The effect of active teaching and subject content coverage on students' achievement: Evidence from primary schools in Kenya

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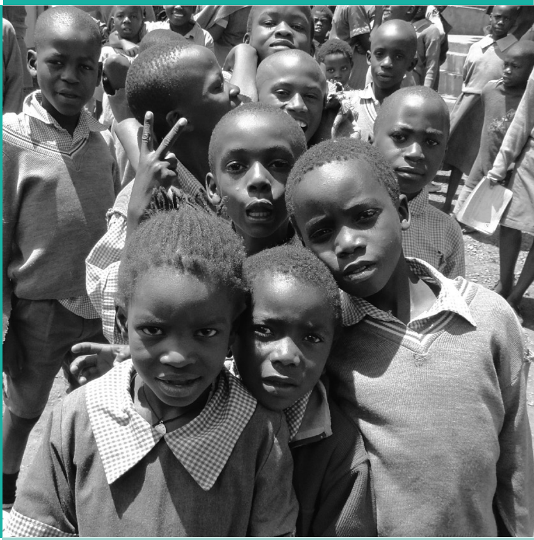

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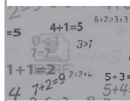


Contents

Abstract 2

1. Introduction **3**

2. Methodology **7**

- 2.1 Data 7
- 2.2 Analytical Plan 8
- 2.3 Variables and their measurement 9

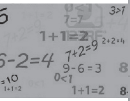
3. Results **13**

- 3.1 Background characteristics 13
- 3.2 OTL and Time on active teaching by school category 15
- 3.3 Univariate Results: OTL and Time on active teaching 16
- 3.4 Effect of OTL and Time on active teaching controlling for level 1 predictors 18
- 3.5 Effect of OTL and Time on active teaching controlling for both level 1 & 2 predictors 20

4. Conclusion **23**

Appendices **24**

References **26**



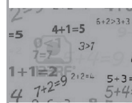
Abstract

In Kenya there is concern over the gap between those schools that are consistently ranked at the top and those at the bottom of the annual league tables. This has raised the issue of inequality in educational opportunity. Our primary concern is to understand what explains the persistent differences in achievement between top and bottom schools given the fact that teachers in both categories of schools are provided by the government. We focus on time-on-task and curricular content covered, and ask whether this explains the difference in performance. We test the following hypotheses: Differences exist on teachers' time-on-task between low and high performing schools; teachers' time-on-task has positive effect on student gain score; and content coverage has a positive effect on student achievement.

For the student achievement gains, we use Item Response Theory test scores of 1889 grade 6 pupils from 70 schools in Kenya. Data on time-on-task was generated from 70 math lessons observed in these schools, while content coverage was developed from students' math note books for the entire period they were in grade 6. Using two level hierarchical modeling, we control for pupil, teacher and school factors. Results show that exposure to content is positively correlated with pupil gain scores. Math teachers in both bottom and top performance schools spend the same proportion of time-on-task. However, time-on-task had a negative effect on gain scores in top schools and a positive effective in bottom schools. The policy implication to education is that optimal time on active teaching differs by student academic background.

Keywords

Gender, instruction, opportunity to learn, math, teacher, gain score



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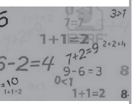
1. Introduction

Student achievement is a product of, among many other factors, the amount of exposure students have had to the content of the assessment (Suter, 2000). Carroll (1963) in his classical work suggested that the amount of time spent learning is determined by two factors: (1) opportunity to learn in form of the amount of time the school and the teacher allocate to a particular learning task or subject area; and (2) learner perseverance, or the amount of time the learner is willing to engage actively in learning. Studies have found existence of a strong, positive, and consistent relationship between the time students spend in learning and their subsequent achievement performance.

As observed by Rowan, Correnti and Miller (2002), time-on-task is one of the instructional process aspects that have received a lot of attention in the recent times in teaching research. In the process-product research, it is argued that what matters is not the amount of time assigned to learning any particular subject or the time students are actively engaged in instruction during class time, but how teachers use this instructional time (Rowan, et al. 2002). Time on task provides pupils with the opportunity to be exposed to the subject content and hence the opportunity to learn (Gillies and Quijada, 2008).

The time-on-task literature indicates that opportunity to learn and student performance are increased in classrooms where teachers maintain the continuity of the lesson (Guice, 2009). Understanding the effect of instructional time on academic achievement is therefore regarded as being very important because of two main reasons: 1) time in class is a choice variable that is affected by policies (e.g. prolonging the school calendar year); and 2) it provides a more general sense of how schooling produces better academic performance irrespective of pupil level variables (Marcotte, 2007).

In addition to active teaching process-product research also finds a strong relationship between content coverage and student achievement (Dunkin 1978; Barr and Dreeben 1983).Variations in student achievement can be explained, at least in part by variations in content coverage (Englert, 1983,

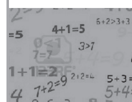


Wyne & Stuck, 1982). Good, Grouws, & Beckerman (1978) found that the coverage of curriculum materials, the number of textbook pages covered by different fourth-grade mathematics classes was significantly related to achievement gain.

