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ABSTRACT

Previous studies of the South African education system have emphasised its bimodal performance, with the weaker part of the schools system containing a majority of schools that are seemingly unable to transform either school resources or even children's socio-economic status (SES) into improved learning outcomes. This stands in contrast to the better functioning and more affluent part of the system.

This study uses data from prePILS, a recent international evaluation, where South African schools that tested in African languages were largely those associated with the weaker performance. The innovation of this paper lies in its empirical investigation of parent-child and teacher-child interpersonal interactions (so-called "softer" factors), such as parents appreciating children's reading, parents checking children's homework frequently, and teachers reporting that they adhere very strongly to the curriculum. Such variables are not often incorporated into education production functions. This study finds that these softer, non-conventional factors are significantly and positively associated with student test scores, even after controlling for other factors. Coefficients relating to these non-conventional inputs are also significant in the poorer and generally lower quality and less functional tier of the school system, where physical resource inputs appear to be associated with only limited cognitive gains.

These research findings indicate that a more effective education policy should perhaps shift the emphasis from the learning inputs usually considered (mainly tangible) towards non-conventional learning 'inputs' related to interpersonal interactions and parental and teacher behaviour.

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Further information regarding PSPPD and the Zenex foundation can respectively be found at www.psppd.org.za and www.zenexfoundation.org.za



1. Introduction

South Africa's primary education system is characterised by severe inequalities in educational outcomes. Two distinctly different learning processes, in an education system still largely reminiscent of the apartheid education system (Van der Berg 2007), produce two distinct outcomes – satisfactory learning outcomes for some in high-quality schools, and poor learning outcomes for most learners in low-quality schools (Fleisch 2008; Van der Berg 2008; Taylor 2011). Education inequality is a legacy of the apartheid system, where quality education was a privilege enjoyed mainly by whites due to unequal government spending by race on education (Keswell 2008). After the end of apartheid in 1994, efforts have been made to equalize education opportunities – especially in funding – , but conformity in education outcomes has not been achieved.

The debate around the possibility that financial inputs influence learning outcomes, was spawned by the findings of the Coleman report (1966) which found that poor black U.S. students performed better in middle-class integrated schools. Since then, education production functions have developed to include those inputs amenable to manipulation such as pupil-teacher ratios or curricula, and those inputs not under as much control such as socio-economic status and parental education (Hanushek, 2007). These 'conventional' education production functions implicitly assume that more school and family resources make a difference to learning outcomes through intermediary pathways such as better school management and more parental effort in promoting cognitive development. While some empirical evidence exists in the developed country context of how these non-conventional parental and school inputs matter in education production (see for example Houtenville and Conway, 2008), the research on the role of these inputs is less developed in the developing country context due to the dearth of data on the subject of 'softer' factors affecting learner achievement.

This paper therefore contributes to the developing country education production literature by investigating the role of parental and teacher efforts in education production in South Africa, using the prePIRLS (2011) data set. The paper is organized as follows: the data and methodology are discussed in the section 2, while section 3 first considers the conventional factors affecting learner achievement in South Africa followed by an investigation of the roles of the 'softer' parent and teacher characteristics in learning achievement.

2. Data and Methodology

In 2011, the *International Association for the Evaluation of Educational Achievement* (IEA) introduced the *preProgress in International Reading Literacy Study* (prePIRLS), a test devised for developing countries with low literacy skills. 4th graders were tested on 400-word texts. Short paragraphs of five sentences were followed by multiple choice and open-ended questions (Mullis et al. 2012). The potential reading scores ranged from approximately 0 to 1000 (5 standard deviations) around the scale centerpoint of 500 points and a standard deviation of 100 (Howie et al., 2009). Literacy competence was tested in the four dimensions of reading comprehension: retrieve explicitly stated information, make straightforward inferences, interpret information, and evaluate content, language and textual elements (Van Staden & Bosker, 2014).

The South Africa-specific prePIRLS 2011 version 2.1 (updated and edited in September 2013) sample included test score data from 15 744 students (7 548 girls and 8 196 boys) in 341 primary schools, as well as family, teacher, and school background information collected from students, parents, teachers, and school principals. All of South Africa's eleven official languages were tested.

For the econometric analysis which follows, robust Ordinary Least Squares (OLS) regressions are employed to estimate education production functions (Hanushek, 2002) of the following form:

$$\text{Test score} = \beta_0 + \beta_1 \text{test language} + \beta_2 \text{school} + \beta_3 \text{family} + \beta_4 \text{student} + \varepsilon$$

The literacy test score, measured in plausible values, is assumed to be a function of test language, school, family, and student variables. Test language (assumed to be indicative of school quality) is either English or one of the African languages¹. School variables includes several tangible inputs that are usually assumed to have an influence on quality. Family attributes refer to wealth and parental attributes. Student variables encompass individual characteristics. Weighting was undertaken to account for the different sub-population group sizes to generalize results to the population of South African 4th graders and clustering of observations within schools was undertaken to generate robust standard errors .

¹ Afrikaans home and test language was excluded from the analysis due to focus on upwards social mobility of African home language students between African- and English-testing schools.

3. Results

3.1 Language of Instruction and Literacy Skills

The apartheid legacy of racial inequality in government spending is still evident in the diversity of educational outcomes in South Africa's primary education system, with the language of instruction being a relatively good indicator of school quality. Schools with English-language instruction (and also Afrikaans instruction, though this is not dealt with here) seems to produce better educational outcomes than their African-language² instruction counterparts.

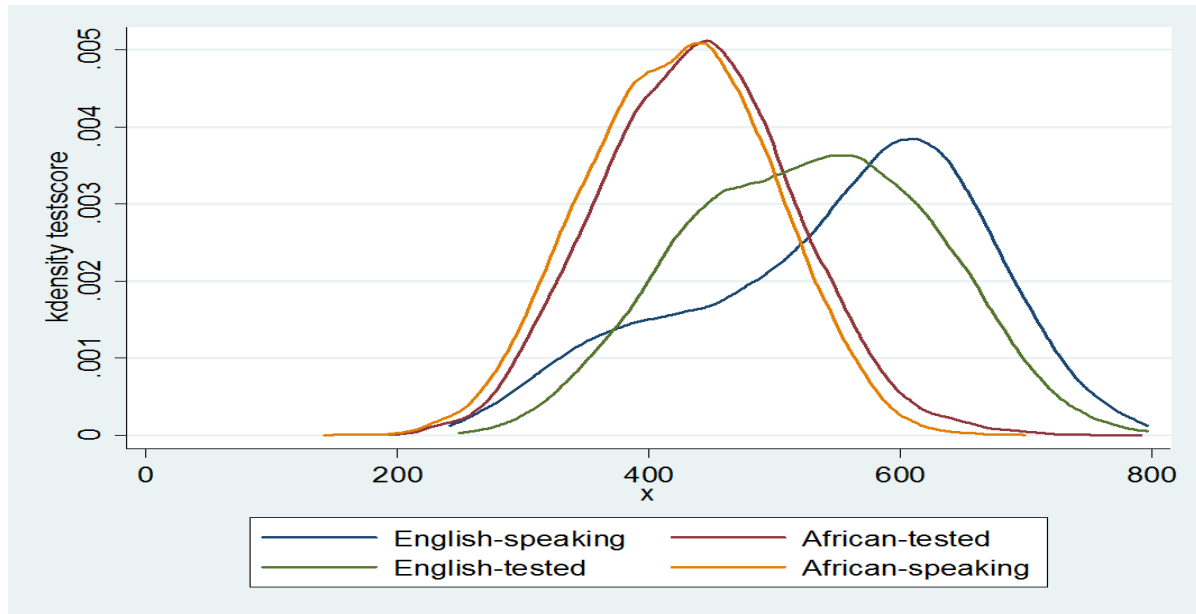
PrePIRLS (2011) data confirm the language-quality divide. The literacy test score can be used to quantify individual learning outcomes as a measure of school quality. In this study, students are grouped by (1) test language, either English or one of the African languages, and (2) by home language, English or one of the African languages. Figure 1 overleaf shows prePIRLS literacy test scores by home language and test language. English-speaking students³ achieved the highest average test score of 548 points (n=832) while English-tested students achieved an average of 527 points (n=2 205). African-speaking students achieved 439 points on average, but African-tested students had an even lower average score of 424 points. Only 32.7% of all English-tested students spoke the test language at home, whilst 67.2% had an African mother tongue. The benefit of exposure to English is not lost on South African households. African mother tongue speakers often opt for English-testing schools as English is the language of business and academia, and in South Africa it is regarded as a ladder to social and economic advancement⁴. Moreover, English (and Afrikaans) compared to the African languages have a more developed academic literature (Taylor & Coetzee, 2013).

