What Do Teachers Know and Do?
A Report Card on Primary Teachers in Sub-Saharan Africa*

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Using data from nationally representative surveys from seven Sub-Saharan African countries, representing close to 40% of the region's total population, we answer three questions: How much instruction time in class do students actually get? Are they taught by teachers who know the material that should be covered? Do teachers have the skills to effectively transfer what they know to students? Averaging across countries, we find that students receive about two and a half hours of teaching a day – or less than half the scheduled time. Further, a large majority of teachers do not master even their students' curriculum and their pedagogical knowledge and skills are strikingly low. As a result, we estimate that less than half a percent of primary public school students attend a school with decent quality standards. We show that the differences in teacher content knowledge and teachers' knowledge and skills in pedagogy can account for a significant part of the variation in test scores across countries. Our findings provide a lens through which the growing experimental and quasi-experimental literature on education in low-income countries can be interpreted and understood, and point to important gaps in our knowledge, which highlight directions for future research.

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1. Introduction

A large share of children in low income countries learn little in school and complete their education lacking even basic reading, writing and arithmetic skills. While the reasons behind this policy failure are likely to be multifaceted, evidence from recent research on education in developing countries, showing that traditional educational inputs have little impact on test scores but increasing teacher effort and pedagogy do, suggest that teacher behavior and teacher ability play a crucial role. However, although we now have causal evidence of how changes in teacher incentives and, consequently teacher behavior, map into learning outcomes, there is scant systematic evidence of what primary school teachers actually know and do.

This paper reports on an ongoing research program intended to help fill this void. Using nationally representative data collected using direct observations, unannounced visits, and tests, from seven Sub-Saharan African countries – Kenya, Nigeria, Mozambique, Senegal, Tanzania, Togo, and Uganda – representing close to 40% of the region's total population, we provide quantitative answers to three questions: How much time do teachers actually spend teaching? Do teachers have the relevant knowledge to teach both lower-order and higher order language and mathematics skills? Do teachers have the pedagogical knowledge and skills to transfer what they know to students in an effective way?

Averaging across countries, we find that students receive about two and a half hours of teaching a day – or less than half the scheduled time, largely because teacher, even when in school, do not teach. Further, teachers' subject and pedagogical knowledge are strikingly low. Only about one in ten fourth grade teachers master their students' curriculum and about a quarter of the teachers even fail simple tasks such as subtracting two-digit numbers or choosing the correct pronoun or conjunction to complete a sentence. Few teachers are able to assess children's abilities and evaluate their students' progress. As a result, we estimate that less than a half of a percent of primary public school students attends schools of decent quality.

We further show, by linking teacher data and data on various school and student characteristics to student literacy and numeracy test scores, that teacher subject knowledge and teacher pedagogy knowledge and skills account for the bulk of the observed variation in test scores across the Sub-Saharan African countries. The level of formal teacher training and education, on the contrary, do not explain much of the variation in the data: A result that can be partly explained by the fact that teachers with more formal training tend to teach less than those with less training, but their subject and pedagogical knowledge are superior to their lower educated colleagues.

The data presented here provide a quantitative lens through which the growing experimental and quasi-experimental literature can be interpreted and understood. Despite close to 100 randomized controlled trials that have been conducted in the area of education in the last 10-15 years, the literature has yet to produce, as recent systematic reviews demonstrate, a consensus among researchers about what are the most effective ways to increase the quality of primary education.[1] In particular, our findings can help us understand

[1] Kremer, Brannen, and Glennerster (2013), drawing on a set of RCT studies, argue that interventions that match teaching to student learning levels, contract teachers, and interventions improving access to schooling are the most effective. Krishnaratne, White, and Carpenter (2013) – a meta-analysis of 69 RCT and quasi-experimental studies – argue that the most compelling evidence of what works is computer-assisted learning tools. McEwan (2014) – a meta-analysis of 77 RCT – finds the largest effects for interventions involving computer-assisted learning. Murnane and Ganimian (2014) – a narrative review drawing on 115 RCT and quasi-experimental studies – conclude that the strongest evidence (unconditionally) of impact comes from studies providing information about school quality and returns to schooling. Conn (2014) – a meta-analysis based on 56 studies conducted in Sub-Saharan Africa – finds that pedagogical interventions (changes in instructional techniques)

both effect sizes of interventions shown to raise students' test scores and why other well-intentioned policy experiments have not had much of an impact on learning outcomes.