Literature based on developing countries shows that, students are often taught for only a fraction of the intended number of hours. Normally, instructional time is wasted through informal school closures, teacher absenteeism, delays, early departures and poor use of classroom time (Abadzi, 2007, Gillies and Quijada, 2008). Further, it is argued that teachers who are present are often involved in other activities leaving students to play instead of engaging in learning. In most cases, invaluable time is spent handing out textbooks, copying from the blackboard or doing small chores. Also, teachers may interact only with the small number of students who are of higher ability and exclude the rest and, to worsen the situation, there is no evident system to track and improve the situation (Abadzi, 2007; IEG, 2008).

Schwille, Porter, Belli, Floden, Freeman, Knappen, et al. (1983) argue that teachers, as they interact with students, are the ultimate arbiters of what is taught (and how); they make decisions about how much time to allocate to a particular school subject, what topics to cover, when and in what order, to what standards of achievement, and to which students and collectively, these decisions and their implementation define the content of instruction. In general, teachers determine the content that is taught. Brophy (1982) suggests that these decisions are likely to be influenced by such factors as external pressures, for example, standardized achievement tests and school-district objectives, knowledge and beliefs about the particular content, and responses to individual differences among students.

To explain learning, Barr and Dreeben (1983) used content coverage, the quantity of instructional content covered in the first grade as an indicator of instruction. The teachers they studied adapted instruction with a single textbook series to a variety of ability levels by varying the extent of the curricular materials they covered in different reading groups. Barr and Dreeben discovered that content coverage has a major effect on how much children learn in first grade, even when initial aptitude is statistically controlled.



The connection between teacher time spent on content and student learning is not new, it was established in the 1970s and 1980s (Carroll, 1989; Fisher & Berliner, 1985). Increasing time on learning has also been linked to enhanced skill development and deeper conceptual understanding (Clark & Linn, 2003; Smith, 2002). These and other studies show a positive correlation between time spent on content and student learning (Huyvaert, 1998; Rangel & Berliner, 2007).

There continues to be inquiry by scholars on how time is spent in schools as this is part of the opportunity provided to students to learn. Benavot and Amadio (2004) and, Benavot 2006 indicate that primary school curricula can be classified into six subject areas. These are mathematics, science (natural), social science, physical education, aesthetic education and languages. A study by Abadzi (2007) indicates that these subjects receive between 80% and 90% of overall instructional time during the first six year of schooling. In primary schools, one third of all instructional time on average is devoted to language instruction while 20% is devoted to mathematics. Arts, sciences, physical education and the social sciences (history and geography) get about 10% of instructional time each on average. However, some systems like in sub-Saharan countries may also include religious/ moral education, hygiene/health education, and vocational education/ practical skills. The time devoted towards language is a reflection of the fact that pupils have to learn English or French, or other 'colonial' languages that have been accepted as the national language. In other instances, language time also doubles as literacy time.

While there are numerous studies going as far back as the 1970s which are devoted primarily to understanding the effect of instructional time on learner achievement, regrettably, the duration required for improving student achievement is still blurred (Abadzi, 2009; Benavot and Amadio, 2004). The consequence of the lack of this vital information is that policy advice has been difficulty to come about, particularly in low income, developing countries where there is desperate efforts to find what works in improving learning outcomes for greater majority of pupils. Therefore, reasons that are not clear and cannot be easily manipulated through policy such as lack of incentives, limited or no community involvement, malnutrition, and poverty are often blamed for poor achievement. It is therefore imperative to explore further and understand the relationship that exists between instructional time, content coverage and student achievement, and which this paper does through a random analysis of classroom observation videos of 72 randomly selected top and bottom performing schools in Kenya. The objective is to establish if there are differences in the active teaching and content coverage that may explain the persistent difference in pupil achievement in these schools.

The rest of the paper presents the methodology, including data used, the findings, analysis and discussion, and finally the conclusion and recommendations.

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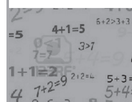
2. Methodology

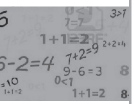
2.1 Data



Data for this study comes from the classroom observation study carried out by the Education Research Program (ERP) at the African Population and Health research Center (APHRC) in the months of May and July in 2009 and February and March in 2010. The study involved collection of data from randomly selected schools in randomly picked districts of Kenya. The sampling process involved first random selection of districts by their performance rank in the Kenya Certificate of Primary Education (KCPE) Examination which is a summative examination taken by pupils to mark the end primary education cycle. The score in this examination is normally used to for screening of those who transit into the different categories of secondary schools in Kenya. The Kenyan 76 districts were first stratified into 10 (10% each) quintiles according to their performance in KCPE over the recent past four consecutive years. This stratification enabled us to select districts that have consistently performed at the top 10%, middle 20% and bottom 10% for each of the four years. Using this criterion, six districts were randomly selected, 2 from each of the categories.