² African languages include nine official languages (isiNdebele, isiXhosa, isiZulu, Sepedi, Sesotho, Setswana, siSwati, Tshivenda, Xitsonga). Afrikaans is not understood as an African language in this context, where language serves as proxy for school quality with Afrikaans closer to English in test scores.

³ Those whose home language is English, though that may not be the language they were tested in; it excludes students with other home languages who happened to be tested in English because they attended schools where testing was conducted in English.

⁴ Casale, Posel (2011) even identify a statistically significant wage premium of English language proficiency for black South Africans, i.e. those who are proficient in English received higher wages, all other things considered.

Figure 1. PrePIRLS literacy test scores by home language and test language



Regression analysis in **Error! Reference source not found.** confirms that being tested in an African language is associated with a test score that is on average almost 85 points lower than that of English-speaking students. In contrast, being tested in English but speaking an African language at home was associated with a significantly lower (59 points) performance than English-speaking students. Controlling for socio-economic factors and school inputs, it is not African home language per se that is correlated with lower literacy skills, but attending a school where instruction took place in an African language. Given the results in Table 1, test language appears to be a plausible proxy for those aspects of school quality that enable learning success.

Table 1. OLS regressions controlling for home language and test language

VARIABLES	(1) Testscore
lang2home: African	23.95*** (7.934)
2.tier: African-tested	-84.98*** (12.24)
3.tier: English-tested (African home lang.)	-59.49*** (11.38)
Constant	539.7*** (26.02)
Observations	7,645
R-squared	0.534
Controls	YES

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

Reference group for lang2home is *English*, for tier is *English-tested* (of English or other home language). Non-displayed controls are femaleStud, ageStud, assets, assets², schoolAssets, university, professional, homework, appreciation, eduT, youngT, curriculum, femaleT, experT, classsize, library, remote rural, and province.

School quality can also be represented by the mean score of a school after controlling for various socio-economic and school inputs. Regression results confirm a highly significant association between a school's mean score and student test scores. **Error! Reference source not found.**2 shows that this association is consistent across both the higher quality English-testing tier and the lower quality African-testing tier. Specifically, a student attending an English-testing school with a 100 points higher mean test score on average has associates with a 88 points higher literacy test score. A student attending an African-testing school with a 100 points higher mean test score associates with a 87 points higher literacy test score, on average. Across both test languages, those two coefficients are surprisingly similar. Hence, once school quality has been accounted for by the mean score of the school, large test score gains from a higher quality school and better performing peers can be achieved in both English and African-language tiers.

Table 2. Regressing mean score per school on test scores

VARIABLES	(1) scoreEnglish	(2) scoreAfrican
meanscoreschool	0.880*** (0.0723)	0.869*** (0.0266)
lang2home: African	-16.71*** (4.833)	8.095 (6.348)
Constant	146.1*** (51.02)	82.79*** (22.73)
Observations	1,738	8,599
R-squared	0.596	0.457
Controls	YES	YES

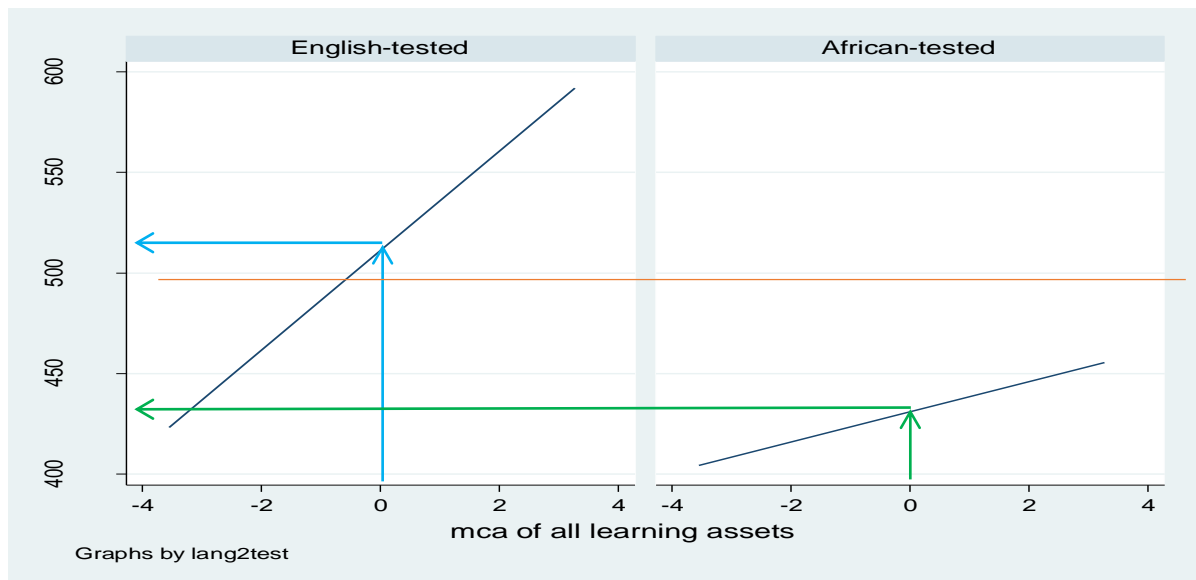
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Reference group for lang2home is *English*. Non-displayed controls are femaleStud, ageStud, asset, asset², schoolAssets, professional, university, homework, appreciation, lang2home, lang2test, rural, library, class size, remote rural, eduT, curriculum, feamleT, youngT, and province.

It is a stylized fact that socioeconomic status (SES) and school quality inputs are at the core of education production functions (Coleman, 1966). Household wealth is one dimension of SES and may be represented by an asset index⁵. **Error! Reference source not found.** overleaf arranges the student population by household asset wealth plotted against their test scores.