Most importantly, we argue that the stylized facts presented here can help guide the next generation of policy experiments. For example, we document substantial shortcoming in teacher knowledge and skills. However, as of yet, we know relatively little about effective ways to raise them.

We proceed by first providing a brief background of the project followed by a short documentation of student learning in the seven countries surveyed. The following three sections provide answers to the main questions outline above: Do teachers teach? What do teachers know? How well do teachers teach? We then use the answers to these questions to estimate how many students in Africa attend a decent public school. Sections 8 and 9 exploit the data to account for the variation in teacher effort, knowledge, and skills across schools, and to account for variation in student learning across countries. Section 10 compares teachers in public and private schools. Finally, in the last section we briefly discuss how our findings can help improve our understanding of the growing experimental literature on education in developing countries and suggest avenues for future research.

2. Measuring teacher effort, knowledge, and skills: The Service Delivery Indicators

The Service Delivery Indicators (SDI) – an ongoing Africa-wide program with the aim of collecting informative and standardized measures of what primary teachers do and know – grew out of concern of a systematic failure of the education system in Sub-Saharan Africa to deliver high quality primary education. This policy failure is evident throughout the education service delivery chain, but, possibly, it is most clearly articulated at the school level. Measuring the behavior and ability of teachers, therefore, is one way to quantify the extent of the problem.

The delivery of education in most low-income countries is characterized by centralized, but weak, state control and often inept locally-governed institutions for education provision. This has created a system where both career concerns and pecuniary incentives of teachers are largely missing. Hiring, salaries, and promotions are therefore largely determined by teachers' seniority and initial educational qualifications, not how they perform. Parents have little influence on how schools are managed and various state and local authorities neither provide technical support nor supervision of performance.

Teacher salaries account for the largest single item in education expenditure, in both developed and developing countries. In Sub-Sahara Africa, salaries for teachers and education officials account for more than 70% of the expenditure in education (UIS/ISU 2013) and approximately 12% of total government expenditure. Although teachers in developing countries are low paid in nominal terms, they earn about twice as much (four times GDP per capita) as their counterparts in developed countries, expressed in GDP per capita (Bruns et al., 2003).

The public sector is the dominant actor in primary education in Africa. However, even though public spending on education has increased in the last decade (reference), so has the number

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have the highest effect size on achievement outcomes, and Glewwe and Muralidharan (2015) – employing a voting counting approach based on 118 studies (of which 80 RCTs) – conclude that teaching at the right level (remedial programs), and teacher performance and accountability interventions are the most promising.

of private schools. Private schools – informal and formal – nowadays account for around 20% of total primary school enrollment in low-income countries (Baum et al. 2014).

The SDI program was piloted in Tanzania and Senegal in 2010 (Bold et al, 2011) and have to date been implemented in seven countries: Kenya (2013), Mozambique (2015), Nigeria (2014), Senegal (2010), Tanzania (2010, 2015), Togo (2014), and Uganda (2013).

In each country, nationally representative surveys of between 150-400 schools were implemented using a multistage, cluster sampling design. Primary schools with at least one fourth grade class formed the sampling frame. The samples were designed to provide estimates for teacher effort, knowledge, and skills in public primary schools, broken down by urban and rural location. For five or the seven countries, representative data were also collected for private primary schools.

The surveys collected a broad set of school, teacher, and student specific information using visual inspections of a fourth grade classrooms and the school premises; direct physical verification by unannounced visits; and teacher and student tests. We focus here on the data on teacher behavior and knowledge. All data, including complementary data on teaching resources, school and classroom infrastructure, student resources, and student-teacher ratio, can be downloaded at www.sdi.com.

3. The starting point: Learning outcomes in Africa

In the last decade, the major IEA and OECD testing programs have expanded dramatically in terms of participating countries, with more than 100 participating countries in at least one of these assessment in 2012 (Hanusheck and Woessmann, 2015). However, only one Sub-Saharan African country (Botswana) participated in the last IEA mathematics tests at the primary level and only three countries participated at secondary level.[2] Average test results at the secondary level suggest average test scores below the lowest 5th percentile score in the US, but as a significant share of students performed below chance (based on multiple choice items), the performance in the tests was in the end deemed too low to provide reliable measurement of achievement of students (TIMSS, 2011).

As part of the SDI assessment of teacher behavior and knowledge, fourth grade students in sampled schools were assessed in basic reading, writing, and arithmetic skills, the “three Rs”. The test, using material up to grade three level, was designed by experts in international pedagogy and based on a review of primary curriculum materials from 13 African countries. While other testing program exist in Sub-Saharan Africa, including SACMEQ, PASEC, and Uwezo, the main advantage of the SDI assessment is that it is possible to link student achievement to teacher characteristics.