The second level of sampling involved random selection of schools from the sampled districts. The selection of schools largely followed the procedure used to select districts, however schools within each district were ranked into 5 quintiles (of 20%) according to their performance in KCPE during the same period. Thereafter, a random selection of six schools that were ranked consistently in the top 20% and six ranked consistently in the bottom 20% was undertaken. In total 72 schools were randomly selected, 12 from each of the six districts.

The classroom observation study employed mixed method approach: that is, data was collected using various methods and tools during the two rounds. The first round involved lesson observation using observation checklists and video-recording of an actual lesson (with the consent of the teacher and the head teacher on behalf of all the pupils as tends to be the practice in Kenya); use of questionnaire to collect data on school, pupil, and teacher characteristics, and math test for the grade 6 pupils and their math teachers. The second round involved collection of the opportunity to learn (OTL) data and retesting



the pupil using the same test used in round 1 with the questions re-shuffled. The OTL data collection involved reviewing exercise books from at least 3 high ability pupils[1] in each subject and recording the content, sub-topic, and topic covered within the classroom for the whole academic year using a structured questionnaire.

This paper uses data generated from the math video recording, teacher, pupil and school characteristics, and math OTL. In total 72 video recordings were collected and 2437 and 72 pupils and teachers were interviewed and tested respectively. School characteristics information was also collected from 72 head teachers, and included information on school management, staffing, enrollment and parental participation in the school affair. In the second round, 1907 of the pupils from 71 schools who had participated in the first round were re-tested, and OTL data was collected from 70 math schools. Therefore, this study uses data from 70 schools, involving 1889 pupils and 70 math teachers, with complete OTL, teacher, and pupil and school information. The teacher questionnaire collected information on teacher attributes such as age, sex, years of teaching experience, level of education and any other relevant professional qualifications. It also gathered data on teacher socio-economic status, the internal and external support teachers had received, among other things. The pupil questionnaire collected information on pupil bio-data, socio-economic background of the pupils, the school environment and their parental educational level (Ngware et al, 2010[2]).

2.2 Analytical Plan

The purpose of this paper is to establish the effect of active teaching and content coverage on student achievement levels between low and high performing schools, and thereby attempt to answer the question of why some schools continuous dominate the examination league tables while others are confined to low ranks. We made the assumption that active teaching and content coverage is a resource that varies between schools while pupil ability varies among pupils

[1]The high ability pupils were selected because they are likely to attend school regularly; have organized, complete and up to date notes. The class-teachers in each of the schools helped us identify which pupils were considered as high ability learners.

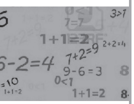
[2]Ngware M. et al. Classroom Observation Study: A Report on the Quality and Learning in Primary Schools in Kenya. *African Population and Health Research Center,* 2010.

in the same school. To conduct this analysis we will fit a two-level multilevel model to evaluate to what degree does content coverage, proportion of lesson time spent on active teaching, pupil and school and other teacher variables influence student achievement.

2.3 Variables and their measurement

Variable	Description
Math gain score	Item Response Theory (IRT) was used to calculate test scores at time 1 and time 2. The IRT scores generated from 40 items in each test using the Rasch models implemented in Winsteps software[3]. IRT uses maximum likelihood estimation methods and comprises a group of parametric and non-parametric models. The test 1 and test 2 IRT scores were thereafter used to calculate the student IRT gain score.
Proportion lesson time spent on active teaching.	Active teaching in this study is defined as the proportions of lesson time spent on active teaching activities. In total, the video rubric had 33 specific activities of which 11 (33.33%) were identified to involve active teaching. The amount of time spend in the 11 activities was tallied and the proportion relative to lesson duration calculated in cases where the lesson was more than 35 minutes, else used 35 minutes. This is due to the fact that a single lesson in Kenya Upper Primary (grades 4 to 8) school is 35 minutes long.
NBTLM	This is the availability of non-basic teaching and learning materials (NBTLM) in the classroom such as wall charts and visual aids: coded as 0=Not available and 1= Available
Opportunity To Learn (OTL)	This is the proportion of content covered in mathematics at grade 6 relative to the grade six math syllabuses. The syllabus contains broad areas of study (Topic), which are further subdivided into sub-topics. Under each sub-topic are the finer areas (contents) of coverage.
Teacher sex	This is the gender of the teachers coded as 0=Female; 1=Male

[3]Rasch Measurement Software & Publications. (2002). Winsteps. [On-line] Available URL: http://www.winsteps.com-accessed on 14th December 2010

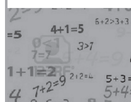


Teacher math score	Teacher pedagogical knowledge – Percentage score in the math teacher test
Lesson observation	Frequency in which the head teachers carries math lesson observation and as reported by the subject teacher
Pupil age	Age of the pupil
Pupil sex	Gender of the pupil coded as 0=Female; 1 =Male
Mother and father Education	Education level of the pupils parental as reported by the pupil: Coded as 1=No/Primary; 2=At least secondary and 3 = Don't know.
Math Homework	The Number of days the pupil has math homework- coded as 1=Less than 4 days a week; 2=At least 4 days a week
School category	School category during sampling 1= Top schools; 2=Bottom schools
School Type	Type of school: 1= Private; 2=Public`
PTR	Pupil teacher ratio: coded as 1=Less than 26; 2=Between 26 and 45 and 3=Above 45
School poverty – poorest 20%	Wealth index is calculated at pupil level and aggregated at school by calculating the proportion of pupils within the school ranked in the poorest 20% relative to the districts wealth index.