⁵ The asset wealth index is constructed using multiple correspondence analysis (MCA), which weights the most unequally distributed asset component the heaviest (Filmer and Pritchett, 2001). In this context, the components included are computer, desk/table, own books, own room, internet connection, daily newspaper, own cellphone, calculator, dictionary, electricity, and running tap water.

Figure 1. Test score-wealth gradients by test language



The gradients in Figure 2 illustrate that students of comparable socioeconomic status (asset wealth) achieve very different literacy scores across the test language tiers. The English-tested gradient is steeper and extends to higher scores than the African-tested gradient. Thus, there is an enormous incentive for students to select into English-testing schools. The regression results in Table 3 below confirm the positive relationship between school wealth⁶ and educational outcomes.

⁶ School wealth is the mean of student assets by school.

Table 3. Regressing quintiles of school assets on test scores

VARIABLES	(2) testscore
lang2home: African	-37.32*** (8.918)
lang2test: African	-24.50*** (8.431)
2.quint_schoolAsset	4.642 (9.120)
3.quint_schoolAsset	11.96 (10.59)
4.quint_schoolAsset	26.17** (11.42)
5.quint_schoolAsset	49.45*** (12.78)
Constant	605.3*** (34.19)
Observations	7,645
R-squared	0.521
Controls	YES

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

Reference category for lang2home and lang2test is *English*, for quint_schoolAsset it is the 1st quintile. Non-displayed controls are femaleStud, ageStud, asset, asset², schoolAssets, professional, university, homework, appreciation, remote rural, library, class size, remote rural, eduT, curriculum, feamleT, youngT, and province.

For the two richest school quintiles (quintiles 4 and 5) there seems to be a significant advantage in literacy test scores compared to the poorest quintile (quintile 1). Learners in quintile 4 and 5 schools achieve test scores which are 26 and 49 points higher than than their quintile 1 school counterparts. The intermediate wealth quintiles, 2 and 3, perform only somewhat (and statistically insignificantly) better than quintile 1 schools. The negative coefficients of lang2home and lang2test signal suggest that African home and test language remain negatively and highly significantly correlated test scores, with students speaking or being tested in these languages respectively achieving 37 and 25 points lower test scores than their respective

English reference groups. Thus, SES, represented by asset wealth, is significantly and strongly associated with higher educational outcomes, while test and home language coefficients remain highly significant, even after accounting for school quality and other background factors.

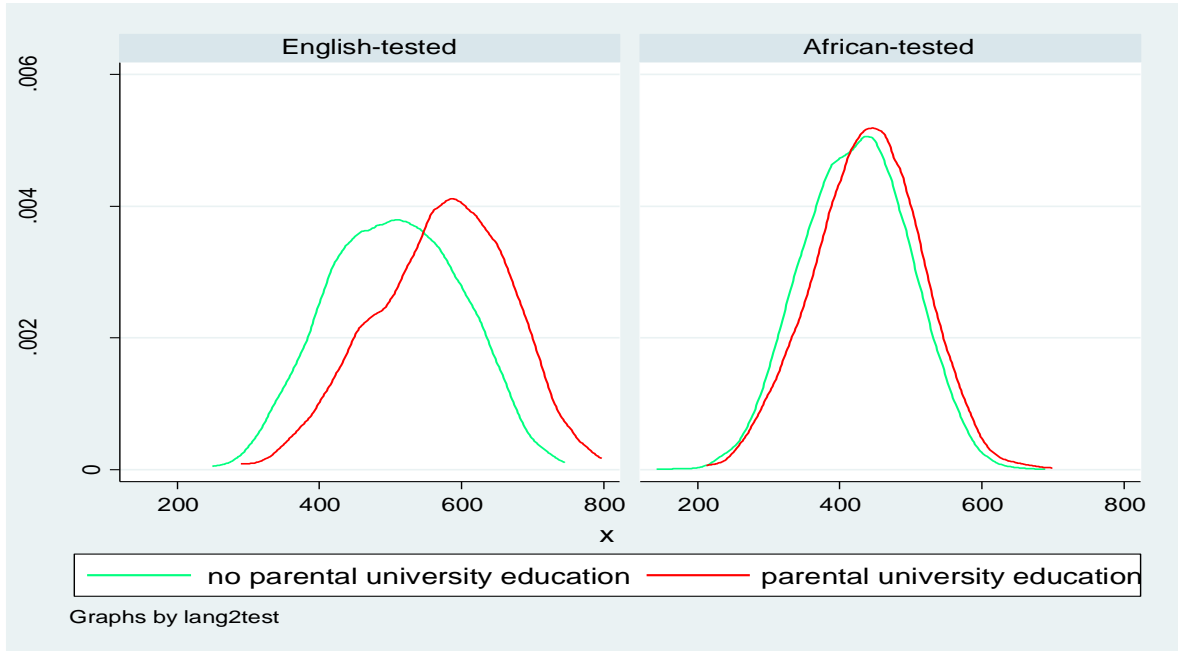
The results in this section provide some evidence of the educational advantage of choosing an English-language school. Learners with low learning deficits associated with being poor. The next section of the paper discusses the association between home and school-level inputs, and literacy.

3.2 Transforming Home and School-level Inputs into Educational Outcomes

The capacity to absorb parental educational inputs varies between the two quality tiers (schools testing in English versus those testing in an African language). Parental university education – whether parents have a tertiary education or instead received only upper secondary or less education – correlate with higher student test scores in the English-tested group, but not in the African-tested group (**Error! Reference source not found.**).

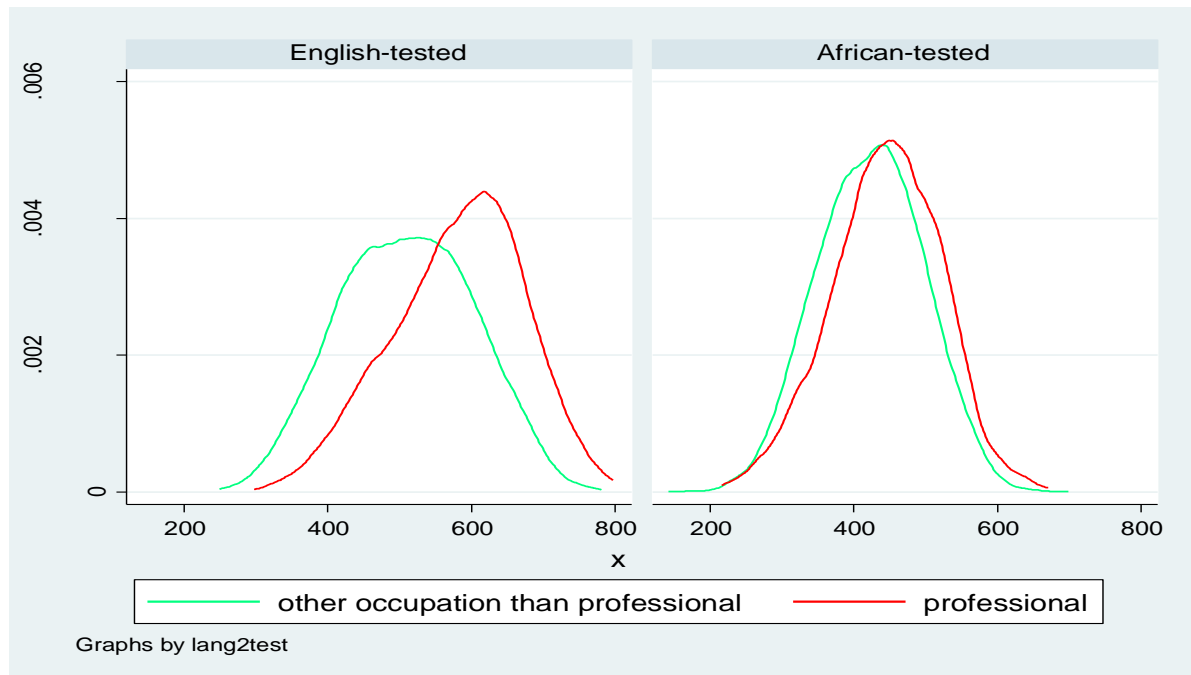
Figure 2. Parental university education⁷ and student test scores by test language

