects. ‘Content knowledge’ measure the percentage of correct questions on the teacher content knowledge test (language for language teachers, math for math teachers, average of language and math for teachers teaching both subjects), ranging from 0 to 1. ‘Pedagogical knowledge’ is measured as percentage of correct questions on the pedagogy test, ranging from 0 to 1. ‘Pedagogical skills’ is the average score of the four skills presented in Table 5, i.e. structuring, planning, asking lower and higher order questions and giving feedback, ranging from zero to 1. ‘Effort (absence from classroom)’ is a dummy set to 1 if the teacher is not found in the classroom and zero otherwise. The information on all teacher quality variables are not available for Senegal and Tanzania (1st survey) and data for those samples are therefore not included. Robust standard errors clustered by school in parentheses. \*Significant at 10% level; \*\*Significant at 5% level; \*\*\*Significant at 1% level.

**Figure 1:** Share of students and teachers mastering specific tasks in mathematics



**Notes:** Source Bold et al. (2017b). Graph reports cumulative knowledge – share mastering the task(s) – of tasks of increasing order of difficulty for students and teachers. All students and all teachers for which student data is available are included.