What Do Local Government Education Managers Do to Boost Learning Outcomes?

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Abstract

Decentralization reforms have shifted responsibility for public service delivery to local government, yet little is known about how their management practices or behavior shape performance. We conducted a comprehensive management survey of mid-level education bureaucrats and their staff in every district in Tanzania, and employ flexible machine learning techniques to identify important management practices associated with learning outcomes. We find that management practices explain 10 percent of variation in a district's exam performance. The three management practices most predictive of performance are: i) the frequency of school visits; ii) school and teacher incentives administered by the district manager; and iii) performance review of staff. Although the model is not causal, these findings suggest the importance of robust systems to motivate district staff, schools, and teachers, that include frequent monitoring of schools. They also show the importance of surveying subordinates of managers, in order to produce richer information on management practices.

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1   Introduction

There is increasing interest in the role that bureaucrats, including local government managers, play in public service delivery. This interest stems partly from the mixed success of decentralization reforms that swept across the developing world over the past three decades (Faguet and Pöschl, 2015).[1] The motivation for decentralization was that it would increase allocative efficiency and ignite bottom-up accountability, by shifting the locus of decision making (over services) closer to the beneficiaries (Ahmad et al., 2003; Oates, 1972; Tiebout, 1956). Contrary to this prediction, there is evidence that the quality of public service delivery actually deteriorated with decentralization in contexts of low state capacity, or high levels of poverty (Galiani et al., 2008; Hanushek et al., 2013). This evidence suggests that the quality of mid-level bureaucrats, who supervise service delivery, can affect the quality. This has inspired recent research examining the role of bureaucrats, in particular (Banerjee et al., 2020; Pepinsky et al., 2017; Rasul and Rogger, 2018; Rasul et al., 2019). But up to now, limited empirical work has been conducted in this area.

This paper describes what local government managers of education services do and explores whether, and which, management practices are associated with learning outcomes in Tanzania. For this purpose, we conducted a very detailed management survey in 2019 —taking inspiration from the World Management Survey (WMS) (Bloom and Van Reenen, 2007)— of District Education Officers (DEOs) and their staff in each of the 184 Local Government Authorities (LGA) in the country. The Tanzanian education system is decentralized and DEOs are responsible for implementing government policies at the LGA level, with an average of 97 primary schools per LGA. DEOs have limited *de jure* discretion at a school level, since central government decides on the curriculum, resource allocation, and the hiring, firing and promotion of teachers. However, they have substantial discretion in the supervision of schools, and how they manage the staff who directly report to them. For this reason, we also surveyed Ward Education Officers (WEOs), who report directly to the DEOs and act as a conduit of communication between the DEO and all schools in the Ward (there are typically 4-5 schools per Ward). By collecting information both from a cadre of staff that the manager supervises, we are able to make a more detailed observation of management practices than the typical manager focused survey. We then combine these survey results with rich sources of secondary data, including: student performance in national standardized exams in 2012 and 2019; 2002 census data; and data from a nationally representative household survey conducted in 2015.

We make a number of empirical contributions. First, we document considerable variation in DEO management practices. We also document positive and significant associations between aggregates of these measures that increases our confidence in the construct validity of the measures we fielded. We further

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[1] The World Bank estimated that 80-100% of all countries were in various stages of decentralizing by the end of the 20th century (Manor, 1999).

validate these measures by showing that a particular set of our measures of managerial behavior is higher in regions supported by two large donor programs focused on boosting related aspects of governance.

Second, we employ flexible machine learning methods to examine the importance of management practices in explaining variation in learning outcomes. Our model also includes historical socio-economic characteristics —such as employment rates, access to government facilities, parents' level of education, parents' investment in their child's education, and child anthropometric measures— and baseline academic performance of each LGA, all of which might be correlated with both current student test scores and current management practices. Given the limited number of observed units and the large number of managerial practices and indicators for socio-economic status, we use a random forest (RF) with permutation-based variable importance algorithm to perform feature selection. RF allows us to explore a wide range of predictors, even when the number of observations is less than the number of predictor variables, since only a subset of predictors are used to construct each tree in the ensemble. We use k-fold cross-validation to tune the parameters of the model, preventing over-fitting but ensuring the model provides a decent approximation of the data generating function. We isolate the subset of important features (i.e. the variables the model relied on most to make its prediction) by permuting each variable and assessing the drop in cross-validated R-squared. The approach provides a way of exploring which managerial practices matter most. Moreover, the tree-based models allow for the detection of complex interactions and higher order relationships, detecting managerial practices that may only be important under specific socioeconomic conditions.

We find that the observed variation in management practices explain about 10 percent of the overall variation in test scores. This magnitude is consistent with recent findings by Fenizia (2019) who notes that public sector managers in Italy explain 9 percent of overall productivity, although the empirical approach of this paper is very different.[2] In our analysis, management practices have less explanatory power than socio-economic factors (23 percent), or prior academic achievement (16 percent). Delving further into which particular practices influence learning outcomes, the three most important practices are: i) monitoring of schools by the WEO; ii) school and teacher incentives administered by the local government manager; and iii) performance review of WEOs. Although the model is not causal, these findings suggest the importance of having robust systems in place that motivate district staff, schools and teachers, including frequent monitoring of schools.

This paper joins a small but growing body of work documenting the managerial practices of middle tier bureaucrats and linking those practices to measures of service delivery. Previous work has shown a positive correlation between school-level management practices and student learning, or student value-added

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[2]The author exploits the rotation of managers, using a fixed effects model to "decompose productivity into the components due to office characteristics, manager effects, and time effects."

4

in learning (Bloom et al., 2015; Crawfurd, 2017; Leaver et al., 2019; Di Liberto et al., 2014). Building on these papers, a new avenue of research has sought to measure and explain the performance of public sector managers that work at a level below the central government and above frontline providers. Rasul and Rogger (2018) and Rasul et al. (2019), for example, examine the role of autonomy and incentives in strengthening civil servants' performance in Nigeria and Ghana, respectively. Other studies, that focus on education, have demonstrated that district superintendents can meaningfully shape school quality in their district (Lavy and Boiko, 2017; Meier and O'Toole Jr, 2002; Walter, 2018).

In addition to our empirical results, we make the following methodological contributions. First, we show the value of employing machine-learning techniques, which allows us to take a data-driven, a-theoretical approach to select the most important practices. Ordinary Least Squares (OLS) estimates are easier to interpret, but depend on the researcher's choice of control variables and construction of indices. Second, we demonstrate that interviewing the staff of mid-tier government managers, as well as the managers themselves, can provide important additional information on management quality.

The rest of the paper is organized as follows. In Section 2, we describe the institutional context in which managers operate. Section 3 describes the primary and secondary data used in the analysis. Section 4 presents the methods and results of the machine learning analysis to identify management practices that predict learning outcomes. We briefly discuss the findings and conclude in Section 5.

2   Context

Over the past three decades Tanzania has undergone a gradual process of decentralization, where responsibility for service delivery has shifted from central to local government, and now falls under a separate line ministry: the President's Office for Regional Administration and Local Government (PO-RALG) (Gershberg and Winkler, 2004). Tanzania is divided into 184 Local Government Authorities (LGAs), commonly known as districts, that represent the most important locus of authority and resources in service delivery, especially in education, health care, agricultural extension, local water supply, and roads. In this section we describe the organization of LGAs and the constellation of stakeholders, programs and policies that potentially shape the behavior of this important set of actors in the education system.

2.1   LGA Organization and DEO roles and responsibilities

Each LGA has a District Executive Director (DED), appointed by PO-RALG, who is the chief administrative officer in the district. The DED supervises a set of departments responsible for education, health, agriculture, water and roads services. For education, each LGA has a primary and a secondary school District Education Officer (DEO), who are respectively the department heads for primary and secondary education

services in the district. The median LGA has 95 primary schools, with a range from 13 to 275. Although their role is quite broadly defined, specific responsibilities include: monitoring of schools; communication with schools; ensure delivery and adherence to the curriculum; ensure quality teaching; administration of standardized examinations; coordination and communication with donors and local government; and transfer of resources such as textbooks. For the purposes of this paper, we focus on the primary school DEOs.

Despite their broad responsibilities for education service delivery, DEOs in fact have limited control over resources, and no control over the curriculum. Schools receive capitation grants directly from central government, which also decides the allocation of new teachers and directly remunerates teachers (Gershberg and Winkler, 2004). The allocation of other resources such as textbooks and instructional materials to schools is governed by formal rules.[3] Consequently, only about 5% of the overall LGA budget for the primary education department is directly under the discretion of the DEO (see Table A.1).

Nonetheless, there are key areas where DEOs have considerable discretion to influence education performance. First, they manage a cadre of staff who report directly to them. The office of the DEO is legally entitled to have, at a minimum, six staff members who report directly to the DEO (see Figure A.1). In addition, they manage Ward Education Officers (WEOs), who are required to visit primary and secondary schools in their Ward on a regular basis, and act as a conduit and communication channel between schools and the DEO. At the time of the survey, there were 3,915 Wards in the country (median number of 20 Wards per LGA), and typically four to five primary schools and one secondary school per Ward. DEOs have discretion in the tasks that they assign their staff —which could range from observing teachers in the classroom and distributing lesson plans to organizing of training— and there could be variation in how well they supervise and motivate their staff to perform these tasks.

Second, DEOs have informal control over whether and how much certain resources are deployed. At a very high level, DEOs play an important role both in the consultations, planning and implementation of education related local government capital development programs.[4] Moreover, they play a key coordination role with donor funded projects —which affords them some control over how and where donor resources are deployed in their LGA— and can exert pressure on the locally elected Ward Development Councils to mobilize the community to provide more resources to schools. Finally, they have power over the following areas of human resource management at a school level: approval of teacher transfers within the LGA, promotion opportunities for head teachers, teacher leave policies, and the allocation of a small pool of funding meant

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[3]Headteachers are required to submit information about the school annually to the Basic Education Management Information System (BEMIS) database, including textbooks needs. However, unlike capitation grants, DEOs receive those books from central government and administer the allocation to schools using BEMIS enrollment records (the current ratio is 1:3, with aspirations to make it 1 textbook per student).