⁷ Note: No parental university education includes the categories upper secondary, lower secondary, some primary, no schooling, not applicable.



In contrast, in the African-tested tier, when not controlling for other factors, students of parents with university education do not seem to differ from their peers who have parents without university education. For parental occupation, in the English-tested tier, students with parents working as professionals seem to reach higher literacy scores than their peers of parents without university education, but in this case the advantage of having a professional parent also extends to African-tested schools, albeit it to a lesser degree (Figure 4).

Figure 3. Parental professional occupation and student test scores by test language



Note: Non-professional occupations include the categories small business owners, clericals, skilled workers, general laborers, never worked outside home, not applicable.

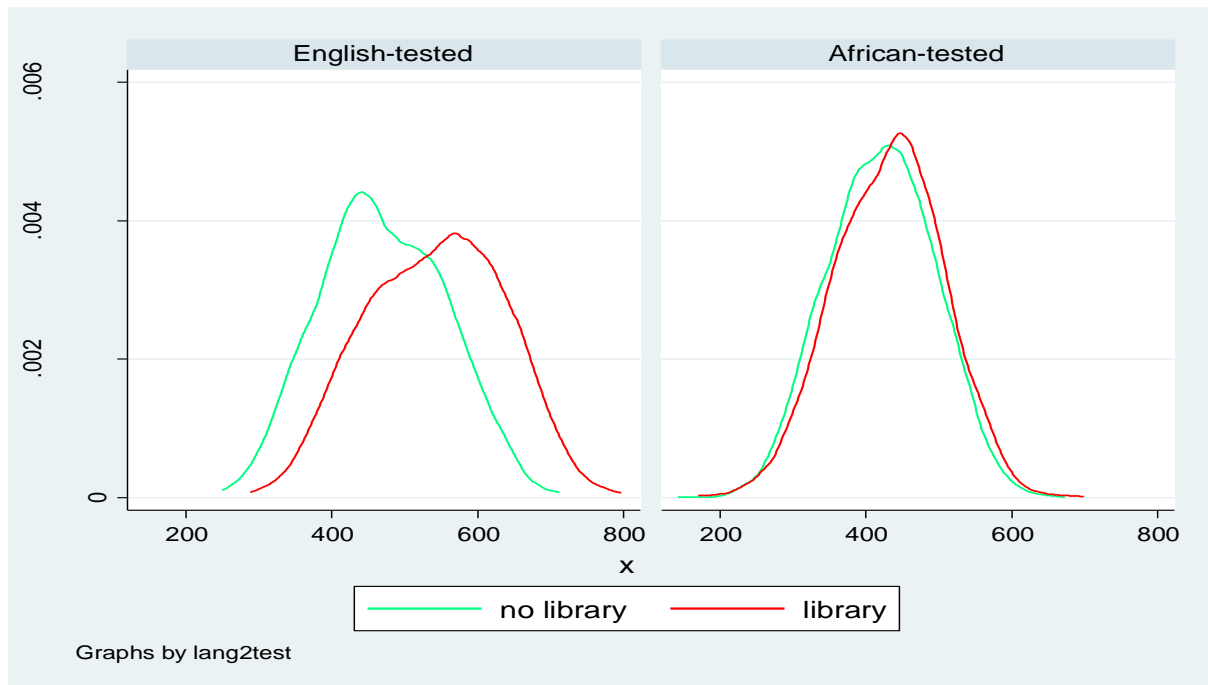
Error! Reference source not found.4 presents regression results of conventional controls regressed on student test scores. Overall, having parents with university education is associated with 15 points higher test scores, and parents working as professionals with 18 points higher test scores. By test language, English-tested students of university educated parents have 9 points higher test scores than those whose parents do not have university education, and those whose parents work as professionals another 14 points higher test scores. In contrast to the graphical presentations, once some controls are added, African-tested students of university educated parents and of professionals score significantly higher: For children of university educated parents, conditional test scores are 18 points higher test scores than for their peers, and professional parents are associated with a similar advantage of 15 points.

The impact of higher parental education/occupation on higher student test scores relates to the consensus from the literature, that better educated parents are more able and likely to interact with their children in enhancing their cognitive development.

The second Coleman determinant of educational success are school inputs. Provision of a library is a traditional material school input. In the English-tested tier, having a library seems to shift the kernel density graph of test scores to a higher level (**Error! Reference source not found.**). In the African-tested tier,

literacy skills seem largely unaffected by the presence of a library. Regression results controlling for other factors (**Error! Reference source not found.**) confirm the large advantage of attending a school with a library amongst English-tested schools, at almost 39 points, but in the African-tested tier there is indeed an advantage, though lower at only about 23 points. Thus, the test score advantage associated with having a school library seems larger in the English-tested tier than in the African-tested tier.

Figure 4. Library and student test scores by test language



Teachers are also assumed to be important inputs to the learning process, although there is some disagreement in the literature the role of teacher attributes of age, gender, qualification and experience in student achievement. Regressing teacher attributes on student test score delivers barely significant coefficients (**Error! Reference source not found.**). Results for the English-tested tier should be interpreted with caution, as the number of teachers involved is relatively small (the number of observations refers to the number of children taught by teachers; given average class sized of around 40, only about 40 teachers are observed in English-tested schools). In the African-tested tier, where more teachers were observed, teacher education variables provide estimates as expected: High levels of teacher education are associated with significantly higher student test scores. The gender of teachers does not seem to influence student test scores, nor does teacher age (except in the case of African-tested schools where for the most part the age of teachers is positively and significantly related to test scores). Some teacher-age-education-heterogeneity may be linked to recent teacher supply changes. To remedy the severe shortages of adequately qualified

teachers especially among African mother tongue instructors of the Foundation Phase, relatively low entry requirements into teacher training may have been applied (Van Broekhuizen, 2015). This could possibly have attracted prospective students to whom other university options were closed due to their poor Matric performance (Cossar, 2009), which in turn may have led to a recent decrease in teacher quality. Overall, those teacher attributes conventionally added to education production functions do not seem to be significantly related to learning outcomes.