[2] The Trends in International Mathematics and Science Study (TIMMS) by the International Association for the Evaluation of Education Achievement (IEA) test grade 4 (primary) and grade 8 (secondary) students related to common elements of primary and secondary school curricula. In Botswana, grade 6 students were assessed as it was deemed too difficult for fourth grade students to take the TIMSS fourth grade assessment. Similarly, in Botswana and South Africa, ninth grade students were assessed with the TIMSS eight grade assessment. No Sub-Saharan African country participate in the testing program run by OECD (Programme for International Student Assessment, PISA).

The test was designed as a one-on-one test with enumerators reading out instructions to students in their mother tongue. This was done so as to build up a differentiated picture of students' cognitive skills; i.e. oral one-to-one testing allows us to test whether a child can solve a mathematics problem even when his/her reading ability is so low that he/she would not be able to attempt the problem independently. The language test (implemented in English, French, or Portuguese) ranged from simple tasks testing letter and word recognition to a more challenging reading comprehension test. The mathematics test ranged from recognising and ordering numbers, to addition of one- to three-digit numbers, to one- and two-digit subtraction, to single digit multiplication and divisions.

Table 1 summaries the finding by listing results for a handful of items covered in the language and mathematics assessment. As evident, after three years of primary public schooling, many students still lack even basic literacy and numerical. For example, almost half of the students assessed could not read a simple word, ranging from 79 percent failing to read a simple word in Portuguese in Mozambique to 18 percent failing to read a simple word in English in Kenya. A majority of the students (70 percent overall, ranging from 29 to 88%) of the students could not read all the words in a basic sentence. And only one in seven students could read a simple paragraph and infer meaning from it.

2 in 10 students could not recognize numbers and 5 in 10 students could not order numbers. One in four (three in four) cannot do single digit addition (subtraction). Just over half of the students assessed managed double digit addition and less than a third mastered double digit subtraction.

The results in table 1 suggest that learning outcomes across Sub-Saharan Africa are lower than in (rural) India, where comparable data exists, in language and similar for mathematics. The most recent evaluation from India, for example, show that 38% of children in third grade in public schools could not read simple words and less than 27% could master double digit subtraction (ASER, 2013).

4. 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 we extended the approach in Chaudhury et al (2006). In each school during a first, in principle announced, visit up to 10 teachers were randomly selected from the teacher roster. About 1-2 weeks after the initial survey, an unannounced visit was conducted during which the enumerators were asked to identify whether the teachers were actually in the school, and if so, if they were actually in class teaching.

Averaging across countries, 45 percent of teachers were absent from class (Table 2). In two of the seven countries, more than half of the teachers were absent and only in one country – Nigeria – do we observe absence below 30%. Absence from school is about as common as being present in the school but absent from class. This implies that of the 8 out of 10 teachers that are found in school, only 6 are actually teaching. The overall correlation between the two measures is only 0.23, making the school absence rate at best a partial measure of teacher effort. This is starkest illustrated for the case of Kenya and Tanzania (2014), which have relatively low school absence rates (14-16 percent) but relatively high classroom absence rates (37-39 percent).

When a large share of teachers is not teaching, unsurprisingly, a large share of classrooms will only be occupied by students. In fact, consistent with the absenteeism findings discussed above, we find, averaging across countries, that every other classroom was an orphaned classroom; i.e., the teacher was missing in action.

What do these results imply for the amount of instruction time students actually get? To answer this, we first recorded the scheduled time of a teaching day from school records, i.e., 5 hours and 26 minutes on average across the seven countries after break times. We then multiply this number by the proportion of teachers absent from classroom. The idea being that if 10 teachers are supposed to teach 5 hours and 26 minutes per day, but four of them are absent from either the school or the class at any one time, then scheduled teaching time is reduced to 3 hours and 15 minutes.

Even when in the class, however, teachers may not necessarily be teaching. In order to measure what happens inside the classroom we randomly selected a mathematics and a language fourth grade class and recorded a snapshot, every minute, of what the teacher was doing.[3]

The percentage of the lesson lost to non-teaching activities varied from 16 percent in Nigeria to 3 percent in Togo. Multiplying the measure of teaching time adjusted for classroom absence by the proportion of a typical lesson that is spent on teaching, we end up with a measure of the estimated instruction time for students.
Students are taught on average 2 hours and 41 minutes per day, or roughly half of the scheduled time (Table Z). Estimated instruction time varies from 3 hours and 15 minutes in Togo to about an hour and a half in Mozambique. As illustrated in Figure X, only about ten percent of the schools provide at least 5 hours of teaching per day. About the same share provide no teaching (because none of the ten randomly sampled teachers was found in the classroom). A quarter of schools teach less than two hours and half the schools teach less than three hours.