[4]Local Government Development Grants pay for capital improvements identified by wards approved by the LGA District Council. They include payments for new infrastructure or renovations to existing infrastructure.

for teacher allowances. All of these enable an motivated DEO to generate teacher and school incentives for performance.

Third, even though the DEOs cannot make direct decisions over hiring and firing of teachers and head-teachers, they can exert substantial soft pressure on schools to increase professional accountability. They can direct their staff to closely supervise particular schools or teachers, and they can leverage their "bully pulpit" to publicly recognize well-performing schools or or shame badly-performing schools. For example, some LGAs hold annual award ceremonies to reward well-performing teachers, schools or WEOs; and some share rankings of school performance, based on average score in the Primary School Leaving Exam (PSLE), with all the head teachers in the LGA (Cilliers et al., 2020).

Note that lack of *de facto* decentralization is common in developing countries, where the delegation of the responsibilities to local government did not coincide with more authority or fiscal autonomy. For example, Figure 1 plots the relationship between two different measures of decentralization —administrative, or fiscal— and log GDP, using data constructed by Ivanyna and Shah (2012). Higher scores are associated with more decentralization. Tanzania ranks 77 out of 182 countries on the administrative decentralization index, lower than South Africa (ranked 62) but higher than Kenya (ranked 105). Tanzania's administrative decentralization score is low overall, but high relative to most other sub-Saharan African countries.[5] Its fiscal decentralization score is much lower and comparable to the majority of African countries. Tanzania ranks 104 out of 182 countries on the index of fiscal decentralization.

Figure 1: Relationship between decentralization and log GDP

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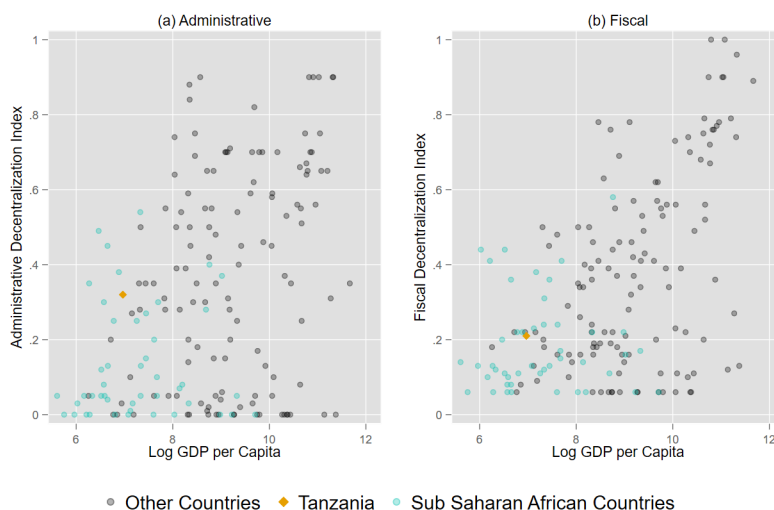
[5]Administrative decentralization is typically understood as an aggregate of three distinct features: deconcentration to lower levels of national government, delegation of responsibility to local government, and devolution to locally elected officials. The index created by Ivanyna and Shah (2012) focuses on control over hiring and firing decisions and regulation of local activities.

2.2 Donor Involvement in Tanzania

Multi-lateral and bi-lateral donors play a pivotal role in education sector programming in Tanzania, both as large contributors of new resources that shape DEO tasks and in defining education system objectives. Two large programs are the Education Quality Improvement Program in Tanzania (EQUIP-T) and Tusome Pamoja. Both were designed to enhance learning outcomes in lagging regions in Tanzania.[6] EQUIP-T operated in 9 out of the 26 regions in Tanzania over a six year period (2014-2020), covering 31 percent of schools in the country. Tusome Pamoja has operated in a different set of four regions in the country over a five year period (2016-2021), covering 16 percent of schools in the country. Each project has some discretion over which aspects of the education production process to address. One of the components of the EQUIP-T program was strengthening district planning and budgeting, with the goal of improving local education sector governance.[7] This included management training for WEOs, monthly meetings between WEOs, DEOs, and School Quality Assurance Officers, and providing motorbikes and stipends to WEOs (so that they could conduct monitoring visits and report to district offices). The program worked within the government's financing system, so all of the implementation funding was wired to the central government, who in turn transferred it to the LGAs to spend. Tusome also engages in a number of activities such as teacher training, training of WEOs on how to provide teacher professional development to teachers, and developing new materials related to basic skills instruction.

3   Data

3.1   Primary data collection

Between September and November 2019 we visited each of the 184 LGAs of mainland Tanzania and interviewed the primary school DEO and WEOs from two randomly selected wards in the LGA. The DEO survey instrument builds on the Development World Management Survey (D-WMS), originally developed by Lemos and Scur (2016) to survey officials in charge of managing schools and hospitals in developing countries. Prior to designing the instrument, we conducted unstructured interviews with DEOs and other education officials in four different LGAs, to help us better understand their day-to-day activities and management practices. These insights informed the creation of a management survey instrument relevant to the Tanzanian context which was further piloted and refined in six different LGAs.

In addition to adapting the instrument to the Tanzanian context, our approach is different to the standard D-WMS in three important ways. First, whereas the D-WMS requires enumerators to rate the managers

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[6]The regions were selected on the basis of their poor education performance and resource constraints.

[7]Other activities include: a) improved access to quality education; b) strengthened school leadership and management; c) stronger community participation and demand for accountability; and d) improved learning and dissemination.

on a 5-point scale along a series of different dimensions, we fielded each dimension as a series of yes/no questions. The purpose was to minimize enumerator discretion, since this forces them to separately judge each component that enters into the scale. See Table B.1 in the appendix for an example of the distinction between the two methods. Second, we drew a clear distinction between the DEOs' management of their staff and management of schools/teachers. To this end, we added questions on how the DEOs motivate schools and teachers to perform well. Third, the survey was conducted in person, rather than over the phone. This was necessary to secure the DEO's undivided attention for the 1-1.5 hour period required to complete the survey. There were ten LGAs where we were unable to survey the DEO, either because the DEO was away during the period of data collection, the DEO did not consent to be surveyed, or a new DEO had not yet been appointed.

The WEO survey included questions relating to the management practices of the DEO: setting targets, performance review, rewarding performance, and frequency of interaction with the DEO. We also asked how frequently they visit schools and about the activities that take place during the school visits. Given the proximity of WEOs to the schools, the WEO survey can provide a plausibly more reliable source of information on the actual monitoring activities that take place in the LGA as well as how the DEOs manage key staff.

We took the following steps to assure high-quality data collection and consistency in answers. First, two enumerators participated in the survey. One enumerator would ask the DEO open-ended questions while the other enumerator rated the management practices. The interviewer followed a clear script for both the open-ended questions and additional prompting questions to ask, if necessary. We decided to separate the two tasks to prevent the enumerator responsible for recording the DEO's responses from inadvertently asking leading questions. Second we trained enumerators extensively on the instruments, with several days spent exclusively on the DEO interview. For one training exercise, enumerators listened to and coded recordings of DEO interviews conducted during the pilot. Third, we recorded 115 out of the 174 DEO interviews that were conducted. Dar es Salaam-based survey supervisors, experts in the DEO survey, would listen to the recordings every evening and provide feedback/training to the DEO survey teams if they identified problems with the interviewing approach or how responses were coded. Appendix section B provides further details on our data quality assurance protocols.

For our descriptive and regression analyses, we construct each management practice score by simply taking the mean of all the indicators relating to a specific practice. Furthermore, we follow Bloom and Van Reenen (2007) and group the DEO practices into four categories, taking the mean of the z-score for each management practice. The categories include: setting targets, operations (budget, curriculum, training, and resource allocation), monitoring (collecting information, sharing performance indicators, documenting

9

problems), and incentives (reward schools and reward teachers). We use the same aggregation for the WEO survey, except that we draw a distinction between how they are managed by the DEOs (including targets, monitoring and incentives), and the tasks that they perform (including monitoring of schools).

3.2 Secondary datasets

This study draws on multiple sources of secondary data. First, we have data on every school's average performance in the Primary School Leaving Exam, from 2012 and 2019. The PSLE is a standardized national exam administered to all grade seven students in the country. The examined subjects are Mathematics, English Language, Science, Social Studies and Kiswahili.[8] Every student gets a score ranging between 0 and 250 (scoring up to 50 for each subject). We use this data both as an objective measure of managerial performance as well as (for prior years outcomes) a proxy for other time-invariant unobserved determinants of learning outcomes.

Second, we make use of two additional datasets, the 2002 Population Census and the 2015 Uwezo household survey, that capture the average socio-economic status of households in each LGA. This data allows us to control for socio-economic determinants of learning outcomes. We use the following variables from the 2002 Census: household head literacy rate, highest education in the household, unemployment, school enrollment, ownership of assets, and bucolic status. The 2015 Uwezo household survey was conducted with 197, 451 households, in 4, 750 villages in every LGA in the country. This dataset includes basic socio-economic characteristics such as the parents' level of education, employment status, wealth, income, asset ownership, access to water and electricity, and children's anthropometric measures. It also includes data on whether a child was enrolled at pre-school and whether the child goes to a public or private school. For each of the selected variables we construct the average at the LGA level, and merge these aggregates with the data from the management survey.[9]

3.3 Descriptive statistics

Section C in the appendix provides basic descriptive statistics of our sample, as well as a breakdown of the management practice scores captured in the WEO and DEO surveys. Out of a total of 184 LGAs, we were able to survey 174 DEOs and 363 WEOs. The DEOs are typically more educated than the WEO, and they mostly have a background in education: 62 percent of DEOs have previous experience as a teacher, compared to 71 percent for the WEO. Surprisingly the DEOs have limited experience in their current roles:

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[8]https://www.necta.go.tz/psle Accessed: June 9th, 2020.