Table 4. Regressing conventional socio-economic and school quality attributes on student test scores

VARIABLES	(1) testscore	(2) Score English	(3) Score African
lang2home: African	-29.86*** (8.236)	-34.04*** (7.241)	29.13*** (9.447)
lang2test: African	-30.87*** (8.803)		
femaleStud	22.21*** (2.188)	16.82*** (3.835)	25.82*** (2.403)
ageStud	-5.062*** (1.279)	-9.682*** (2.615)	-4.780*** (1.323)
asset	4.570*** (0.833)	8.388*** (1.510)	1.097 (1.013)
asset ²	-0.451 (0.418)	0.371 (0.512)	-1.937*** (0.531)
schoolAssets	23.47*** (4.567)	30.68*** (5.413)	19.12*** (6.313)
university	15.56*** (3.648)	9.439* (4.725)	18.30*** (4.702)
professional	18.17*** (3.678)	13.65*** (3.634)	15.13** (6.002)
2.eduT: post-secondary, non-tertiary (ISCED 4)	14.00 (10.92)	-0.733 (18.15)	11.06 (11.89)
3.eduT: 1st stage of tertiary, 1 st or 2 nd qualif.(ISCED 5B)	0.747 (15.01)	-25.23 (20.09)	7.287 (15.69)
4.eduT: 1 st stage of tertiary, 1 st degree(ISCED 5A, 1 st)	7.036 (12.50)	-3.729 (21.27)	5.792 (13.46)
5.eduT: 1 st stage of tertiary, 2 nd degree(ISCED 5A, 2 nd)	17.10 (18.05)	-21.30 (20.73)	22.38 (19.38)
6.eduT: missing	7.627 (10.90)	-18.27 (18.19)	2.434 (11.66)
femaleT	-7.688 (8.901)	6.130 (15.11)	-1.944 (9.843)
2.ageT: 30-39	-10.38 (15.42)	-25.40 (18.52)	34.15** (15.81)
3.ageT: 40-49	11.17 (12.82)	-6.973 (14.38)	53.28*** (17.12)
4.ageT: 50-59	-7.127 (14.76)	-5.643 (14.49)	39.39* (21.32)

5.ageT: over 60	38.68**	26.27	94.47***
	(14.91)	(18.17)	(28.97)
classSize	-0.342	0.120	-0.164
	(0.248)	(0.559)	(0.258)
1.library: yes	18.40**	38.84***	22.62**
	(7.971)	(8.358)	(10.15)
2.library: missing	30.74**	61.61***	6.603
	(14.67)	(12.37)	(20.53)
remote_rural	8.159	137.6***	-5.212
	(9.045)	(32.81)	(10.81)
2.province: Eastern Cape	4.121	-24.68**	-0.773
	(9.931)	(11.37)	(13.30)
3.province: Northern Cape	0.569	-9.696	-7.539
	(16.89)	(16.80)	(14.91)
4.province: Free State	-30.68***	-3.054	-38.79***
	(9.628)	(13.26)	(11.10)
5.province: KwaZulu-Natal	-3.713	10.56	-14.17
	(10.44)	(8.666)	(13.86)
6.province: North West	-39.74***	-154.7***	-51.35***
	(9.822)	(28.60)	(10.95)
7.province: Gauteng	-43.08***	-15.98	-80.29***
	(10.50)	(9.733)	(12.10)
8.province: Mpumalanga	-30.61**	-7.964	-42.85***
	(12.86)	(17.97)	(14.49)
9.province: Limpopo	-45.54***	-155.0***	-51.40***
	(11.19)	(28.19)	(13.94)
Constant	636.1***	617.1***	415.0***
	(32.65)	(45.07)	(37.66)
Observations	7,934	1,598	6,336
R-squared	0.486	0.538	0.250
Controls	YES	YES	YES

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

The reference category of lang2home and lang2test is *English*. Reference category for university is *upper secondary, lower secondary, some primary, lower secondary or no school, not applicable*, for professional is *occupation as small business owner, clerical, skilled worker, general laborer, never worked outside home, not applicable*. Reference category for library is *no library*. Reference category for eduT is *incomplete and upper secondary (ISCED 3)*, for ageT is *under 30 years*. The dummy remote_rural is 0 for *urban, sub-urban, medium-sized city, small town, missing*. Reference category for province is *Western Cape*.

In sum, the advantages often associated with SES in the form of parental education and occupation and school inputs, material (library) and immaterial (teachers), do not always convert into higher test scores. Particularly in the lower quality African-tested group where the need for improvement is most urgent. Thus, alternative determinants of academic success, effective in both education quality tiers, need to be found.

3.3 Non-Conventional Inputs

In a search for determinants of learning success that could be effective in both education quality tiers, the focus now shifts to non-conventional variables, so-called “softer” factors that are not as often included in education production functions, and not often included in the questionnaires of school-based testing surveys. Beyond parental education and occupation the prePIRLS 2011 data set offers a range of parent-child interaction variables, such as how much the child feels appreciated by the parents when reading (appreciation) or how often the parents check their child’s homework (homework).

Error! Reference source not found. indicates that parental appreciation seems to be associated with higher literacy scores in both education quality tiers. The advantage from parental appreciation (as perceived by the child) seems more pronounced in the English-tested tier, but in the African-tested tier, the kernel density graph also shifts to the right, i.e. to higher test scores. Similarly, across both test language tiers, higher frequency of homework checks by parents, as reported by the child, is associated with higher student test scores. Without controlling for anything else, it seems as if English-tested students achieve a greater test score advantage from homework checks than African-tested students (**Error! Reference source not found.**7).