2.4 Models

The model fitted in this study takes the form shown in equation 1, which is a value added model, that describes the gain achievement (ΔY_{ij}) for pupil i in school j decomposed into fixed and random effects.

$$\Delta Y_{ij} = \beta_x X_{ij} + \beta_t T_j + \beta_s S_j + \varepsilon_{ij} \qquad \text{.............................. (1)}$$



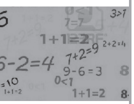
The pupil gain score is a function of pupil (X), teacher (T) and school (S) characteristics and a random error (ε) (Rivkin, Hanushek & Kain, 2005)[4]. The pupil characteristics include age, gender and parental education; teacher characteristics include their gender, math subject pedagogical knowledge, use of non-basic teaching and learning materials and experience; while the school characteristics included head-teacher supervision, school type and category. Since our data consists of one teacher per school, the teacher characteristics can also be said to be school level characteristics. However, for the purpose of highlighting which characteristics describe schools and which describe teachers, we present them independently in the model. Therefore, the proportion of time on active teaching and content coverage, the main explanatory variables are considered as teacher characteristics.

From Equation 1, we first fitted a null model with an aim of detecting significant differences in student achievement between schools without predictors being considered (Equation 2). The null model is used as a base to determine the relative reduction in variance that is attributable to the predictors added thereafter in the model (e.g. school, and pupil variables)

$$\begin{aligned} \Delta y_{ij} &= \beta_j + e_{ij}\,; \quad e_{ij} \sim N(0,\, \sigma_e^2) \\ \beta_j &= \beta_0 + u_j\,; \quad u_j \sim N(0,\, \sigma_u^2) \end{aligned} \qquad \text{(2)}$$

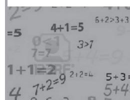
In the next model we carry out a univariate analysis using the main explanatory variables; time on active teaching and OTL. OTL was calculated in three different ways: Proportion of topic, sub-topic and content covered. We fit a univariate model for each of the OTL measures in order to isolate the one that is highly related with pupil gain score and to be used in the subsequent models. We thereafter control for pupil and both school and teacher characteristics independently as the only predictors. In the final model, we control for both pupil and school level characteristics in the same model. The final model is as presented in Equation 3.

[4]Rivkin, S.G., Hanushek, E. & Kain, J.F. (2005). Teachers, Schools and Academic Achievement. Econometrica, 73(2); 417-58.



$$\begin{aligned} \Delta y_{ij} &= \beta_{0,j} + \beta_1 . x_{ij} + \beta_2 . t_j + \beta_3 . s_j + e_{ij} \; ; \quad e_{ij} \sim N(0, \sigma_e^2) \; .... (3) \\ \beta_{0j} &= \beta_0 + u_j \; ; \quad u_j \sim N(0, \sigma_u^2) \end{aligned}$$

This type of modeling allows us to estimate the relative variance attributable to the different level predictors; i.e. the amount of variation attributable to level 2 predictors relative to level 1 predictor.



3. Results

3.1 Background characteristics

The study involved 1889 pupils: girls (924) and boys (965) and 70 teachers and schools. There were notable significant differences in parental education: 57.73% of the pupils in top schools reported that their mothers had at least secondary education compared to 46.1% in the bottom performing schools (table 1). Similarly, 63.63% of the pupils in top schools reported that their fathers had at least secondary education compared to 49.74% in the bottom performing schools.

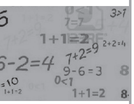
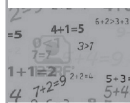