[9]One challenge in merging is that the number of LGAs in the country has expanded by roughly 50 percent in the past decade. There were 132 and 159 LGAs in 2002 and 2015 respectively, compared to 184 in 2019. We overcame this problem by first merging at a ward level. For wards that never split, this allows us to determine which LGA a household would have belonged to, given the 2019 sub-divisions. For splitting wards, we assign the same aggregate measure of the mother ward in the earlier datasets.

the average years of experience of a DEO is 2.27, and over a quarter of them have less than a year of experience.

Figure C.1 further demonstrates that there is a large variation in all of the management practices. Moreover, an examination of the separate indicators (Tables C.3 to C.9) reveals that there is a wide range of initiatives taken by DEOs and tasks performed by WEOs that could conceivably improve learning, but these practices and tasks are not universally employed. For example, almost all DEOs reported at least one target, but fewer than 40 percent of them had well-defined strategies for reaching each target. Similarly, almost all DEOs reward schools/teachers for good academic performance, but fewer than 30 percent of them communicated these rewards *ex ante* to the teachers and schools. Surprisingly, 72 percent of DEOs indicated that teachers can receive financial rewards. 30 percent of DEOs organize award ceremonies in their LGA. There is also variation in how deeply the DEO engages with the information created by the WEOs: Almost all WEOs write reports, a smaller fraction (70 percent) share this with their DEO, and a smaller fraction (52.3 percent) believe that the DEO actually reads it, and an even smaller fraction (45.2) believe that the reports are acted upon.

Figure 2 shows the correlations between the main families of management practices, as measured in the DEO survey. There is a moderate degree of correlation between all the measures, but the magnitudes of the correlation are relatively small, ranging between 0.03 and 0.41. We observe moderate and statistically significant pairwise correlations between targets, operations and monitoring. The correlation between incentives and the other families is smaller.

Figure 2: Correlation matrix

Targets			
0.379***	Monitoring		
0.412***	0.349***	Operations	
0.159*	0.140	0.031	Incentives

* for p-values <.05, ** for p-values <.01, and *** for p-values <.001

Note. The correlations between the targets, monitoring, operations, and incentives family scores, respectively. Each family is the mean of the management practice scores. See Table B.2 for the management practices that constitute each family.

3.4 Validation

As a further test for the validity of our instruments, we document co-variation between management practices and donor-driven governance reform. Table 1 shows that the DEO management practices and activities performed by WEOs are different in the regions where two large donor-funded programs were operating the past five years (see section D in the Appendix for a more detailed discussion). The overall management score, as captured in the DEO survey, is 0.25 standard deviations (SD) larger in the Equip-T regions, compared to regions that are served by neither donor. There seems to be better target setting, operations, and monitoring, but weaker school/teacher incentives. Few of these outcomes are statistically significant at conventional levels of significance, but the magnitudes are large and we have limited statistical power given that there are only 26 regions in the country.[10] The difference is more stark in the WEO survey, with a difference in the overall score of 0.74SD, with the largest differences in access to resources (1.4 SD) and monitoring (0.78). Moreover, WEOs in *both* the donor-funded regions report performing more tasks overall, more activities when they visit schools, and have access to more resources. All of these impacts are consistent with the governance reform, resource transfer, and donor activities highlighted in Section 2.

4 Empirical strategy

We employ a random forest model to identify the managerial practices that are most predictive of academic performance. Our logic is that managerial practices that are predictive of good (bad) academic performance potentially improve (inhibit) the ways schools function and thus indirectly influence the students in these schools. Predictive power provides a useful starting point in determining *which* managerial practices matter. A random forest averages across many regression trees when making a prediction, where each tree leverages a random sub-sample of training data and variables. The advantage of the random forest over other modeling methods is that it can capture both non-linear relationships in the data and layered interactions, offering a better approximation of the data generating process. Moreover, by randomly sampling features when generating trees, a random forest reduces the influence of dominant features. This allows the model to explore different sources of variation in the training data more effectively.

Our outcome of interest is each LGA's average exam performance in the 2019. We also include in the model the socio-economic characteristics of each LGA, as captured in the 2002 census and 2015 household survey, as well as exam performance data from 2012.[11] In contrast to typical regression analysis, we do not pre-process the data to construct aggregate measures for each management practice and an index for

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[10]The donor-funded programs are implemented at a regional level, and we clustered our standard errors at this level.

[11]We do not include exam performance from more recent years, since recent exam performance could itself be a result of current management practices. In particular, the donor-funded programs that instated governance reforms were directly targeted at LGAs that performed badly in the PSLEs prior to 2014.

Table 1: DEO and WEO practices— by donor involvement

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Panel A. DEO Survey						
Overall	0.247	0.278	0.032	0.180	0.013	174
Targets	0.379	0.263	0.132	0.194	0.030	174
Operations						
Overall	0.299	0.218	0.172	0.182	0.019	174
Curriculum	0.443	0.204	-0.359	0.188	0.080	174
Resource Allocation	0.350	0.180	0.644	0.243	0.059	174
Teacher Allocation	-0.355	0.195	0.079	0.307	0.033	174
Training	0.258	0.242	0.025	0.208	0.015	174
Budget	0.085	0.227	0.061	0.279	0.002	174
Monitoring						
Overall	0.270	0.213	0.096	0.207	0.015	174
Collect Information	0.456	0.201	-0.225	0.169	0.066	174
Identify Problems	0.321	0.284	0.187	0.284	0.021	174
Number of Performance Indicators	0.120	0.181	0.339	0.197	0.014	174
Share Performance Indicators	-0.241	0.174	-0.066	0.124	0.012	174
Incentives						
Overall	-0.320	0.252	-0.381	0.127	0.029	174
Reward Schools	-0.296	0.237	-0.222	0.147	0.019	174
Reward Teachers	-0.254	0.213	-0.432	0.155	0.028	174
Panel B. WEO Survey						
Overall	0.739	0.183	0.591	0.164	0.183	184
Targets	-0.040	0.222	-0.067	0.201	0.001	184
Resources	1.401	0.162	1.329	0.113	0.601	184
Activities	0.368	0.124	0.320	0.152	0.056	184
Incentives						
Overall	-0.239	0.179	-0.084	0.169	0.020	184
Performance Review	-0.264	0.170	0.148	0.132	0.042	184
Performance rewarded	-0.091	0.134	-0.273	0.148	0.016	184
Monitoring (WEO)						
Overall	0.779	0.183	0.369	0.238	0.186	184
Meetings	0.807	0.161	0.480	0.250	0.219	184
Reporting	0.375	0.164	0.080	0.166	0.052	184
Monitoring (Schools)						
Overall	0.187	0.136	0.170	0.145	0.015	184
Number of Visits	-0.175	0.144	-0.273	0.163	0.021	184
Activities During School Visits	0.433	0.161	0.508	0.131	0.083	184

Notes. Each row represents a separate regression. Standard errors are clustered at the regional level.

socio-economic status; we rather include each indicator separately. This allows for the model to be as flexible as possible, and further reduces the discretion of the researcher.

When running the models, we first break up our managerial sample into a training (122 LGAs) and test (52 LGAs) dataset. We then employ k-fold cross-validation using the training data to tune the hyper-parameters of the random forest.[12] We then test the out-of-sample R^2 using the held out test data. Our best performing model yields an out-of-sample R^2 of 46.93%, providing support that model offers a good approximation of the data generating process.

In addition to testing for predictive accuracy, we leverage interpretable machine learning techniques to determine (i) variable importance and (ii) functional relationships. The former determines which variables matter to the prediction task, whereas the latter captures how those variables relate to the outcome (i.e. the marginal effect). Variable importance (VI) captures the extent to which the model relies on a particular variable when making a prediction. If a variable is deemed "important", then excluding that variable from the model results in a *reduction* in predictive accuracy. Variable importance offers a way to look through the "eyes of the model" to see which variables it relied on to make its prediction. We rely on a model agnostic technique that uses permutations to calculate variable importance. The method takes the training data X^{train} and outcome y^{train}, a trained model $\hat{f}(X^{train})$, and error measure $L(y^{train}, \hat{f}(X^{train}))$ — which in our case is the model fit (R^2) — as input. We then isolate a variable j in X^{train} and permute the order of the variable for all i observations, effectively breaking the association between X_j^{train} and y^{train}.[13] If $L(y^{train}, \hat{f}(X_{j-permuted}^{train})) < L(y^{train}, \hat{f}(X^{train}))$, then we can conclude that j is important to the model in generating its prediction. In other words, we scramble each variable, one at a time, and see if the model can still predict accurately without it. If not, then we conclude that the variable was important in generating the models prediction.

We can calculate the magnitude of that importance as Equation 1

$$VI_j = L(y^{train}, \hat{f}(X^{train})) - L(y^{train}, \hat{f}(X_{j-permuted}^{train})) \tag{1}$$

where the importance of variable j for model $\hat{f}(X^{train})$ is determined by the reduction in predictive accuracy between the permuted and non-permuted models. We repeat this process for all p variables contained within the training data, $j \in 1, 2, \ldots, p$. Given that the permutations are random, we permute each j variable

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[12]Specifically, we tune the `mtry` (i.e. the number of variables that are randomly selected when constructing each tree in the Random Forest Ensemble) and `trees` (i.e. the number of trees generated and then averaged across, in essence, the forest that is generated.) parameters, which determine the random number of variables that are selected when building each tree, and the number of trees used to build each forest. We hold all other hyperparameters at their default values. We use the `ranger` package using the `R` statistical programming language (Wright and Ziegler, 2017). We use 5 folds when generating the cross-validation samples.

[13]See Fisher et al. (2018) for more information on the permutation-based variable importance.

multiple times, generating a distribution for every VI_j. Thus, we report the variable importance both as a point estimate reflecting the average variable importance across all permutations, and an interval, reflecting the 95% interval of the VI_j. Finally, we report the variables in terms of importance in decreasing order.