Figure 5. Parental appreciation and student test scores

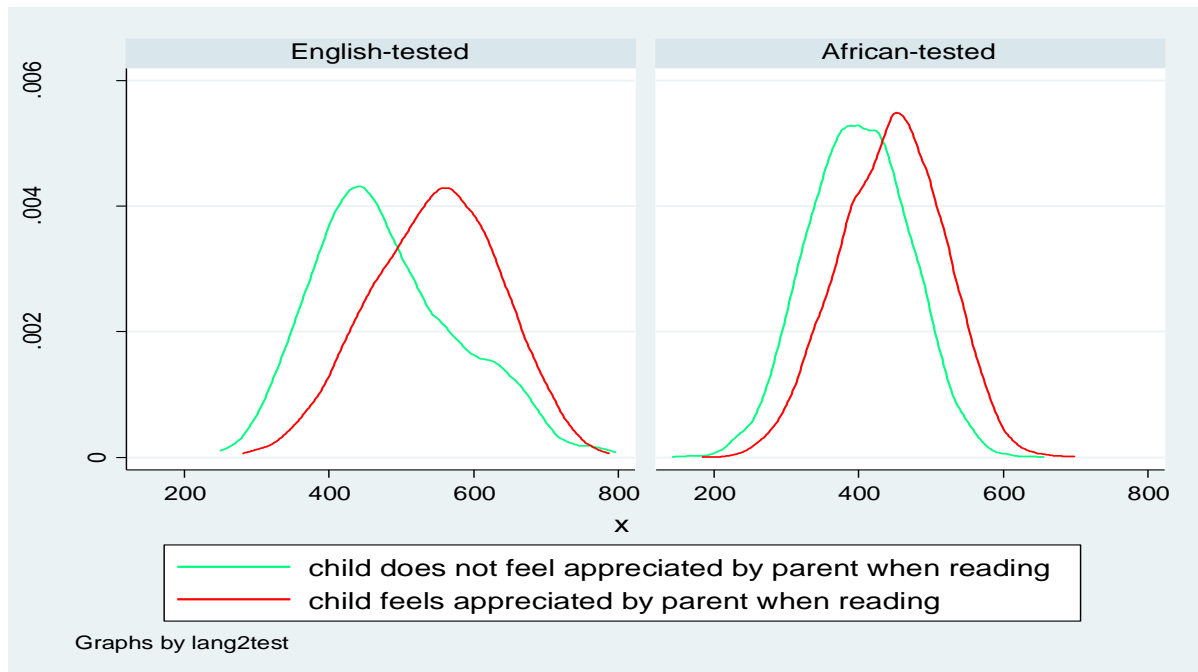
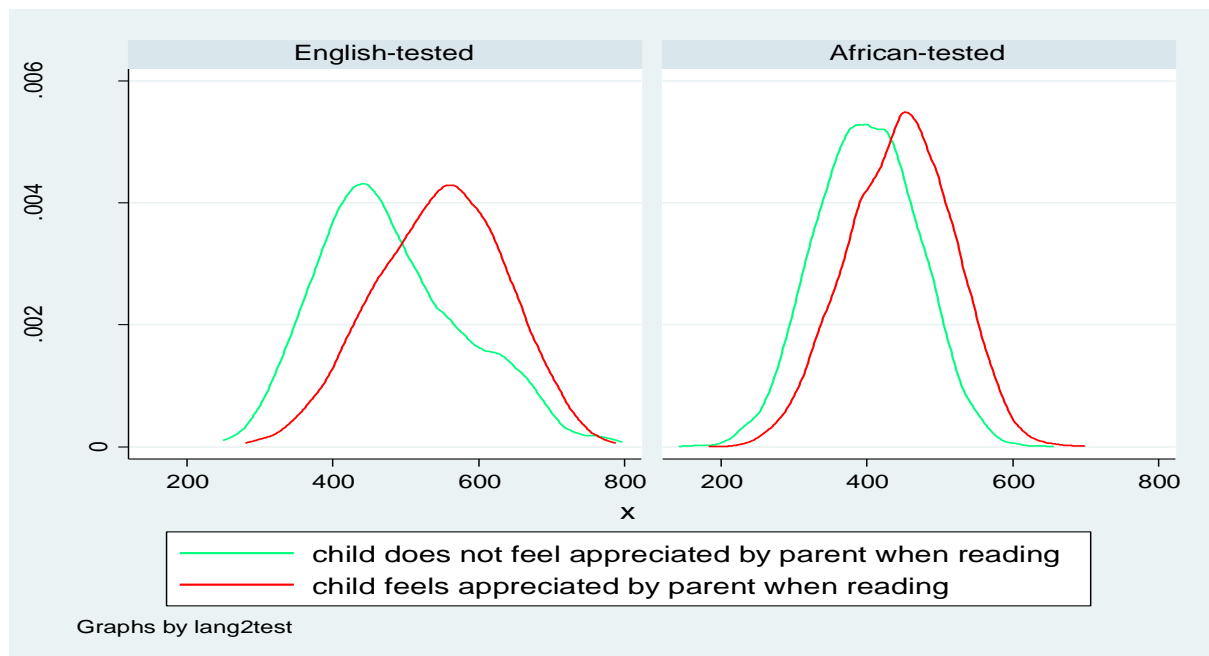
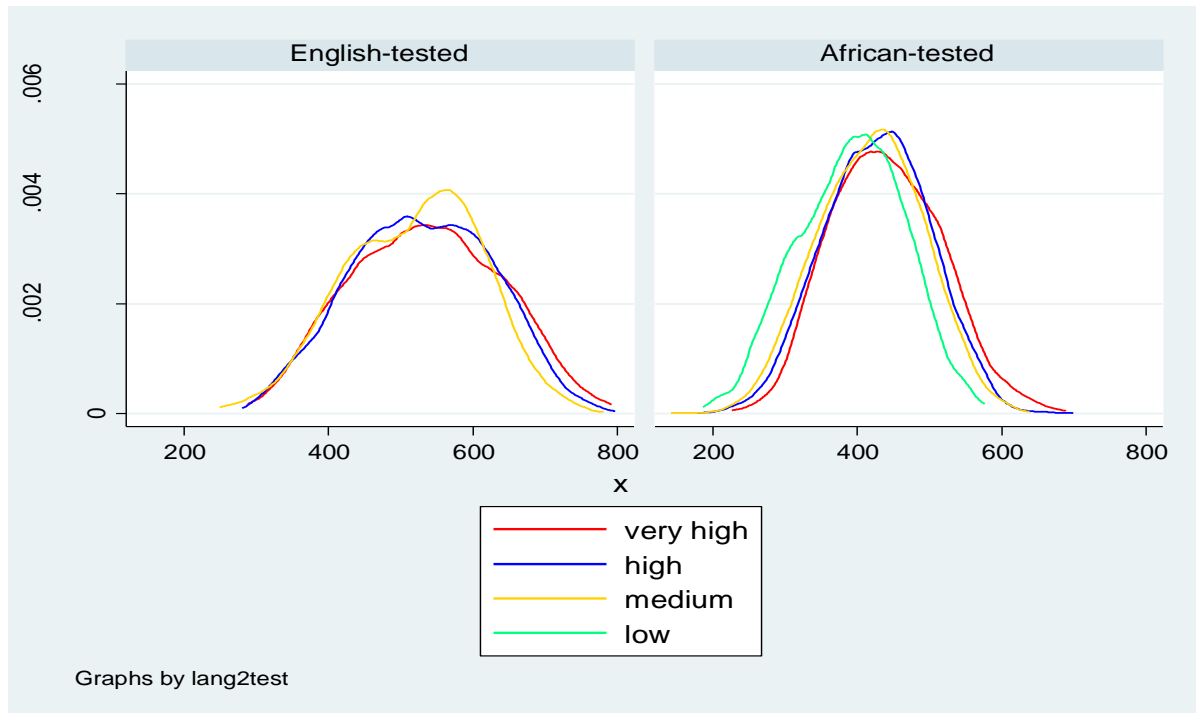


Figure 7. Parental appreciation and student test scores



An aspect of teacher behaviour that can be captured by non-conventional variables is curriculum adherence (*curriculum*) as reported by teachers themselves. Across the test language tiers, very high curriculum adherence correlates with higher test scores (**Error! Reference source not found.**).