Table 1: Pupil, school, and teacher background characteristics

	Top schools	Bottom schools	Total	
	Number (%)	Number (%)	Number (%)	p-value
Pupil Level variables				
Pupil sex: Female	563 (50.31)	361 (46.88)	924 (48.91)	0.078
Male	556 (49.69)	409 (53.12)	965 (51.09)	
Mean pupil age †	12.05 (sd=1.57)	12.36 (sd=1.74)	12.18 (sd=1.65)	0.989
MEDU: None/Primary	345 (30.83)	341 (44.29)	686 (36.32)	0.001
Secondary and Higher	646 (57.73)	355 (46.1)	1001 (52.99)	
Don't know	128 (11.44)	74 (9.61)	202 (10.69)	
FEDU: None/Primary	233 (20.82)	248 (32.21)	481 (25.46)	0.001
Secondary and Higher	712 (63.63)	383 (49.74)	1095 (57.97)	
Don't know	174 (15.55)	139 (18.05)	313 (16.57)	
Math homework<4 times/week	453 (40.48)	358 (46.49)	811 (42.93)	0.011
At least 4 times a week	666 (59.52)	412 (53.51)	1078 (57.07)	
School level variables				
Math teacher mean score	*62.83 (sd= 15.48)*	*58.32 (sd=15.66)*	*60.64 (sd=15.62)*	0.432
NBTLM: Not available	21 (58.33)	28 (82.35)	49 (70.00)	0.038
Available	15 (41.67)	6 (17.65)	21 (30.00)	
Public school: No	7 (19.44)	7 (20.59)	14 (20.00)	1.000
Yes	29 (80.56)	27 (79.41)	56 (80.00)	
H/Teacher obs: Rarely/Never	19 (52.78)	23 (67.65)	42 (60.00)	0.231
Sometimes/Often	17 (47.22)	11 (32.35)	28 (40.00)	
Mean of poor pupils (20%)	*13.74 (sd= 14.20)*	*25.90 (sd= 17.54)*	*19.65 (sd=16.94)*	0.039
Teacher sex: Female	15 (41.67)	17 (50)	32 (45.71)	0.632
Male	21 (58.33)	17 (50)	38 (54.29)	

† Means are reported since the variables are continuous ones.



In the top schools teachers scored a mean of 62.83% in the mathematics test whereas those in the bottom schools scored a mean of 58.32%; but the difference was not statistically significant. There is a significant different in the availability of non-basic teaching and learning materials (NBTLM) in the math lessons between the top and bottom schools. That is 82.35% of the bottom ranked schools had no NBTLM as compared to 58.33 of the top ranked schools. Head-teacher lesson observation was rare; with 60% of the math teachers reporting that head teachers are rarely or never observed them teach. There is also a significant difference in the proportion of pupils in a school ranked in the poorest 20% category relative to district wealth index. The mean poverty in the bottom schools is 25.90% compared to 13.74% among the top schools.

3.2 OTL and Time on active teaching by school category

Table 2 shows the mean content coverage and proportion of lesson time used in active teaching by school category. Teachers in both bottom and top performance schools spend the same proportion of time of lesson time in active teaching as well as content coverage. Table 2 also shows while most of the teachers covered 91% and 88% of the grade 6 math syllabus in terms of topics, the content coverage was very low (i.e. 54% and 47%) among the top and bottom schools respectively.

Table 2: OTL and Time on active teaching by school category

	Top		Bottom		
	Mean	Std. dev	Mean	Std. dev	P-Values
Proportion of Topic covered	0.910	0.125	0.875	0.141	0.280
Proportion of sub-topic covered	0.737	0.160	0.685	0.153	0.167
Proportion of content covered	0.540	0.147	0.474	0.164	0.079
Proportion of lesson time on active teaching	0.621	0.168	0.617	0.186	0.911

3.3 Univariate Results: OTL and Time on active teaching

Table 3 presents both null model and univariate results on the effect of proportion of topics, sub topics and content coverage as well as time on active teaching on pupil IRT gains score. The intercept of 0.56 in the null model indicates the estimated overall school average in student achievement. The random part of the null model reveals that the variance at pupil and school level is significantly different from zero. This means that there is significant variation in mean school gain scores. Therefore, 10.4% of the total variance in pupil IRT gains score is attributable to the school level.

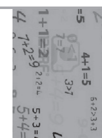


Table 3: Multilevel coefficient: Univariate analysis (pupils=1889; schools=70)

	Proportion of () covered				
Fixed effects	**Model 1:** Null model Coef. (CI)	**Model 2a**: Topic: Coef. (CI)	**Model 2b**: Sub-topic : Coef. (CI)	**Model 2c**: Content Coef. (CI)	**Model 2d**: Active teaching Coef. (CI)
Constant	0.563 [0.505 ; 0.621]	0.042 [-0.328 ; 0.413]	0.308 [0.045 ; 0.571]	0.374 [0.179 ; 0.568]	0.644 [0.421 ; 0.868]
Coefficient		0.585*** [0.173 ; 0.996]	0.359* [-0.001 ; 0.719]	0.372** [0.007 ; 0.737]	-0.13 [-0.478 ; 0.217]
Random effect					
School	0.044	0.038	0.041	0.041	0.043
Pupil	0.379	0.379	0.379	0.379	0.379
Intra-class correlation	0.104	0.090	0.098	0.098	0.103
Log likelihood	- 1,810.726	- 1,807.103	- 1,808.876	-1,808.781	- 1,810.460

**** significant at 1%; ** significant at 5%; * significant at 10%;*

The univariate results also show that a unit increment in the proportion of topic and content covered in math classes significantly increases pupil IRT score by 0.585 and 0.372 respectively; while the proportion of sub-topics covered is significant at 10%. However proportion of time on active teaching is not significantly associated with pupil gain score. The proportion of topic, sub-topic and content covered as well time on active teaching are at school level, and are associated with decrease in the school level variance (14.83%, 7.14% and 7.14% respectively); hence each of these OTL measure accounts for some of the variation school level seen in the null model. From table 3, since proportion of topic covered (OTL) is highly associated with pupil achievement; it is used in the subsequent analysis together with time on active teaching.