We innovate on the permutation-based variable importance technique by introducing the idea of a "cluster" permutation. As noted previously, many of the managerial practices captured in the survey fall within general categories, such as training, curriculum, budgeting, etc. These categories, or clusters, are not composed of any one managerial practice, but rather many. To understand the importance of a specific managerial practice, we propose permuting *all* variables associated with that strategy to assess its importance when generating a prediction. If $X_c^{train} \subseteq X^{train}$ where $c = 1, \ldots, C$ and C is the total number of variable clusters, then the cluster variable importance is determined by Equation 2.

$$VI_c = L(y^{train}, \hat{f}(X^{train})) - L(y^{train}, \hat{f}(X_{c-permuted}^{train}))$$

(2)

The key difference between Equation 1 and Equation 2 is that more than one variable is permuted at a time. Likewise, we permute a cluster multiple times to generate an estimate of the variation in VI_c. We view the cluster variable permutation (hereafter "CVI") approach as being superior to standard dimension reduction techniques as it (*a*) does not require us to discard information and (*b*) allows for interpretation by further unpacking the variables contained within the cluster.

5   Results

Figure 3 shows the cluster variable importance for the socio-economic and management variables, as well as variable importance of the 2012 average test scores. The R^2 decreases by 0.1 when the managerial variables are permuted, relative to a reduction of 0.23 and 0.16 respectively when the socio-economic variables or the 2012 test scores data are permuted. The management practices thus account for 10 percent of the variation in test scores, even after accounting for the contribution of socio-economic characteristics and historical exam performance of a LGA to current performance.

Figure 4 shows the cluster variable importance of the different managerial practices that are most predictive of performance. The three most important managerial practices are: (i) school visits, as reported by the WEO, (ii) school and teacher incentives provided by the DEO, and (iii) performance review of the WEO. It is noteworthy that two of the three most important practices are captured by the WEO survey, rather than the DEO survey. These results highlight a methodological contribution of this study: the importance interviewing managers' staff, and not only the managers themselves, in order to capture relevant aspects of managerial quality. Together, these results suggest that rewarding performance —either teachers, schools,

Figure 3: Variable importance for the three main variable subsets
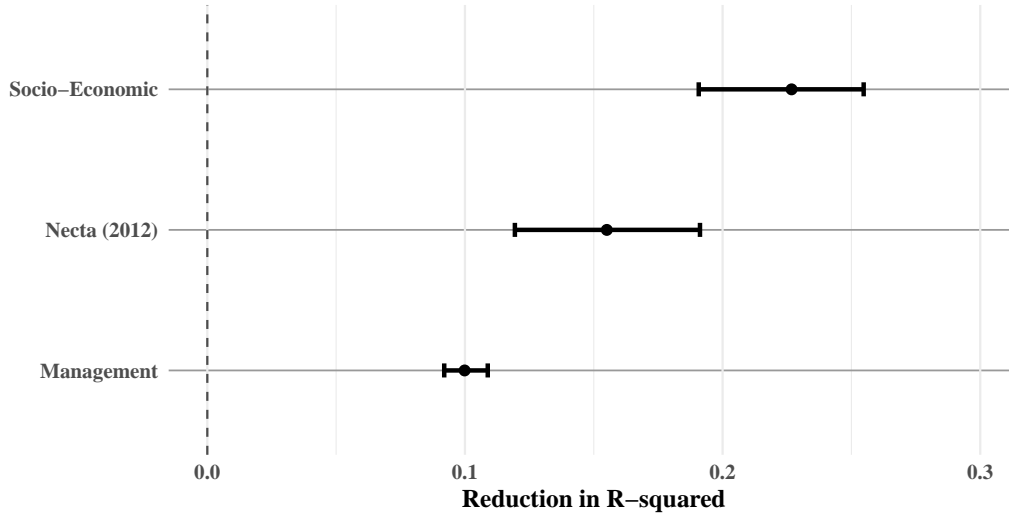
The figure plots the cluster variable importance for the two main categories of variables —socio-economic factors and management practces— and variable importance for LGA-level average performance in the 2012 NECTA standardized exam. The points captures the average CVI for each cluster (or average VI for NECTA (2012), and the bars reflect the 95% interval of the permuted distribution.

or WEOs— and monitoring of schools are two key ingredients to management practices that improve school performance, at least in the Tanzanian context.

Figure 5 presents the partial dependencies for each composing variable for each of the three practices with the highest CVI: the marginal effect of a variable on the predicted outcome (Zhao and Hastie, 2019). The bar plots capture the predicted change in the outcome when changing the specific variable from the minimum to the maximum value. The line plots capture the marginal predicted values for each variable. All features have been transformed to have a minimum value of 0 and a maximum value of 1. In terms of school visits, the number of times that a WEO has visited a school is the strongest predictor of performance. Moving from the least to the most number of visits changes the predicted test score by of roughly 0.03 standard deviations. In terms of performance review of the WEO, whether the DEO actually discussed the performance measures is the strongest predictor for performance. Turning to incentives, whether performance incentives are based on objective indicators is highly predictive, but whether the incentives are financial in nature or not, is not. The relationships identified in Figure 5 are not causal, but they are intuitive and point to future experimental work to test for causal relationships.

6 Discussion and conclusion

This study examines the contribution of mid-tier government education managers to the quality of education in their district. For this purpose, we conducted a detailed management survey on all DEOs in

Figure 4: Cluster variable importance of DEO managerial practices and WEO activities
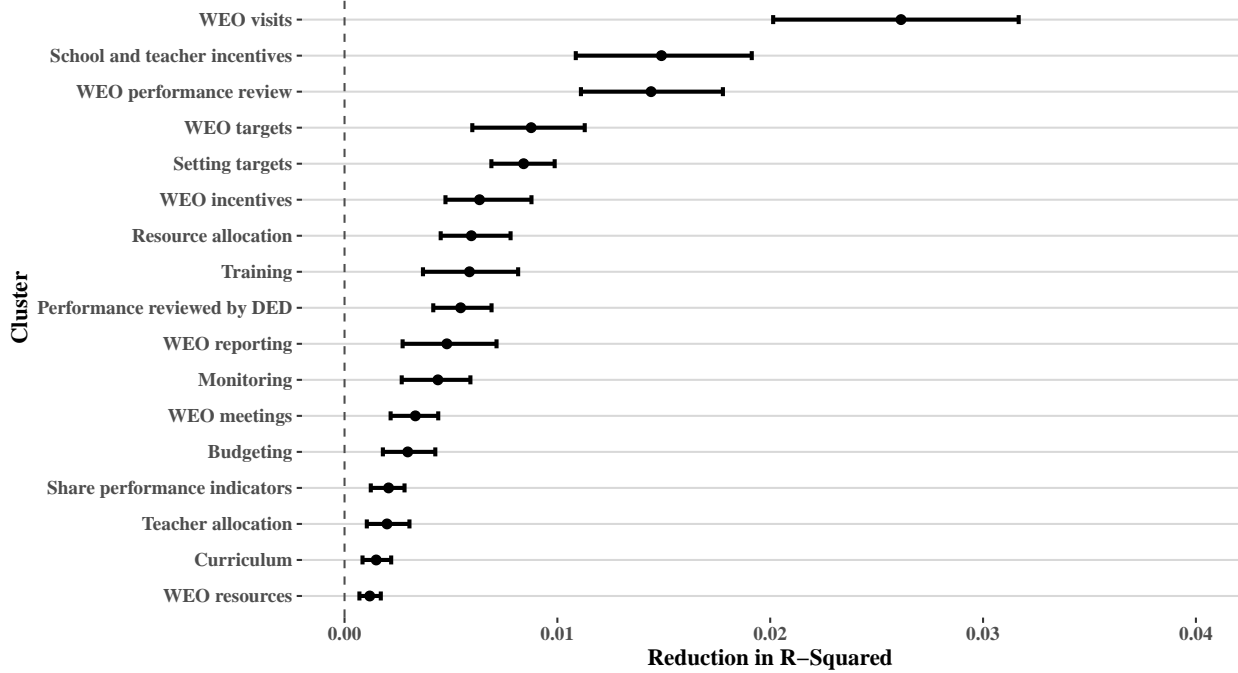
The figure plots the cluster variable importance for each management practice, including data from both the DEO and WEO surveys. The points captures the average CVI for each cluster, and the bars reflect the 95% interval of the permuted distribution. See Tables C.3 to C.9 for the indicators for each management practice.

Tanzania, as well as a random sample of key staff stationed close to schools— the WEOs. We then link this with socio-economic attributes and exam performance data and use machine learning techniques to identify the attributes that are the strongest predictors of performance. There are three main findings. First, we find that the management practices explain 10 percent of the variation in academic performance. Second, we find that behaviors measured in the WEO survey are most predictive of learning, especially the number of times that WEOs visit a school. The other management practice that is highly predictive is the existence of a robust reward system for well-performing schools, teachers, and WEOs. These results demonstrate the value of surveying managers' staff, as well as the managers themselves, in order to get a more accurate picture of the quality of managerial practices. They also show the merits of using machine learning techniques in observational data when the number of predictors is larger than number of observations.