Figure 6. Teacher curriculum adherence and student test scores



Regression results in **Error! Reference source not found.**⁵ indicate a correlation of the non-conventional parental and teacher variables with test scores across the quality tiers, even after controlling for some other factors such as the school's asset index⁸. Across test language tiers, parental appreciation is associated with a 32 point higher literacy test score. For the English-tested tier, students who feel their parents appreciate when they read have test scores that are almost 19 points higher, while for the African-tested tier this is associated with an even larger test score advantage of 34 points. Hence appreciation seems to be have even larger effects for African-tested students compared to English-tested students. For both test language tiers jointly, students of parents checking homework every day perform about 21 points higher that those who never or seldom check, while the gain associated with parents who check only once a week is somewhat lower for African-tested students at about 8 points. Across test language tiers, medium or high rather than very high teacher curriculum adherence (as reported by teachers) is associated with a 18 to 20 points disadvantage in literacy scores, while low curriculum adherence is associated with a large disadvantage of 53 points compared to very high adherence. For the English-tested tier, the coefficients on curriculum adherence are small and insignificant, indicating that this is not much of a factor in this part of the school

⁸ This model excludes conventional attributes such as parental education and occupation and excludes conventional teacher attributes such as age, education, gender. This model specification focuses on the non-conventional family and school attributes.

system. In contrast, for the African-tested tier, curriculum adherence shows very high and significant coefficients. Learners whose teachers report that they practice very high curriculum adherence perform 45 points better than those who report medium or even high adherence, controlling for other factors. Low curriculum adherence is associated with a 68 points disadvantage in these African-tested schools, compared to students whose teachers report very high curriculum adherence. These are large coefficients even when considering that there is likely to be bias from overestimated self-reporting of teacher curriculum adherence.

Model explanatory power for the African-tested tier is considerably lower than for the English-tested tier. Across the two model specifications of conventional attributes (table 4) and non-conventional attributes (**Error! Reference source not found.**5), model explanatory power of English-tested students decreases slightly (from $R^2=0.538$ to 0.513), but increases for African-tested students (from $R^2=0.250$ to 0.306)⁹. It is promising to find non-conventional literacy skills determinants seemingly specific to African test language. As a result, non-conventional parental and teacher variables, such as appreciation, homework checking, and curriculum adherence, are associated with relatively large test score coefficients that are significant in both school quality tiers.

Table 2. Regressing non-conventional variables on student test scores

VARIABLES	(1) testscore	(2) scoreEnglish	(3) scoreAfrican
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⁹ The full regression model (**Error! Reference source not found.**) with all conventional and non-conventional attributes maximizes R^2 for all specifications, but the model explanatory power gap between the English- and African-tested sample remains.

lang2home: African	-33.67*** (7.785)	-30.98*** (6.794)	18.07** (8.839)
lang2test: African	-37.13*** (8.793)		
femaleStud	20.62*** (2.422)	13.78*** (3.984)	24.83*** (2.544)
ageStud	-5.673*** (1.347)	-9.092*** (2.646)	-4.830*** (1.461)
asset	2.958*** (0.929)	7.583*** (1.432)	-0.912 (1.287)
asset ²	0.0125 (0.441)	0.476 (0.525)	-1.772*** (0.565)
schoolAssets	28.79*** (3.872)	43.36*** (5.309)	17.99*** (5.537)
1.homework: once a week	13.74*** (4.369)	25.24*** (8.297)	8.138* (4.417)
2.homework: every day	20.90*** (3.498)	22.11*** (6.219)	20.28*** (3.663)
appreciation	32.08*** (3.535)	18.81*** (5.465)	34.14*** (3.599)
2.curriculum: high	-20.33 (13.91)	-10.65 (11.55)	-44.25** (20.41)
3.curriculum: medium	-17.52 (14.79)	-4.974 (16.02)	-44.46** (19.90)
4.curriculum: low	-52.76*** (13.27)		-68.48*** (16.85)
classSize	-0.218 (0.254)	0.618 (0.633)	-0.0550 (0.282)
remote_rural	11.68 (8.473)	107.4*** (34.78)	7.109 (8.488)
2.province: Eastern Cape	-10.45 (9.435)	-21.12 (14.87)	-30.48** (13.53)
3.province: Northern Cape	-16.89 (14.27)	-24.91 (16.79)	-32.08** (13.67)
4.province: Free State	-28.97*** (10.69)	-21.25 (14.03)	-35.95*** (12.44)
5.province: KwaZulu-Natal	-15.70* (9.462)	-4.322 (11.83)	-34.08** (13.64)
6.province: North West	-51.09*** (9.786)	-124.2*** (30.75)	-63.80*** (12.52)
7.province: Gauteng	-51.84*** (11.32)	-30.05** (13.24)	-88.78*** (13.52)
8.province: Mpumalanga	-45.32*** (9.593)	-39.77* (21.16)	-60.41*** (12.72)
9.province: Limpopo	-54.52*** (10.45)	-143.9*** (31.07)	-69.59*** (13.42)
Constant	664.7*** (27.37)	598.3*** (44.78)	510.4*** (34.41)
Observations	7,704	1,620	6,084
R-squared	0.501	0.513	0.306
Controls	YES	YES	YES

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

Reference category for curriculum is very high, for homework is parent checks homework never, once or twice a month, missing, and the dummy appreciation turns 0 when the child does not feel appreciated by parent when reading.

Remote_rural dummy=0 for urban, sub-urban, medium-sized city, small town, missing. Reference category for province is

In the full model (**Error! Reference source not found.**) including conventional and non-conventional factors, the non-conventional coefficients – homework check (15.60 points on average), appreciation (29.65 points), and curriculum adherence (35.50 points on average) – add up to a test score advantage of 80.75 points, on average. Thus, students of parents checking homework and encouraging their children and of conscientious teachers seem to gain a relatively large advantage in literacy achievement. In contrast, conventional factor coefficients – parental education (14.75 points), occupation (18.45 points), and presence of a library (16.23 points) – adds up to a test score advantage of 49.13 points, on average. Thus, the correlation of conventional factors with literacy scores seems considerably smaller than the correlation of non-conventional factors with literacy scores. This gap becomes more distinct when student demographics are decomposed by test language (table 7 below and expressed in bar chart form in Appendix B table AB10).

Table 7. Aggregated coefficients of conventional versus non-conventional factors shaping literacy scores

	All students	English-tested	African-tested
Conventional factors (university, professional, library)	49.13	62.53	50.49
Non-conventional factors (homework, appreciation, curriculum)	80.75	40.59	102.24

Note: Non-displayed controls are lang2home, femaleStud, ageStud, asset, asset², schoolAssets, eduT, femaleT, ageT, classSize, remote_rural, and province.

For English-tested students, conventional factors add up to a test score advantage of 60.23 points, as opposed to the sum of non-conventional factors with 40.59 points. Hence, conventional factors seem to be more pronounced than non-conventional factors in the English-tested demographic. For African-tested students, conventional factors add up to a test score advantage of 50.49 points, compared to the sum of non-conventional factors with 102.24 points. Thus, the impact conventional factors seem to be less pronounced than that of non-conventional factors in the African-tested demographic. Literacy scores in the English- and African-tested tiers seem to similarly affected by conventional factors, while non-conventional factors expose much larger coefficients for literacy scores in the African- than in the English-tested tier.

Our analysis suggests that non-conventional measures of parental and teacher attitudes and behavior can be a path to increasing school quality in the African-tested tier. Enhancing those non-conventional learning inputs may be especially rewarding, because they may be easier to change. Parental education and occupation are difficult to alter because they were fixed in the past. Improving teacher qualifications could be difficult and slow. The pure availability of material inputs, such as a library, does not in itself seem to boost literacy skills. In contrast, non-traditional factors linked to soft factors such as inter-personal interaction and motivation can be altered more easily. Parents may be encouraged to cheer their children when reading and become part of the learning process through regularly checking of their children's homework. Teachers can be incentivized to adhere to the curriculum. Teacher incentives, a factor that economists take great interest in, have been much studied in the development context (Duflo, Hanna 2005; Glewwe et al. 2003). In sum, effective education policy may aim at a shift from supporting conventional learning inputs to non-conventional 'inputs' associated with parental and teacher behaviour.