3.4 Effect of OTL and Time on active teaching controlling for level 1 predictors

In table 4, model 3 shows the results on both OTL and time on active teaching. The results indicate that OTL significantly influences pupil IRT score, while time on task still remains insignificant and negatively influences pupil IRT gain score. The variance at level 2 decreases insignificantly by 2.63% (i.e. (0.038-0.037)/0.038) in model 3, when compared to univariate results on proportion of topic coverage on IRT gain score presented in table 3 (model 2a). Model 4 controls for pupil characteristics, OTL remains positive and statistically significant. With an exception of pupil age (significant at 10%), the other pupil characteristics insignificantly influence pupil IRT score.

The intra-class correlation for model 3 reduces insignificantly when the pupil level factors are introduced; i.e from 8.9% to 8.1% in model 4. This is coupled by a reduction in school level (level 2) variance by 10.81% with very little proportional variance reduction at pupil level. Furthermore, when the null model is compared with Model 4 that controls for pupil (level 1) predictors there is a 25% decrease in variance at level 2.

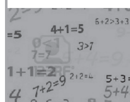
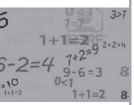


Table 4 : Multilevel coefficient (pupils=1889; schools=70)

		Model 3		**Model 4** –Pupil characteristics	
		Coef.	CI	Coef.	CI
Fixed effects	Variable Category				
Constant		0.112	[-0.326 ; 0.55]	0.274	[-0.212 ; 0.761]
Proportion of topic covered		0.575***	[0.164 ; 0.986]	0.528***	[0.13 ; 0.925]
Prop. of time on active teaching		- 0.098	[-0.429 ; 0.232]	-0.077	[-0.397 ; 0.243]
Pupil gender	Female			-	
	Male			0.021	[-0.037 ; 0.079]
Pupil age				-0.017*	[-0.036 ; 0.002]
Mother Education	No Educ./Primary			-	-
	Post primary education			-0.012	[-0.086 ; 0.061]
	Don't know			-0.041	[-0.151 ; 0.07]
Father Education	No Educ./Primary			-	
	Post prim education			0.061	[-0.016 ; 0.138]
	Don't know			0.067	[-0.032 ; 0.166]
Math Homework	Less than 4 times			-	
Random effects					
	At least 4 times/ week			0.046	[-0.022 ; 0.115]
School		0.037		0.033	
Pupil		0.379		0.378	
Intra class correlation		0.089		0.081	
Log likelihood		-1,806.93		-1802.46	

*** significant at 1%; ** significant at 5%; * significant at 10%;



Model 5 of table 5 shows the effect of OTL and active time on teaching controlling for school and teacher characteristics. The significant effect of OTL as seen above diminishes, though it remains positive (0.428, CI: -0.028; 0.884). The proportion of time utilized on active teaching also remains insignificant and negatively associated with pupil IRT gain score. With an exception of the availability of non-basic teaching and learning materials (NBTLM) and Pupil Teacher Ratio (PTR), all other school and teacher variables are insignificant. The intra-class correlation decreases to 5.4%. This shows that the school level variables are attributable to the reduction of variation at school (level 2) level.

3.5 Effect of OTL and Time on active teaching controlling for both level 1 & 2 predictors

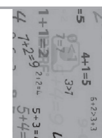
The final model (model 6) is the full model and shows the effect OTL and time on active teaching on pupil IRT gain score controlling for pupil, school and teacher characteristics. Proportion of topic covered (OTL), though positive it is not significant; i.e. pupil IRT score increases on average by 0.258 points holding pupil, school and teacher characteristics constant. Schools that had NBTLM available in the classroom, their pupil's significantly gained higher IRT scores compared with those where the materials were not available.

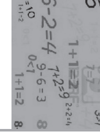
The results further show that an increase in pupil teacher ratio is associated with a significant decrease in pupil IRT gain scores. That is schools that had a PTR of more than 45, their pupils rather gained on average -0.213 IRT scores. Pupil IRT gain score is also negatively associated with pupil age. A one year increment in the age of the pupil is associated with a -0.016 IRT gain score. It is also evident that there is no significant difference in pupil IRT gain score between top and bottom performing schools, despite the fact that bottom schools gained negatively (models 5 and 6).

The random part of model 6 shows a reduction of the intra-class correlation to 5.1%; this is attributable by the decrease in school level variance from 0.022 to 0.020 (9.10%), with pupil level variance largely remaining the same. Therefore, much of the variation noted in pupil IRT gain scores in attributable to unobserved pupil level characteristics than unobserved school level characteristics.