Of course, all of the results of this study are from observational data and cannot have a causal interpretation. Yet, they are consistent with previous experimental or quasi-experimental studies on school and teacher incentives. Previous studies have shown that increased monitoring of schools and teachers is associated with improved school performance (Muralidharan et al., 2016), especially if combined with financial incentives (Cilliers et al., 2018; Duflo et al., 2012). Similarly, rewarding well-performing schools have been shown to

Figure 5: Partial dependencies of the top 3 managerial practices
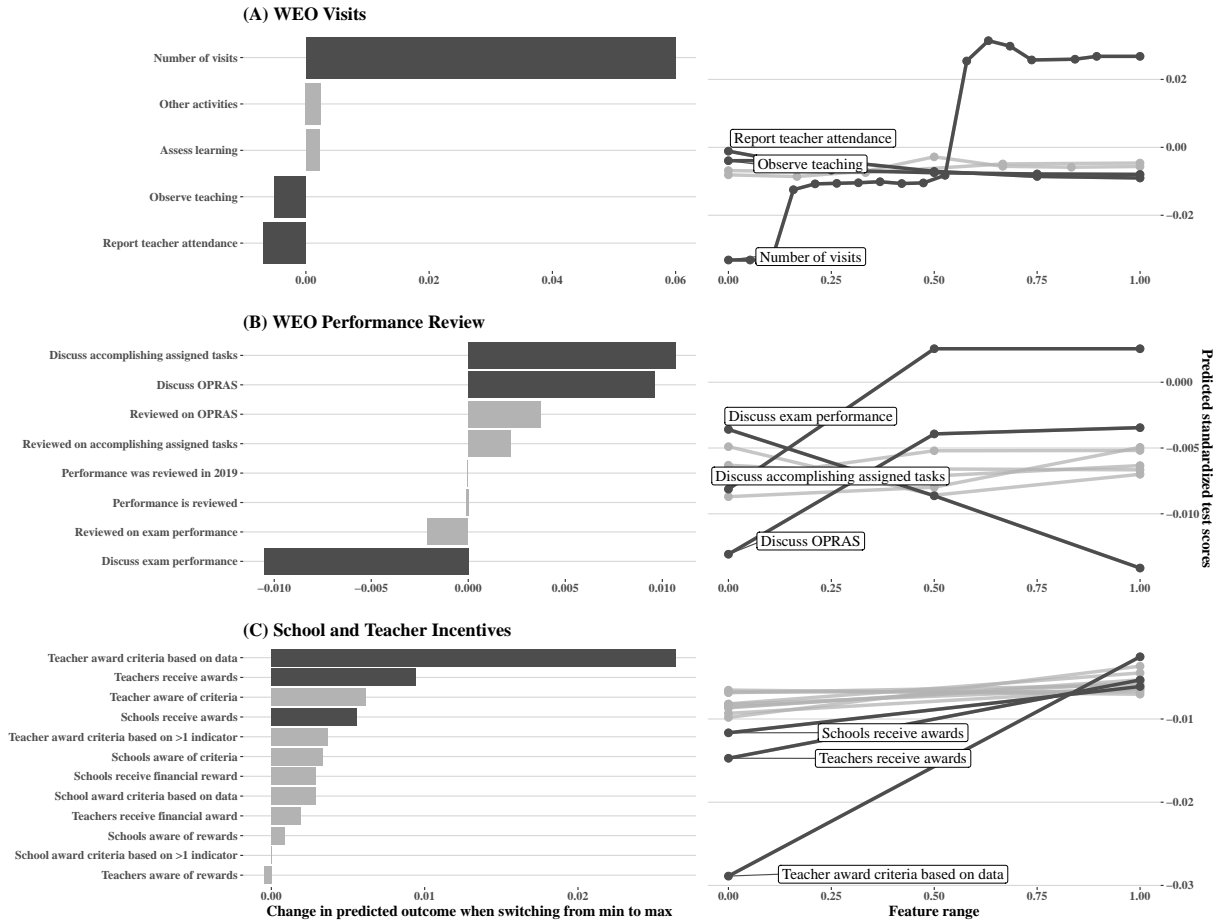
The figure reports the partial dependencies (marginal effects) for each of the three practices with the highest CVI reported in Figure 4. Each panel (A, B, and C) capture a different managerial strategy. The bar plots capture the predicted change in the outcome when changing the specific variable from the minimum to the maximum value. The line plots capture the marginal predicted values for each variable. All features have been transformed to have a minimum value of 0 and a maximum value of 1. For each panel, the variables with the largest net change are highlighted in both graphs. These variables reflect the tactics that matter most for each strategy.

improve school performance in Tanzania, even if not combined with explicit financial incentives (Cilliers et al., 2020); and teacher incentives have been shown to improve student learning in Tanzania (Mbiti et al., 2019).

A key policy implication of this study is that Tanzania's close-to-school district staff, the WEOs, are an under-utilized resource, and there could be high returns to improved management and task assignment. Their job description enables them to visit schools on a regular basis, and thus also monitor schools and teachers during their visits. Similarly, the fact that school performance is higher in LGAs where there is more substantive performance review suggests that a more succinct framework for which performance measures to discuss and how to do so could yield gains in performance. Future experimental work can test

if exogenous improvements in the management practices and WEO activities highlighted in this study can improve student learning.

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ONLINE APPENDIX

Contents

1

Appendix A   Context

Table A.1: Budget for the 2016/17 fiscal year (per school)

	Tanzanian Shillings	US Dollars
Other charges	381,815	166
Capitation	3,448,416	1,500
Special schools	1,003,520	436
Travel for leave	760,755	331
Moving expenses	1,022,973	445
Senior teacher allowance	429,984	187
Total	7,047,463	3,065

Note. Total per-school LGA budget in the 2016/17 fiscal year by line item. "Other charges" refers to discretionary budget under the control of the DEO. The DEO does not have control over the dispersement of capitation grants.

Figure A.1: Reporting structures in each LGA
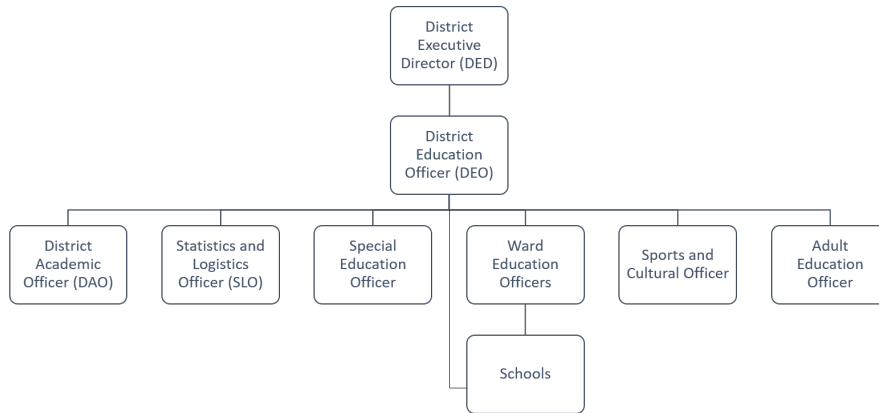
Note. WEOs and at least six additional staff members report directly to the DEO. The DEO, in turn, reports to the District Executive Director.

Appendix B   Additional Information on data collection

Given the complexity of the DEO survey and its unique interviewing mode, we took special measures to ensure data quality. The data quality assurance process began with enumerator selection. We hired enumerators who had prior experience conducting a survey of public sector officials modeled on the D-WMS. These enumerators helped implement the pilot and provided critical feedback to the research team on the questionnaires and DEO survey protocol. They had the conceptual knowledge and relevant prior experience to guide novice enumerators during the training and in the field.

Prior to field launch, we trained enumerators extensively on the instruments, with several days spent exclusively on the DEO interview. For one training exercise, enumerators listened to and coded recordings of DEO interviews conducted during the pilot. We reviewed these recordings to clarify complex or confusing concepts in the DEO survey. These recordings were supplemented by frequent quizzes that tested enumerator knowledge and assessed progress. In these quizzes, the research team would provide examples of DEO responses and ask enumerators to classify or characterize those responses in the way that the survey instrument required. We selected enumerators who displayed the best understanding on these quizzes as the "recorders" for the DEO interview (the role on the team that required the most enumerator discretion). The training included one day of fieldwork in education offices in Dar es Salaam and a debrief.

Beyond the measures outlined above, we implemented standard field data quality assurance measures such as backchecks (shortened surveys) conducted on a randomly selected subsample of respondents and daily high-frequency checks throughout collection. We used backcheck and high-frequency check discrepancies to identify concepts or questions that needed further clarification and monitor the effectiveness of particular enumerators. We shared the key findings of these checks with the team supervising enumerators on a daily basis - and they in turn communicated feedback to individual enumerators (or the entire team for common errors).

Table B.1: Example of Distinction Between Our Survey Instrument and the D-WMS Survey Instrument

Example Scoring Grid for the Development World Management Survey (taken from Walter, 2018)

		Our Survey Instrument				
		Do schools in this district follow a standardized curriculum based on national mandates?	Does the DEO take steps to ensure that schools prepare lesson plans or schemes of work?	Does the DEO and his/her staff coordinate and develop lesson plans together with the schools?	Does the directorate share a standardized template for the lesson plans with the schools? For all grades and subjects?	Does the DEO instruct his staff to monitor schools to make sure that teachers are developing lesson plans and schemes of work?
1	Schools do not follow a curriculum, and do not prepare teaching plans					
1.5	Schools follow a standardized curriculum based on state and national mandates (without flexibility or initiative to take into account local contexts and adapt the curriculum to their needs), and use textbooks provided by the government. Schools do not prepare teaching plans.	●				
2	Schools follow a standardized curriculum based on state and national mandates (without flexibility or initiative to take into account local contexts and adapt the curriculum to their needs), and use textbooks provided by the government. Teaching plans for the different grades are developed at some schools, but not at others. Plans are not compared and synchronized across schools.	●				
2.5	Schools follow a standardized curriculum based on state and national mandates (without flexibility or initiative to take into account local contexts and adapt the curriculum to their needs), and use textbooks provided by the government and may use other materials. Teaching plans for the different grades are developed at some schools, but not at others. Head teachers and DEO officers sometimes have informal conversations about these plans.	●	●			
3	Schools follow a standardized curriculum based on state and national mandates (without flexibility or initiative to take into account local contexts and adapt the curriculum to their needs), and use textbooks provided by the government and other useful resources. Head teachers and DEO officers coordinate and develop teaching plans together based on a range of resources available at the schools (not only textbooks) to ensure that there is consistency/standardization across schools and years.	●	●	●		
3.5	Schools follow a standardized curriculum based on state and national mandates (with some flexibility or initiative to take into account local contexts but not to adapt the curriculum to their needs), and use textbooks provided by the government and other useful resources. Head teachers and DEO officers coordinate and develop teaching plans together based on a range of resources available at the schools (not only textbooks) to ensure that there is consistency/standardization across schools and years.	●	●	●	●	
4	Schools follow a standardized curriculum based on state and national mandates (with some flexibility or initiative to take into account local contexts and adapt the curriculum to their needs), and use textbooks provided by the government and other useful resources. Head teachers and DEO officers coordinate and develop teaching plans together based on a range of resources available at the schools (not only textbooks) to ensure that there is consistency/standardization across schools and years.	●	●	●	●	

Note: We broke down the D-WMS scale into a series of binary variables that relate to each management practice (e.g., curriculum), and then adapted it to focus on activities under the discretion of the DEO. Dots represent areas of overlap between the survey instruments. The prompting questions asked for this set of questions are: "How do you ensure that students of a given grade in different schools are learning the same topics in the same way within a similar timeframe?"; and "How do you make sure that the teachers are well prepared and teaching according to the curriculum?'"