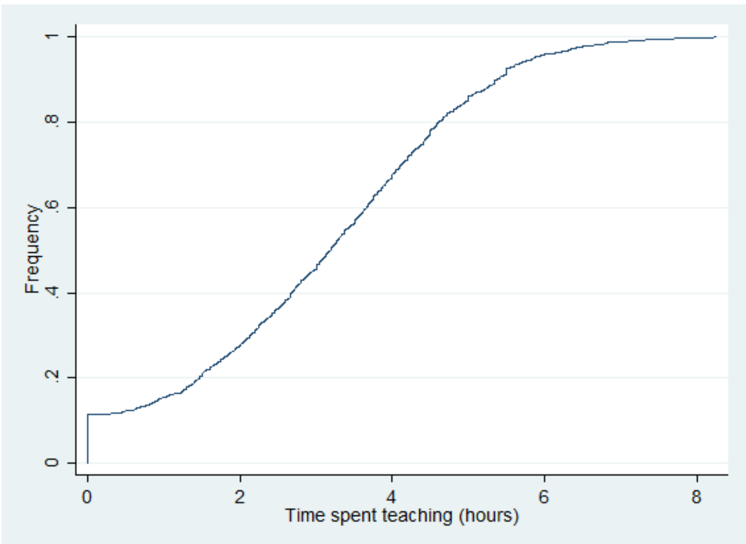

Figure XX: Distribution of time spent teaching across schools

Finally, absenteeism rates appear to be remarkably stable over time in countries. Chaudhury estimates a school absence rate of 27% in Uganda in 2006, which compares to our

[3] This approach likely provides an upper bound on the time devoted to teaching. In the two pilot countries, Tanzania and Senegal, data on teacher behavior were collected while observing the teacher both inside and from outside the class-room. We find that time spent teaching when in class is about 10 percent lower if the enumerator stands outside the classroom rather than inside.

measure of 30% in 2013. Similarly, the classroom absence rate in Tanzania has changed little between 2010 and 2015), however, the composition of this absence is somewhat different. While in 2010, almost half this absence was accounted for by absence from school, now more teachers are in school, but conditional on being in school, they are less likely to be in the classroom.

5. What do teachers know?

For teachers to be effective, they must have the knowledge necessary for good teaching. In particular, they must know the subject they teach (subject content knowledge), how to translate this knowledge into meaningful teaching (general and pedagogy content knowledge) and how children learn (knowledge of the context of learning). We now measure whether primary school teachers across Sub-Saharan Africa have – what we consider the minimum – knowledge in these three areas required for good teaching.

To measure the knowledge of primary school teachers, and specifically those teaching lower primary, all language and mathematics teachers teaching grade 4 in the previous year were assessed in each school. On average X teachers were tested in each school.

To assess subject content knowledge, teachers were given authentic pieces of children's work in Language (English/French/Portuguese) and in Mathematics, based (mainly) on the curriculum the teacher was teaching.[4] In contrast to other approaches where teachers sit exams, this method of assessment values teachers as professionals and does not undermine their self-esteem (see Johnson, 2011).

We start by assessing whether teachers master their students curriculum in Language. For this, we focus on tasks that were common across the student and the teacher test, namely spelling and simple grammar exercises. To allow for some margin of error, we count a teacher as mastering the student curriculum if they marked 80% or more of the questions on spelling and grammar correctly.

As can be seen in Table 3, 40% of teachers do not make it over even that very low bar, though there is wide variation across countries: close to 90% of teachers in Senegal and Uganda are considered to be as knowledgeable as their students should be, but only 25% of Nigerian teachers. In fact, while most language teachers in grade four appear to know more than the average fourth grader in the country, this was by no means true for all of them. ??% of the teachers are worse at spelling than the average grade 4 student.