Table 5 : Multilevel coefficient (pupils=1889; schools=70)

		Model 5: school character		Model 6: Full model	
		Coef.	CI		Coef.
Fixed effects	Variable Category				
Constant		0.428	[-0.028 ; 0.884]	0.549	[0.043 ; 1.055]
Proportion of topic covered		0.268	[-0.103 ; 0.638]	0.258	[-0.105 ; 0.620]
Proportion of time on active teaching		-0.189	[-0.480 ; 0.103]	-0.171	[-0.458 ; 0.116]
Pupil gender	Female			-	-
	Male			0.018	[-0.04 ; 0.076]
Pupil age				-0.016*	[-0.035 ; 0.003]
Mother Education	No Education/Primary			-	-
	Post primary education			-0.025	[-0.098 ; 0.047]
	Don't know			-0.052	[-0.162 ; 0.058]
Father Education	No Education/Primary			-	-
	Post primary education			0.053	[-0.024 ; 0.13]
	Don't know			0.064	[-0.035 ; 0.163]
Math Homework	< 4 days a week			-	-
	At least 4 days a week			0.041	[-0.027 ; 0.108]
School Category	Top	-	-	-	-
	Bottom	-0.063	[-0.169 ; 0.042]	-0.060	[-0.163 ; 0.044]





Teacher math score	score	0.002	[-0.001 ; 0.005]	0.002	[-0.001 ; 0.005]
Head Teacher observation	Never or rarely	-	-	-	-
	Sometimes or often	-0.074	[-0.174 ; 0.027]	-0.075	[-0.174 ; 0.024]
Teacher sex	Female	-	-	-	-
	Male	-0.019	[-0.114 ; 0.075]	-0.013	[-0.106 ; 0.080]
NBTL materials	Not available	-	-	-	-
	Available	0.181***	[0.072 ; 0.291]	0.175***	[0.068 ; 0.283]
School poverty (Poor 20%)		-0.002	[-0.006 ; 0.002]	-0.002	[-0.005 ; 0.002]
School type	Private	-	-	-	-
	Public	0.036	[-0.121 ; 0.192]	0.060	[-0.095 ; 0.214]
PTR	Less than 26	-	-	-	-
	Between 26 and 45	-0.072	[-0.217 ; 0.073]	-0.075	[-0.218 ; 0.067]
	Above 45	-0.213**	[-0.397 ; -0.028]	-0.205**	[-0.387 ; -0.024]
Random Effects					
School		0.022		0.020	
Pupil		0.379		0.378	
Intra class correlation		0.054		0.051	
Log likelihood		-1795.678		-1792.055	

*** significant at 1%; ** significant at 5%; * significant at 10%;

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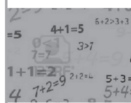
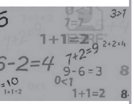


4. Conclusion

The purpose of this paper was to examine the effect on active teaching and content coverage on pupil achievement, and thereby answer the question why some schools dominate the league tables in Kenya certificate of primary education while are others are confined to the bottom ranks. Active teaching was measured by the proportion of lesson time spent on active teaching activities, and content coverage was measured by the proportion of content covered at grade six relative to the grade six Kenya math syllabus content. The study findings indicate that content coverage positively and significantly influences pupil achievement if it's the only predictor while proportion of lesson time, although insignificant, is negatively associated with pupil gain score.

The results further indicate that the proportion of topic, sub-topic and content covered as well as time spent on active teaching at school level are associated with a decrease in the school level variation. This is an indication that these opportunity to learn measures account for some variation at school level. When controlling for pupil, school and teacher characteristics, schools that had non-basic teaching and learning materials available in the classroom, had their pupil's significantly gaining higher IRT scores compared with those where the materials were not available. The results also show that an increase in pupil teacher ratio is associated with a significant decrease in pupil IRT gain scores.

Nevertheless, there is no significant difference in the proportion of lesson time spent on active teaching and opportunity to learn between top and bottom performing schools. It is also evident that there is no significant difference in pupil IRT gain score between top and bottom performing schools, despite the fact that bottom schools gained negatively (i.e. test 1 was lower than test 2) Therefore, we concluded that opportunity to learn and active time on task are not the source of variation in pupil achievement between top and bottom performing schools. Answers to the variation lie elsewhere, and instead of blaming teachers in low performing schools, the Kenya government may need to look deeper at non-school factors as being, partly, the main cause of the persistent differences which yields the undesirable failing schools and a few succeeding schools.