Table B.2: Summary of management practices and activities captured in the surveys

	Family	Management practice	No. indicators
	DEO survey		
1	Targets	District targets	14
2	Monitoring	Collection of Information	6
		Identifying problems	5
		Performance indicators	1
		Sharing Performance Indicators	4
3	Incentives	Reward School Performance	10
		Reward Teacher Performance	12
4	Operations	Curricular Guidance	5
		Budgeting	3
		Resource Allocation	7
		Teacher Allocation	7
		Training	5
	WEO Survey		
1	Targets	WEO Targets	7
2	Monitoring (WEO)	Meetings with DEO	6
		Reporting to DEO	5
3	Monitoring (Schools)	No. of school visits	1
		Activities during school visits	11
4	Incentives	Performance Review by DEO	8
		Performance Rewarded by DEO	6
5	Other	No. of tasks	7
		Resources	8

Appendix C Descriptive Statistics

Tables C.1 and C.2 provide some basic descriptive statistics of our sample, including demographic characteristics of our survey respondents in our sample, as well as the examinations, Census, and Uwezo data. Figure C.1 shows histogram plots of the families of management practices, as captured during by the DEO survey. Figure C.2 shows the same for the WEO survey, as well as the total number of times a WEO visited a school in the past two weeks, and the number of activities performed during these visits. Tables C.3 to C.9 show the mean score for each indicator that constitute these scores. There is clearly large variation in all of these management practices, variation in the activities initiated by the DEOs, and variation in the tasks performed by the WEOs. Key insights include:

1. **DEO Targets.** (Table C.3) All DEOs have at least one target, and most of them are focused on student learning: for 19 percent of DEOs the pass rate in the PSLE exam is their main target, and for another 47 percent pupil learning (not specified) is the main target. However, only 67 percent of DEOs discussed practices they have to meet these targets.

2. **DEO Operations.** (Table C.4) Almost all DEOs distribute resources such as textbooks in a systematic way, following government guidelines. But only half of DEOs indicated that they go beyond government guidelines to address specific needs faced by schools in the district. Almost all DEOs report following the standard government curriculum, but a smaller fraction (35 percent) go further in helping teachers develop lesson plans and schemes of work. An even smaller fraction of DEOs actually organize training for teachers (26 percent) or head teachers (21 percent).

3. **Rewarding school and teacher performance.** (Table C.6) Almost all DEOs reported to reward schools/teachers for good academic performance, but fewer than 30 percent of them communicated these rewards *ex ante* to the teachers and schools. Surprisingly, 72 percent of DEOs indicated that teachers can receive financial rewards. 30 percent of DEOs organize award ceremonies in their LGA.

4. **WEO targets.** (Table C.7). Almost all WEOs have their own targets, and the target is almost always student learning in the schools in their wards. More than half of WEOs have a specific target for exam performance.

5. **Monitoring by the DEO** (Table C.8). There is variation in how deeply the DEO engages with the information created by the WEOs . Almost all WEOs write reports, a smaller fraction of (70 percent) share this with their DEO, and a smaller fraction (52.3 percent) believe that the DEO actually reads it, and even smaller fraction (45.2) believe that the reports are acted upon.

6. **Monitoring by the WEO.** (Table C.8). WEOs interact frequently with schools —they visited four schools on average in the past two weeks— but there is variation in what they do when they visit the schools. 63 percent check teacher attendance, 42 percent actually record teacher attendance, 41 percent observe teaching in the classroom, 45 percent assess student learning, but only 4 percent record student learning. This information is therefore unlikely to flow back to the DEO.

7. **Performance review and rewards by DEO.** (Table C.9). 82 percent of WEOs state that they can get rewarded if they perform well, and 75 percent believe that the reward system is fair. The most common type of award is a bonus. This is surprising, since there are no official performance pay mechanisms in PO-RALG, and DEOs have a small discretionary budget.

Figure C.1: Distribution of management scores by family — DEO survey

(a) Targets

(b) Monitoring

(c) Operations

(d) Incentives
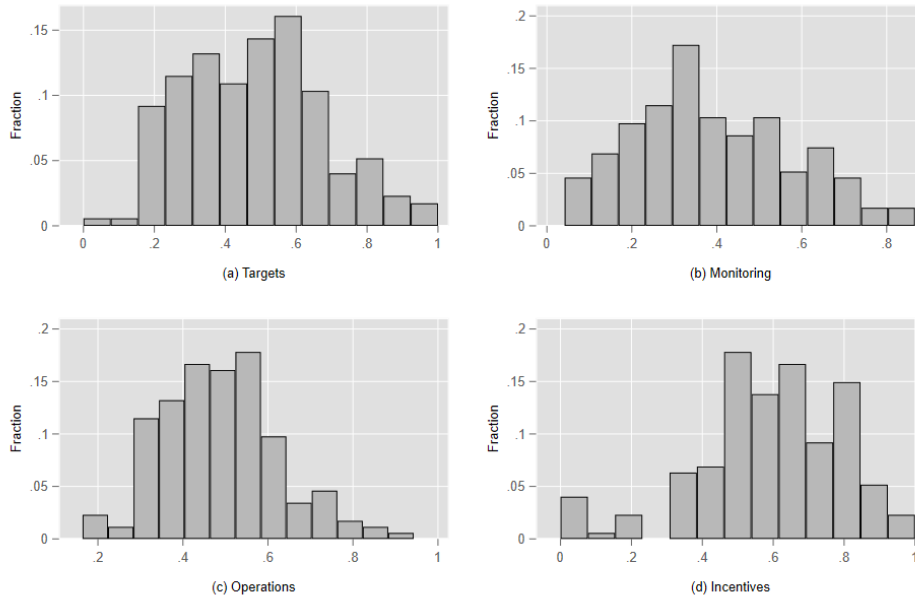
Table C.1: Basic Descriptive Statistics of the Sample

	Mean	Standard Deviation	Min	Max	N
DEO Survey					
Age	49.42	4.92	35	60	170
Male	0.68	0.47	0	1	174
Years of Experience in Role	2.24	2.64	0	17	174
At Least 1 Year of Experience	0.74	0.44	0	1	174
Has Masters Degree	0.65	0.48	0	1	173
Experience - Teacher	0.64	0.48	0	1	174
Experience - Head Teacher	0.47	0.50	0	1	174
Experience - WEO	0.25	0.43	0	1	174
WEO Survey					
Age	43.10	7.10	30	60	363
Male	0.74	0.44	0	1	363
Years of Experience in Role	3.13	2.94	0	22	363
At Least 1 Year of Experience	0.84	0.37	0	1	363
Has Masters Degree	0.20	0.40	0	1	363
Experience - Teacher	0.85	0.35	0	1	363
Experience - Head Teacher	0.61	0.49	0	1	363
Experience - WEO	0.20	0.40	0	1	363
Examinations Data					
Exam Performance, 2019	133.96	14.29	101	177	184
Schools Per Ward	4.54	2.29	1	28	3,914
Schools Per District	96.67	43.24	13	275	184
Wards Per District	21.27	7.60	6	42	184
2005 Census Data					
Ward Illiteracy Rate (%)	37.95	12.81	8	75	184
Dependency Ratio	1.72	0.26	1	2	184
Highest Education Level in Household	6.64	0.98	4	10	184
Households Where Head is a Paid Employee (%)	10.62	9.35	2	49	184
Household Heads With Livestock (%)	2.20	7.89	0	77	184
Households Owning a Radio or Telephone (%)	53.21	14.38	18	89	184
Households Using Electricity for Lighting (%)	7.03	11.52	0	60	184
Households Using Unprotected Wells for Drinking Water (%)	29.98	21.04	0	91	184
Household Members Who Are Unemployed (%)	7.85	2.07	2	13	184
Household Members in School (%)	21.41	5.26	4	37	184
Schools in Rural Areas (%)	69.94	25.58	0	100	184
Schools in Semi Urban Areas (%)	22.09	17.38	0	80	184
Schools in Urban Areas (%)	7.98	18.45	0	100	184

Note. Data from the DEO survey, WEO survey, PSLE examinations data and Census respectively. See Table C.2 for the descriptive statistics of the Uwezo data.