Having knowledge equivalent to the fourth grade curriculum is of course not sufficient to teach language in lower primary, because language teaching, by its very nature, is monolithic. That is to say, it is very difficult to teach a student how to compose even a simple text without having 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

[4] The subject test was 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

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) a Cloze passage to train vocabulary and reading comprehension and a letter written to a friend describing their school, which the teacher had to mark and correct.[5]

We formally define `minimum knowledge in language' as marking at least 80% of the items on the language test correctly. Despite this rather generous definition, only 2% of the language teachers in Sub-Saharan Africa are considered to have minimum subject knowledge. Moreover, subject knowledge among language teachers is uniformly low across the eight countries, with Kenya counting 7% of language teachers as having minimum subject knowledge, and Togo, Mozambique, Tanzania (both 2010 and 2015) and Nigeria counting effectively none.

In Table 4, we disaggregate by task to understand why performance is so strikingly low and which areas of language teaching specifically need improvement. First, there are clearly some teachers who are weak in all areas of the curriculum: one in five cannot spell a simple word (like traffic for example) and the same number does not manage a grammar exercise that asks them to choose the correct option, out of three, to complete the following sentence "______ [Who, How much, How many] fingers do you have?" Second, many or most teachers struggled with those tasks that required at least some knowledge beyond the lower primary curriculum to mark: they marked correctly less than half of the Cloze passage, which asked students to fill in blanks in a simple story (without prompts). And they corrected only a quarter of the spelling, grammar, syntax and punctuation mistakes in a child's letter.

On the mathematics side, we deem a teacher in grade 4 to have minimum subject content knowledge if he or she can confidently correct children's work in such aspects of numeracy as manipulating numbers using basic operations and solving simple math story problems. This requirement amounts to scoring correctly all but one (to allow for slips) of the questions on the lower primary portion of the mathematics test.

We see in Table 3 that less than two thirds of mathematics teachers have minimum knowledge according to this definition and there is again wide variation across countries with over 90% of mathematics teachers being deemed to have minimum knowledge in Senegal, but only 26% of mathematics teachers in Mozambique.[6]

Looking at the disaggregated data in Table 4, overall, 77 percent of teachers could subtract double digits, but only around 60% could do so in Togo. Similarly, 70 percent of teachers could multiply double digits, but less than half the math teachers in Mozambique could do this. By implication, almost a quarter of math teachers, and close to half in some countries, do not master simple calculations. When it comes to understanding and solving a simple math story problem, half managed to do so, but only a quarter gave the correct answer in Mozambique and Togo.

A very good mathematics student in fourth grade would – according to our definition – also be considered to have minimum knowledge for teaching. However, as for language teachers, we observe a strikingly high share of mathematics teachers who do not master their students'

[5] In Tanzania (2010) and Senegal (2010), this final task consisted of correcting 6 unconnected sentences for grammar and spelling.
[6] The difference between Tanzania (2015) and Tanzania (2010) is somewhat puzzling as the questions on the mathematics side are identical.

curriculum. For example, ??% of the teachers are worse at subtracting double digit numbers than the average grade 4 student.

That the two measures of teacher knowledge (i.e. knowing the students' curriculum and minimum knowledge for teaching) coincide for mathematics teaching – but not for language – is a consequence of the subject's modular nature. That is, it is in principle possible 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 the students they teach and the mathematics test therefore also included questions one would only encounter in upper primary. As seen in Table 4, many mathematics teachers struggled with advanced tasks: only a minority of teachers, and in some countries almost none, could interpret information in a Venn diagram and/or a graph. As we will see below, this low competence in interpreting data has implications for teachers' ability to monitor their students' progress. Finally, only few teachers (15%) had the necessary higher order skills to solve an advanced math story problem and only one third could solve a logic puzzle.

Knowing one's subject and curriculum is a necessary, but not sufficient, condition for good teaching. Teachers must also know how to translate their subject knowledge into effective pedagogy. There is broad agreement that for teaching to be effective, lessons must be well-designed and structured (general content and pedagogy knowledge). Teachers must also have knowledge of the context of learning: how to monitor student's learning by asking appropriate questions (mixing lower and higher order ones), giving feedback, and by being able to analyze records of student achievement (see Johnsons, 2011, Coe, Aloisi, Higgins and Major, 2014, Ko and Sammons, 2013, Mujis and Kyriakides, 2014, Kieme, 2012).

We first measure teachers' knowledge of pedagogy and the context of learning and then examine in the next section to what extent they apply such knowledge in the classroom.