Appendices

Fig 1: Random Intercepts for each of the schools-Model 6 (n=70)

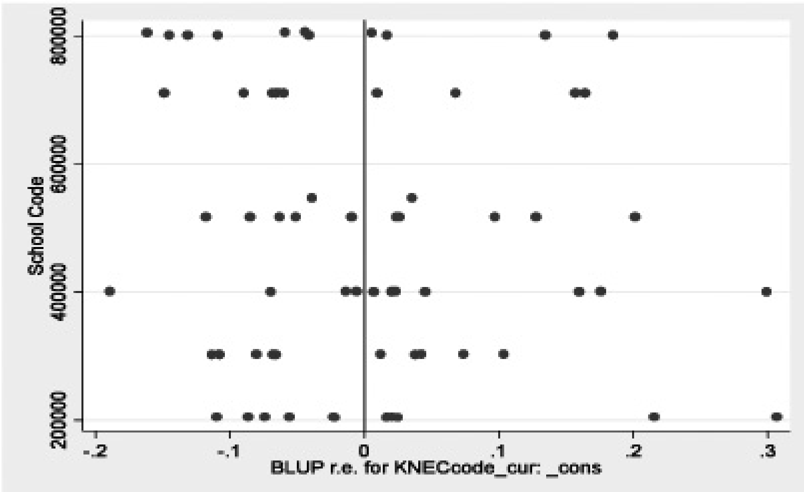
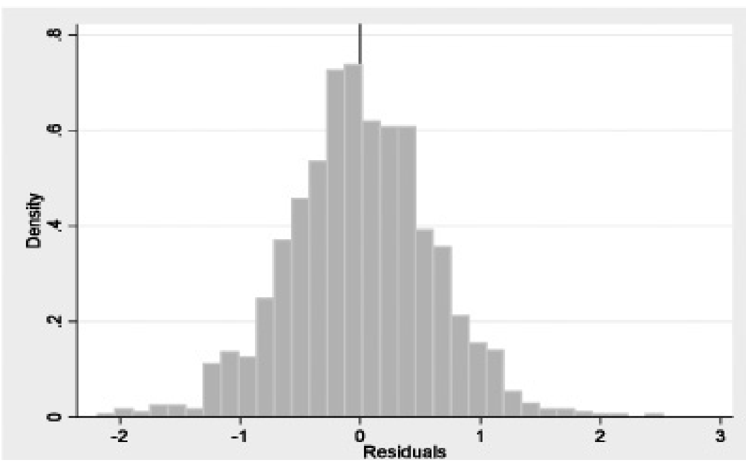


Fig 2: Distribution of pupil level random errors - model 6 (n=1889)



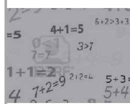


Fig 3: Scatter diagram between fitted and actual pupil IRT gain score (n=1889)

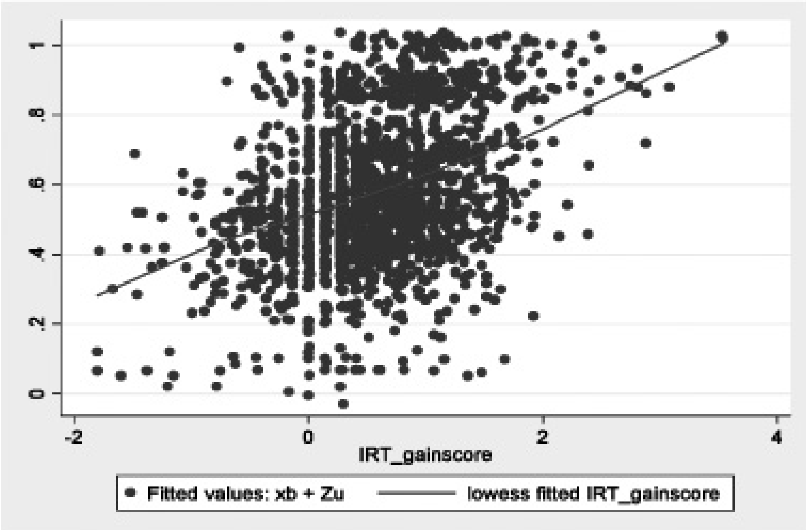
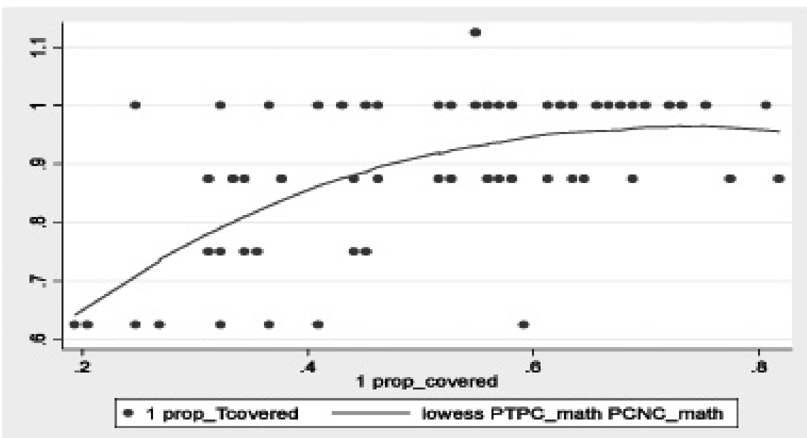
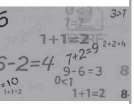


Fig 4: Relationship between proportion of topic and content coverage





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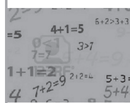

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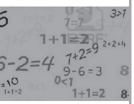

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