Table C.2: Descriptive Statistics — Uwezo District-Level Data

	Mean	Standard Deviation	Min	Max	N
Household Head Female	0.24	0.08	0	1	174
Household Head Education: None	0.18	0.11	0	1	174
Household Head Education: Some Primary	0.69	0.09	0	1	174
Household Head Education: Some Secondary	0.11	0.07	0	0	174
Household Head Education: Post Secondary	0.02	0.03	0	0	174
Home Language: Kiswahili	0.50	0.33	0	1	174
Home Language: English	0.01	0.00	0	0	174
Home Language: Native Language	0.50	0.33	0	1	174
Household Size	5.73	0.96	4	8	174
Number of Children in Household	2.85	0.64	2	4	174
Wealth Quintile 1	0.19	0.12	0	1	174
Wealth Quintile 2	0.19	0.08	0	0	174
Wealth Quintile 3	0.20	0.05	0	0	174
Wealth Quintile 4	0.19	0.06	0	0	174
Wealth Quintile 5	0.23	0.17	0	1	174
Household Has Access to Electricity	0.37	0.18	0	1	174
Household Has a Toilet	0.86	0.16	0	1	174
Household Owns a Bicycle	0.42	0.19	0	1	174
Household Owns a Camel	0.00	0.00	0	0	174
Household Owns a Motor Vehicle	0.02	0.03	0	0	174
Household Owns a Cart	0.04	0.06	0	0	174
Household Owns Cattle	0.24	0.20	0	1	174
Household Owns a Computer	0.02	0.03	0	0	174
Household Owns a Donkey	0.03	0.09	0	1	174
Household Owns a Motorbike	0.10	0.04	0	0	174
Household Owns a Phone	0.72	0.13	0	1	174
Household Owns a Radio	0.58	0.13	0	1	174
Household Owns Sheep/Goats	0.26	0.19	0	1	174
Household Owns a TV	0.16	0.16	0	1	174
Asset Wealth Index	0.27	0.08	0	1	174
Lighting: Electricity	0.16	0.19	0	1	174
Lighting: Solar	0.21	0.13	0	1	174
Lighting: Gas	0.00	0.00	0	0	174
Lighting: Paraffin	0.45	0.18	0	1	174
Lighting: Other	0.18	0.16	0	1	174
Wall Material: Mud	0.49	0.28	0	1	174
Wall Material: Polythene	0.00	0.00	0	0	174
Wall Material: Iron Sheet	0.04	0.04	0	0	174
Wall Material: Timber	0.01	0.03	0	0	174
Wall Material: Stone/Bricks	0.46	0.28	0	1	174
Water Source: Rainwater	0.02	0.05	0	0	174
Water Source: River/Lake	0.12	0.12	0	1	174
Water Source: Well	0.38	0.22	0	1	174
Water Source: Tap	0.38	0.24	0	1	174
Water Source: Spring	0.10	0.12	0	1	174

	Mean	Standard Deviation	Min	Max	N
Income Source: Formal Wage	0.04	0.05	0	0	174
Income Source: Transfers	0.01	0.01	0	0	174
Income Source: Own Business	0.15	0.14	0	1	174
Income Source: Farming	0.70	0.24	0	1	174
Income Source: Casual Wage	0.06	0.05	0	0	174
Income Source: Homemaker	0.01	0.01	0	0	174
Income Source: Pension	0.01	0.01	0	0	174
Income Source: None	0.01	0.02	0	0	174
Meals Accompanied By: Fruits	0.10	0.07	0	0	174
Meals Accompanied By: Vegetables	0.64	0.15	0	1	174
Meals Accompanied By: Milk	0.09	0.08	0	1	174
Meals Accompanied By: Mikunde	0.18	0.12	0	1	174
The Color of the Salt Has Changed to Blue	0.77	0.23	0	1	174
Read to Child Last Week	0.28	0.09	0	1	174
Discuss Performance With Teacher	0.40	0.14	0	1	174
Checked Homework	0.66	0.12	0	1	174
Number of Pre-Primary School Age Kids	0.35	0.04	0	0	174
Number of Primary School Age Kids	0.61	0.04	0	1	174
Mother Is Younger Than 25	0.09	0.04	0	0	174
Mother Is 25-35 Years Old	0.43	0.06	0	1	174
Mother Is Older Than 35	0.47	0.08	0	1	174
Mother's Education Level: None	0.23	0.13	0	1	174
Mother's Education Level: Primary	0.71	0.11	0	1	174
Mother's Education Level: Secondary	0.06	0.05	0	0	174
Mother's Education Level: College	0.01	0.01	0	0	174
Mother's Education Level: University	0.00	0.01	0	0	174
Paid Private Tuition	0.13	0.10	0	1	174
Child Has Never Enrolled in School	0.24	0.09	0	0	174
Child Went to Preschool Before Class One	0.64	0.16	0	1	174
Child Reports Being Enrolled in School	0.72	0.10	0	1	174
Preschool Attendance Status	0.10	0.04	0	0	174
Public School	0.38	0.08	0	1	174
MUAC Indicates Severe Acute Malnutrition	0.02	0.02	0	0	174
MUAC Indicates Moderate Acute Malnutrition	0.02	0.01	0	0	174
MUAC Indicates Risk for Acute Malnutrition	0.03	0.02	0	0	174
MUAC Indicates Well Nourished Child	0.84	0.05	1	1	174

Note: MUAC refers to Mid-Upper Arm Circumference.

Figure C.2: Distribution of management practice scores and activities (WEO survey)
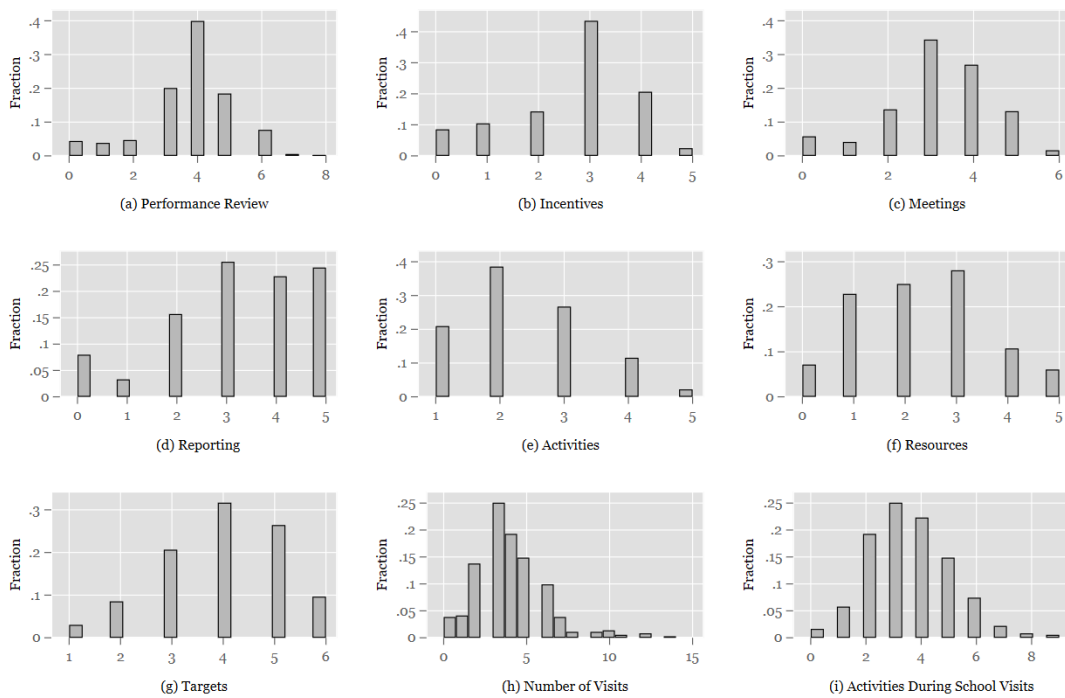
Note. Distribution of the total numbers of indicators met by each WEO by strategy. Number of visits and activities performed during school visits are reported separately.

Table C.3: DEO Practices — Targets and Monitoring by DED

	Mean	Standard Deviation
Targets		
At least one target	0.99	0.08
More than one target	0.26	0.44
At least some targets are specific	0.43	0.50
All targets are specific	0.17	0.37
Strategy for reaching at least some targets	0.70	0.46
Strategy for reaching all targets	0.39	0.49
Activities linked to targets	0.61	0.49
Staff assigned to targets	0.51	0.50
School targets	0.21	0.41
All or some school targets are specific	0.17	0.37
All school targets are specific	0.06	0.23
Non-performance targets	0.14	0.35
PSLE is the highest target	0.20	0.40
Learning (unspecified) is the highest target	0.47	0.50
Monitor by DED		
DED/HR officer reviews DEO performance	0.94	0.24
Learning is indicator in performance	0.14	0.35
Meeting OPRA-defined targets is indicator in performance review	0.07	0.26
DED discusses school academic performance with DEO	0.29	0.46
DEO receive rewards if perform well (DEO)	0.86	0.35
Reward system is fair (DEO)	0.84	0.36
DEO can receive a financial award	0.29	0.45

12

Table C.4: DEO Practices— Operations

	Mean	Standard Deviation
Curriculum		
Follow standardized curriculum	0.84	0.37
Ensures that schools prepare lesson plans or schemes of work	0.69	0.46
Coordinate and develop lesson plans together with schools	0.38	0.49
Monitor schools/teachers on curriculum	0.57	0.50
Shares a standardized template for the lesson plans	0.24	0.43
Resource Allocation		
Distributes resources in a systematic way	0.97	0.18
Adapts to specific needs	0.49	0.50
Keeps record of school shortages	0.68	0.47
Records shortages by school and area	0.40	0.49
Support schools with lack of materials	0.57	0.50
DEO encourages creative use when resources are insufficient	0.32	0.47
DEO lobbies for resources from government	0.20	0.40
Teacher Allocation		
Follows government guidelines	0.98	0.13
Goes beyond government guidelines	0.14	0.35
Teacher transfers based on need	0.78	0.41
Keep records of staffing and enrollment	0.68	0.47
Use data to make decisions	0.54	0.50
Involve many stakeholders	0.12	0.33
Allocation decisions ongoing, not only annually	0.11	0.31
Training		
Organizes training of teachers	0.29	0.46
Organizes training of head-teachers	0.21	0.41
Takes steps to identify training needs	0.21	0.41
Has a system in place to identify training needs	0.13	0.34
System to monitor teaching practice	0.62	0.49
Budget		
Can show budget	0.37	0.49
Budget is linked to activities	0.97	0.18
Budget involves many stakeholders	0.43	0.50

Table C.5: DEO Practices— Monitoring

	Mean	Standard Deviation
Collect Information		
Collects data other than ministry requirements	0.48	0.50
Monitoring is systematic	0.41	0.49
Inspect teachers' lesson plans	0.68	0.47
Monitor teacher instruction	0.77	0.42
Assess student learning	0.53	0.50
Uses information from WSV reports	0.56	0.50
Identify Problems		
Formal process to get info from staff	0.78	0.42
Documents problems	0.57	0.50
Always documents problems	0.40	0.49
Takes steps to avoid issues	0.16	0.37
Process to solve regular problems	0.41	0.49
Number of Performance Indicators		
Number of performance indicators	1.53	1.21
Share Performance Indicators		
Share performance indicators with at least some schools	0.36	0.48
Share performance indicators with all schools	0.08	0.27
Sharing is systematic	0.28	0.45
More than one indicator shared	0.17	0.38