To measure general pedagogical knowledge, we 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).[7] 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 they score 80% or more on this portion of test.[8]

To measure teachers' knowledge of the context of learning, we asked them 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, we asked them to use a marking scheme to give feedback on strengths and weaknesses in students' writing and to distinguish weak and strong

[7] The parts of the test assessing pedagogical knowledge were designed to be consistent with what Sub-Saharan African countries might reasonably expect of their teachers and based on a review of policy documents from developing and developed countries on teacher standards that set out minimum requirements for teachers' professional practice and conduct (Johnson, Cunningham and Dowling 2011)

[8] Strictly speaking, minimum knowledge should be a score of 100%, but we adjust this downwards to allow for some margin of error.

learners. In a third task, teachers were provided with a list of students' grades and 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. Again, these tasks are crucial, but largely unmeasured, aspects of effective teaching. We deem a teacher to have `minimum knowledge about the context of learning' if they could answer 80% of the items on the three tasks correctly.

Across 7 countries, only 10% of teachers were considered to have minimum general pedagogy knowledge. In fact, most countries employ fewer than 5% of teachers with the necessary pedagogy knowledge to teach –with Tanzania being somewhat of an outlier with 36% of teachers having minimum general pedagogy knowledge. While teachers were – at least to some extent – able to read and understand factual texts (score of 42% on this task, Table 4), they were not able to translate this information into teaching as they struggled to formulate lesson aims and learning outcomes based on their reading (score of 23% on this task).

As with general pedagogy knowledge, we found essentially no teachers across Sub-Saharan Africa that were knowledgeable about the context of learning. Very few could formulate questions that checked basic understanding (average score of 15%), let alone come up with a question that asked students to apply what they had learned to other contexts (average score of 5%). Only 1 in 5 teachers could give feedback on strengths and weaknesses in students' writing using a marking scheme (ranging from 1 in 10 in Mozambique to 1 in 3 in Kenya) and just over 1 in 10 could monitor and comment on the learning progression of students (ranging from 1 in 20 in Togo to 1 in 3 in Kenya).

6. How well do teachers teach?

In contrast to teacher knowledge, constructing and interpreting ordinal measures of teaching practices and skills is more challenging because whether a particular teaching practice is effective or not depends both on the context and the types of students. However, the literature (quoted in section 5) has identified a set of skills and practices that are consistently associated with gains in student learning (Mujis et al. 2014), knowledge of which we measured in the previous section: (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.

To quantify teaching practices, we use a modified Stallings (1980) classroom observation snapshot module recording, each minute for 30 minutes, which activities from a pre-determined list took place inside the classroom.

The findings are summarized in Table 5. Regarding structuring and lesson design, we observe that less than half the teachers explained the topic of the lesson at the start and summarized what was learned at the end – varying from a low of 16% in Mozambique to a high of 63% in Kenya. Moreover, in line with poor knowledge on lesson planning displayed in the pedagogy test, almost 40% of lessons seemed unplanned to the observers.

Some monitoring of understanding took place in almost all classrooms, but often very little time was spent on this, especially when it came to group activities. On average, one student was actively learning during 30% of the lesson (answering a question (20% of snapshots), writing on the board (5% of snapshots), interacting one-on-one with the teacher (10% of snapshots)). In contrast, several students are actively learning in only 15% of snapshots (reciting answers (8%), being tested (7%) and kinesthetic group exercise (1%)), ranging from a low of 6% in Tanzania and Mozambique to a high of 24% in Kenya and Uganda.

Most teachers (80%) asked questions that required students to recall information or to practice what was learned, but only just over half asked questions that required higher order skills and encouraged students to apply what was learned to different contexts and be creative. Overall, 32% of teachers mixed lower and higher order questions in their class – ranging from 14% of teachers in Mozambique to 48% of teachers in Uganda.

In response to students' answers, less than half the teachers gave positive feedback and corrected mistakes without scolding students, with a low of 17% in Mozambique and a high of 66% in Uganda.

The dimensions of teaching practices measured in the SDI have been selected on apriori grounds, because they are identified in the literature as promoting learning (see citations above). In our sample of Sub-Saharan African schools, too, there is a positive (and significant) correlation between the measures of teaching practice and test scores (see appendix).

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7. Taking stock: How many students go to a decent school?

To do: Computes the probability that a given fourth grade student selected at random from the sample population happen to go to a school where the following preconditions for teacher productivity are in place:

- Students are provided with at least 80% of scheduled teaching
- Mathematics and language teachers have minimum subject knowledge
- Teachers have at least basic pedagogical knowledge
- Teachers have at least basic skills to teach

8. Accounting for the variation in teacher effort, knowledge, and skills across schools

To do: Estimate a parsimonious model linking measures of formal training and education, and contractual status, to teach effort, knowledge, and skills. A fixed effect model with country fixed effects and a short set of controls will do. To assess the "robustness", one can also run a FE regression with school fixed effects. DATA WORK DONE. TO WRITE BASED ON PREVIOUS TEXT.

9. Accounting for variation in student learning

Present the Oaxaca-Blinder decomposition but revise the text, and use data for all countries.

10. How do private schools compare to public schools?

Starting points:

- When public institutions do not work, an argument could be made to facilitate low-income families' exit options – enroll their children in private schools
- Rapid growth of private schools at the same time as public spending on education has increased
- One possible reason – growth in enrollment has further diluted the quality of public education, resulting in exit of better-of children
- Main criticism of private schooling – economic stratification and reduce pressure of public schools to supply quality education
- Private schools may be more accountable and responsive to parents

Present and discuss the key indicators for private schools and compare with the public ones.

11. Interpreting the evidence through the lens of the data on teacher behavior and ability

The complementarities between effort, knowledge, and skills – what does it imply? Give examples from the RCT literature, including

- Strong evidence that teacher effort can be raised, leading to improved learning outcomes, by linking payments or tenure to performance. But incentives alone will likely not be enough given teachers' limited knowledge and skills
- Brining teachers to school is just the first step, because of high absenteeism from class once in school and significant time spent not teaching when in the classroom
- Contract teachers: More effort but less skills
- Effect sizes – std deviations – what does it mean in our setting – given the test we designed. Provide informative examples
- Program shown to work, even going to scale, like remedial education and literacy programs. One reason why they work is that they "automate" the teacher to follow rather simple tasks (just like some type of computer assisted learning. A "short run" solution, especially at early grades. But
    - We know little about how to effectively teach teachers how to teach "higher-order" tasks
    - We know little of how to improve pedagogy along the dimensions uncovered in the SDI, including
        - Having clearly structured lessons;
        - Having an appropriate mix of basic and higher-order tasks;
        - Being able to write lesson plans;
        - Being able to assess students' progress and give feedback

Table 1. Student Knowledge in 8 sub-Saharan countries

	All	Uganda	Kenya	Nigeria	Togo	Mozambique	Tanzania (2nd)	Tanzania (1st)	Senegal
Literacy									
Pupil can read a letter	63	72	89	50	72	38	58	46	79
Can read a word	54	58	82	21	57	21	63	54	74
Pupil can identify basic words	28	30	50	21	57	21	23	6	18
Pupil can ready sentence	31	35	71	18	16	13	32	12	51
Pupil can read paragraph	14	6	26	6	9	7	24	6	25
Pupil comprehension score	17	21	40	9	10	5	26	5	16
Numeracy									
Can regognize numbers	82	91	97	11	96	81	92	90	97
Can order numbers	51	46	71	20	49	20	91	43	66
Can do single digit addition	76	81	92	51	74	48	78	94	86
Can do double digit addition	56	53	82	30	61	18	60	70	77
Can add triple digits	53	53	85	20	61	8	59	64	78
Can do single digit subtraction	66	74	87	45	60	28	73	81	79
Can do double digit subtraction	30	24	59	18	16	5	38	40	39
Can multiply single digits	26	21	48	18	10	4	37	39	31
Can multiply double digits	9	1	5	3	3	0	11	13	39
Can multiply triple digits	5	1	1	2	3	0	9	8	19
Can do single digit division	33	34	57	18	30	9	38	39	41
Can divide double digits	15	11	33	9	7	3	18	16	20
Problem-solving: division	15	13	27	9	19	11	20	13	8
Problem-solving: multiplication	5	2	10	3	6	0	9	8	5
Complete a sequence	10	10	26	11	8	4	14	1	3

Table 2. Teacher Absence in 8 sub-Saharan countries

	All	Uganda	Kenya	Nigeria	Togo	Mozambique	Tanzania (2nd)	Senegal	Tanzania (1st)
Absence from class (%)	45	57	47	25	38	61	47	31	52
– Absence from school (%)	23	30	16	16	23	46	14	18	23
– Absence from classroom (%) ... ... conditional on being in school	28	39	37	11	22	29	39	13	31
Scheduled teaching time	5h 26mins	7h 13mins	5h 31mins	4h 44min	5h 28mins	4h 17mins	5h 54mins	4h 37mins	5h 43mins
Time spent teaching	2h 41mins	2h 56mins	2h 30mins	3h 10min	3h 15mins	1h 41mins	2h 57mins	2h 40mins	2h 16mins
Orphaned classrooms	48	52	44	52	48	55	37		
Observations	2527	319	239	458	147	203	387	387	387