Table C.6: DEO Practices— Incentives

	Mean	Standard Deviation
Reward Schools		
Schools receive awards	0.94	0.24
Award criteria based on data	0.93	0.26
Criteria based on more than 1 indicator	0.27	0.45
Schools aware of criteria	0.48	0.50
Schools aware of rewards	0.29	0.46
Schools receive financial award	0.67	0.47
Award ceremony	0.39	0.49
In-kind award	0.41	0.49
Verbal recognition	0.16	0.36
Certificate	0.24	0.43
Reward Teachers		
Teachers receive awards	0.88	0.33
Award criteria based on data	0.86	0.35
Criteria based on more than 1 indicator	0.38	0.49
Teachers aware of criteria	0.46	0.50
Teachers aware of rewards	0.30	0.46
Teachers receive financial reward	0.72	0.45
Award ceremony	0.30	0.46
In-kind award	0.24	0.43
Verbal recognition	0.09	0.28
Certificate	0.14	0.35
Possibility of promotion	0.01	0.08
Attend seminars	0.03	0.17

Table C.7: WEO Practices— Targets, Resources, and Activities

	Mean	Standard Deviation
Targets		
Has own target	0.98	0.15
Staff has multiple targets	0.73	0.45
At least some of own targets are specific	0.59	0.49
All of own targets are specific	0.25	0.43
Targets are somewhat difficult	0.49	0.50
Highest target is exam performance	0.59	0.49
Highest target is student learning (non-exam)	0.36	0.48
Resources		
Sufficient budget for maintenance	0.12	0.32
Sufficient budget for fuel	0.16	0.37
Computer	0.04	0.21
Tablet	0.50	0.50
Internet (paid by the government)	0.02	0.16
Received training this year	0.89	0.31
WEO received training by DEO this year	0.09	0.28
Received training by NGO/donor	0.48	0.50
Activities		
Write mock exams	0.22	0.42
Organize training for schools	0.29	0.46
Invigilate mock exams	0.21	0.41
Write reports	0.51	0.50
Attend training	0.20	0.40
Follow up on construction	0.50	0.50
Meetings with stakeholders	0.42	0.49

Table C.8: WEO Practices— Monitoring of schools and monitoring of WEO

	Mean	Standard Deviation
Monitoring of WEO		
Meetings		
Have regularly scheduled meetings	0.89	0.32
Meet at least monthly	0.65	0.48
School academic achievement	0.64	0.48
Challenges faced by the unit	0.52	0.50
Progress towards meeting targets/goals	0.26	0.44
Planned upcoming activities	0.23	0.42
Reporting		
Write school reports	0.92	0.27
Shared at least monthly	0.66	0.47
Share reports with the DEO	0.70	0.46
Report is always read	0.52	0.50
Report is always acted upon	0.45	0.50
Monitoring of Schools		
Number of Visits		
Number of visits	3.97	2.17
Activities During School Visits		
Inspect school documents	0.25	0.43
Ask about needs faced by school	0.19	0.40
Check teacher attendance	0.63	0.48
Observe teaching	0.42	0.49
Record teacher attendance	0.43	0.50
Inspect lesson plans, etc.	0.53	0.50
Talk to students	0.19	0.39
Assess student learning	0.45	0.50
Record student performance	0.04	0.21
Talk to parents	0.06	0.23
Inspect facilities	0.36	0.48

Table C.9: WEO Practices— Incentives

	Mean	Standard Deviation
Performance Review by DEO		
Performance is reviewed	0.95	0.22
Performance was reviewed in 2019	0.75	0.44
Review exam performance	0.39	0.49
Review OPRAS	0.68	0.47
Review accomplishing assigned tasks	0.16	0.37
Discuss exam performance	0.29	0.46
Discuss OPRAS	0.47	0.50
Discuss accomplishing assigned tasks	0.09	0.28
Performance Rewarded by DEO		
Can get rewarded	0.83	0.38
Reward system is fair	0.75	0.43
Receive bonus	0.42	0.49
Receive (public) recognition	0.27	0.44
Receive (verbal) recognition	0.33	0.47
Possibility of a raise	0.05	0.21

Appendix D   Management practices by donor presence

Table 1 shows that DEOs in the Equip-T regions demonstrate higher scores in targets, curriculum, resource allocation, and information collection. Table D.1 shows that the key difference in terms of curriculum is that DEOs in Equip-T regions play a more active role in the development of lesson plans; Table D.2 shows the key difference in monitoring is that they collect data other than ministry requirements;

In terms of improvement of monitoring of WEOs, Table D.3 shows that WEOs in the Equip-T regions are far more likely to write school reports and share them at least monthly with the DEOs; and Table D.4 shows that WEOs in the Equip-T regions are more likely to have regularly scheduled meetings, meet at least monthly, discuss challenges faced by the district during these meetings, and discuss planned upcoming activities. In terms of activities, Table D.5 shows that WEOs in Equip-T regions are more likely to organize training for schools, attend training, and follow up on construction. Finally, Table D.6 shows that WEOs in Equip-T regions are 21 percentage points more likely to state that they have sufficient budget for fuel and maintenance for their vehicles to visit schools, and also all of them have access to tablets.

Table D.7 shows that WEOs in the Tusome regions do very different activities when they visit schools: they are more likely to observe teaching in the classroom, record teacher attendance, and assess student learning. This reflects the pedagogical program put in place by Tusome Pamoja, which relies on WEOs to observe teaching and provide feedback on their teaching practices.

Table D.1: DEO curriculum, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Follow standardized curriculum	0.055	0.053	-0.168	0.097	0.041	174
Ensures that schools prepare lesson plans or schemes of work	0.245	0.064	-0.124	0.068	0.090	174
Coordinate and develop lesson plans together with schools	0.256	0.117	-0.175	0.140	0.102	174
Monitor schools/teachers on curriculum	0.110	0.102	0.006	0.126	0.011	174
Shares a standardized template for the lesson plans	0.032	0.106	-0.104	0.099	0.011	174

Table D.2: DEO monitoring, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Collects data other than ministry requirements	0.281	0.126	-0.245	0.116	0.136	174
Monitoring is systematic	0.073	0.126	-0.328	0.085	0.076	174
Inspect teachers' lesson plans	0.138	0.102	0.221	0.090	0.035	174
Monitor teacher instruction	0.154	0.126	0.211	0.100	0.044	174
Assess student learning	0.157	0.102	-0.018	0.098	0.024	174
Uses information from WSV reports	-0.038	0.123	-0.219	0.202	0.024	174

Table D.3: Reporting by the WEO, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Write school reports	0.118	0.040	0.126	0.040	0.050	363
Shared at least monthly	0.266	0.044	0.105	0.094	0.064	363
Share reports with the DEO	0.152	0.068	0.030	0.099	0.023	363
Report is always read	0.015	0.071	0.008	0.068	0.000	363
Report is always acted upon	-0.007	0.078	-0.171	0.062	0.016	363

Table D.4: WEO Meetings, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Have regularly scheduled meetings	0.148	0.048	0.138	0.066	0.052	363
Meet at least monthly	0.447	0.060	0.190	0.077	0.178	363
School academic achievement	0.006	0.049	0.019	0.082	0.000	363
Challenges faced by the unit	0.256	0.070	0.000	0.072	0.060	363
Progress towards meeting targets/goals	0.030	0.076	0.194	0.087	0.025	363
Planned upcoming activities	0.161	0.079	0.081	0.104	0.029	363

Table D.5: Activities performed by the WEO, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Write mock exams	0.017	0.058	-0.041	0.070	0.002	363
Organize training for schools	0.138	0.080	0.101	0.048	0.020	363
Invigilate mock exams	-0.013	0.051	-0.096	0.043	0.007	363
Write reports	-0.098	0.100	-0.180	0.068	0.019	363
Attend training	0.145	0.060	0.137	0.089	0.032	363
Follow up on construction	0.208	0.085	0.170	0.063	0.039	363
Meetings with stakeholders	-0.052	0.095	0.197	0.086	0.030	363

Table D.6: Access to resources for WEOs, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Sufficient budget for maintenance	0.214	0.081	0.026	0.028	0.094	363
Sufficient budget for fuel	0.236	0.085	0.024	0.030	0.089	363
Computer	0.068	0.046	0.054	0.032	0.024	363
Tablet	0.925	0.029	0.989	0.007	0.896	363
Internet (paid by the government)	-0.005	0.015	-0.012	0.017	0.001	363
Received training this year	0.091	0.060	0.170	0.048	0.042	363
WEO received training by DEO this year	0.064	0.038	0.019	0.043	0.011	363
Received training by NGO/donor	0.232	0.106	0.463	0.099	0.119	363

Table D.7: Number of schools visits and activities performed during visits by the WEO, by donor presence

	Equip-T		Tusome			
	Coefficient	SE	Coefficient	SE	R^2	N
Number of visits	-0.363	0.324	-0.631	0.359	0.012	363
Inspect school documents	0.024	0.055	0.090	0.108	0.005	363
Ask about needs faced by school	0.078	0.048	-0.061	0.039	0.016	363
Check teacher attendance	0.056	0.056	0.070	0.064	0.004	363
Observe teaching	0.096	0.072	0.249	0.079	0.033	363
Record teacher attendance	0.088	0.070	0.128	0.047	0.011	363
Inspect lesson plans, etc.	0.036	0.060	0.030	0.072	0.001	363
Talk to students	0.032	0.069	-0.034	0.054	0.004	363
Assess student learning	0.107	0.086	0.254	0.060	0.034	363
Record student performance	0.008	0.024	0.009	0.051	0.000	363
Talk to parents	0.045	0.020	0.048	0.026	0.010	363
Inspect facilities	0.097	0.080	0.020	0.106	0.008	363