Table 3. Teacher Knowledge in 8 sub-Saharan countries

	All	Uganda	Kenya	Nigeria	Togo	Mozambique	Tanzania (2nd)	Senegal	Tanzania (1st)
Subject content knowledge									
Equivalent to student Language curriculum	61	90	66	24	54	77	41	86	51
Minimum Knowledge Language	2	3	7	0	0	0	1	4	1
Minimum Knowledge Mathematics %	56	55	82	31	24	26	62	91	78
Pedagogy knowledge									
Minimum Knowledge General Pedagogy	10	6	10	1	4	4	36		
Minimum Knowledge Context of Learning	1	0	0	0	3	0	0		
Observations	2527	319	239	458	147	203	387	387	387

Table 4. Teacher Knowledge in 8 sub-Saharan countries

	All	Min	Max
% correct on grammar task	79	57	92
% correct on Cloze task	41	27	68
% correct on composition task	25	10	50
Double digit subtraction	77	59	87
Multiplying two digit numbers	71	49	87
Simple math story problem	56		
Venn diagram	43	18	72
Interpreting data in a graph	26	11	65
Logic puzzle	31		
Advanced math story problem	15		
Text comprehension: factual	42	23	64
Structuring: aims and learning outcomes	23		
Checking understanding: formulate question that recalls what was learned	15		
Checking understanding: formulate question that applies learned to other contexts	5		
Feedback and monitoring: Commenting on childrens’ work	22	12	33
Feedback and monitoring: Evaluating students’ progress	13	5	28
Observations	2527		

Table 5. Teacher skills in 8 Sub-Saharan African Countries

	All	Uganda	Kenya	Nigeria	Togo	Mozambique	Tanzania (2nd)
Structuring							
Teacher introduces and summarizes the topic of the lesson	40	29	63	57	29	16	46
Lesson appears planned to enumerate	63	36	77	64	65	71	67
Checking students' understanding							
Learning activity took place	95	98	92	88	100	100	94
One student is active (% of lesson)	32	32	39	18		32	38
Several students are active (% of lesson)	15	24	24	15		7	6
Teacher asks a mix of lower and higher order questions	32	48	33	39	25	14	32
Feedback							
Teacher gives positive feedback and praise, corrects mistakes	41	66	59	29	28	17	46

Table 6. Student Knowledge in Private and Public Schools

	Public	Private
Literacy		
Pupil can read a letter	63	93
Can read a word	54	86
Pupil can identify basic words	28	79
Pupil can ready sentence	31	71
Pupil can read paragraph	14	48
Pupil comprehension score	17	57
Numeracy		
Can regognize numbers	82	79
Can order numbers	51	71
Can do single digit addition	76	87
Can do double digit addition	56	76
Can add triple digits	53	80
Can do single digit subtraction	66	82
Can do double digit subtraction	30	52
Can multiply single digits	26	41
Can multiply double digits	9	18
Can multiply triple digits	5	11
Can do single digit division	33	55
Can divide double digits	15	33
Problem-solving: division	15	21
Problem-solving: multiplication	5	18
Complete a sequence	10	22
Non-verbal reasoning score	53	63

Table 7. Teacher Absence in Private and Public Schools (unweighted mean)

	Public	Private
Absence from class (%)	48	31
– Share accounted for by absence from school	23	13
–Share accounted for by absence from class, conditional on being in school	31	22
Scheduled teaching time	5h 34mins	6h 14mins
Time spent teaching	2h 35mins	4h 0mins
Orphaned classrooms	45	37

Table 8. Teacher Knowledge in Private and Public Schools (unweighted mean)

	Public	Private
Subject content knowledge		
Score Language	48	58
Equivalent to a good 4th grader: 80 %	62	70
Minimum Knowledge Language : 80 %	3	6
Score Mathematics	57	67
Minimum Knowledge Mathematics : 100 %	62	65
Pedagogy knowledge		
Score Pedagogy	25	30
Minimum Knowledge General Pedagogy	13	9
Minimum Knowledge Context of Learning	0	1

Table 9. Classroom instruction (unweighted)

	Public	Private
Teacher introduces and summarizes the topic of the lesson	43	49
Lesson appears planned to enumerate	65	66
Learning activity took place	94	96
One student is active	34	36
Several students are active	16	19
Teacher asks a mix of lower and higher order questions	31	41
Teacher gives positive feedback and praise	45	54