Table 6. Full regression model including all controls on student test scores

VARIABLES	(1) testscore	(2) scoreEnglish	(3) scoreAfrican
lang2home	-29.39*** (7.626)	-33.56*** (6.894)	26.89*** (8.144)
lang2test	-27.20*** (8.192)		
university	14.75*** (3.342)	9.220* (4.660)	16.80*** (4.252)
professional	18.45*** (3.740)	14.33*** (3.813)	17.24*** (5.937)
femaleStud	20.03*** (2.263)	14.87*** (3.804)	24.07*** (2.374)
ageStud	-4.875*** (1.269)	-9.388*** (2.579)	-4.097*** (1.292)
asset	2.738*** (0.877)	7.291*** (1.456)	-0.512 (1.149)
asset ²	-0.304 (0.391)	0.265 (0.477)	-1.634*** (0.499)
schoolAssets	22.86*** (3.803)	29.92*** (5.553)	15.71*** (4.955)
1.homework: once a week	12.12*** (4.071)	21.39** (8.529)	6.678* (3.845)
2.homework: every day	19.07*** (2.970)	18.21*** (6.013)	17.65*** (2.946)
appreciation	29.65*** (2.839)	17.39*** (5.335)	31.13*** (3.056)
2.eduT: post-secondary, non-tertiary (ISCED 4)	16.41	-5.272	19.52*

	(10.40)	(17.71)	(10.93)
3.eduT: 1st stage of tertiary, 1 st or 2 nd qualif.(ISCED 5B)	-3.456	-35.81	2.297
	(12.99)	(21.80)	(12.64)
4.eduT: 1 st stage of tertiary, 1 st degree(ISCED 5A, 1 st)	6.098	-11.92	8.658
	(11.69)	(19.88)	(11.92)
5.eduT: 1 st stage of tertiary, 2 nd degree(ISCED 5A, 2 nd)	18.71	-23.68	19.93
	(14.57)	(20.51)	(12.70)
6.eduT: missing	7.121	-22.03	4.516
	(10.56)	(17.48)	(11.00)
2.curriculum	-21.72*	-4.045	-49.66***
	(11.22)	(10.08)	(12.62)
3.curriculum	-18.66	2.751	-44.80***
	(11.43)	(13.67)	(11.55)
4.curriculum	-66.12***		-82.39***
	(16.39)		(14.66)
femaleT	-7.193	10.37	-6.859
	(7.943)	(13.58)	(8.478)
2.ageT: 30-39	-7.500	-23.57	24.32*
	(12.70)	(18.27)	(13.80)
3.ageT: 40-49	9.861	-8.582	40.03***
	(11.21)	(15.23)	(14.49)
4.ageT: 50-59	-6.240	-4.356	24.88
	(12.28)	(15.16)	(18.08)
5.ageT: over 60	34.34**	16.75	94.39***
	(15.52)	(17.13)	(25.07)
classSize	-0.220	0.138	-0.0381
	(0.210)	(0.564)	(0.216)
1.library	16.23**	38.98***	16.45**
	(6.717)	(8.712)	(7.909)
2.library	28.03**	58.42***	0.459
	(14.15)	(12.94)	(16.05)
remote_rural	13.05*	125.4***	6.020
	(7.184)	(34.73)	(7.860)
2.province: Eastern Cape	-10.60	-22.96*	-27.02***
	(9.365)	(12.09)	(9.913)
3.province: Northern Cape	-8.844	-8.195	-23.97
	(17.61)	(22.52)	(14.74)
4.province: Free State	-30.48***	-4.221	-44.38***
	(9.774)	(13.07)	(8.806)
5.province: KwaZulu-Natal	-13.51	8.152	-33.90***
	(8.838)	(8.206)	(10.60)
6.province: North West	-50.10***	-148.2***	-71.69***
	(10.16)	(30.19)	(9.320)
7.province: Gauteng	-50.80***	-19.37**	-87.76***
	(10.43)	(9.337)	(10.51)
8.province: Mpumalanga	-38.54***	-13.29	-63.97***
	(11.00)	(16.75)	(9.462)
9.province: Limpopo	-52.59***	-144.7***	-69.52***
	(10.26)	(28.40)	(10.80)
Constant	615.7***	595.2***	447.5***
	(30.28)	(44.56)	(28.63)

Observations	7,645	1,598	6,047
R-squared	0.532	0.550	0.349
Controls	YES	YES	YES

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

The reference category of lang2home and lang2test is *English*. Reference category for university is *upper secondary, lower secondary, some primary, lower secondary or no school, not applicable*, for professional is *occupation as small business owner, clerical, skilled worker, general laborer, never worked outside home, not applicable*. Reference category for library is *no library*. Reference category for eduT is *incomplete and upper secondary (ISCED 3)*, for ageT is *under 30 years*. Reference category for curriculum is *very high*, for homework is *parent checks homework never, once or twice a month, missing*, and the dummy appreciation turns 0 when *the child does not feel appreciated by parent when reading*. The dummy remote_rural turns 0 for *urban, sub-urban, medium-sized city, small town, missing*. Reference category for province is *Western Cape*.

Frequencies weights, robust standard errors and clustering on school level apply.

3.4 School-level success

To confirm the importance of non-conventional variables in learner achievement, the focus is narrowed to successful schools scoring above the national average of 461 points. For the English-tested schools there are 70 such classrooms in 63 above-average performing schools. The individual test scores per school are centred closely around the school mean score with no scores under 400 points and students scoring above 700 points occurring in groups. In this tier, academic achievement seems to be rather systematically related to the amount of conventional inputs. The English-tested classrooms were mainly composed of African mother tongue speakers who always speak English at home. Specifically, 39 classes were dominated by African mother tongue speakers¹⁰, 14 classes were dominated by English mother tongue speakers, and the rest of the classes were mixed. This reflects the conventional perception that many African mother tongue students opt for English-language instruction in the pursuit of school quality. Geographically, the greater share of English-tested African mother tongue speakers dominated classes is located in Gauteng, KwaZulu-Natal, some in Limpopo, Mpumalanga, North West, and Freestate. The English-tested English mother tongue speakers dominated classes are located in the Western Cape and Eastern Cape.

Descriptives in this subgroup of above average achievers confirm earlier regression results: student asset wealth seems weakly linked to test scores, while school asset wealth is associated more strongly with test scores. Isolating the poorest 50% of these above-average achieving schools

¹⁰ Where there was at least 5 more mother tongue speakers of one language group than of any other.

includes 12 poor, English-testing schools. Their group mean school score of 439 points is far lower than the mean school score of all English-tested schools of 527 points, and they all have predominantly African mother tongue speakers. Among these 12 poor but achieving schools, one particularly excels with a mean school score of 528, and all 30 students scored above 450 points, with a test score maximum of 670 points. Observable characteristics reveal that all students are poor, that there is no library, and parental educational and occupational backgrounds are heterogeneous. No student knew the test language, English, before they started school. Their teacher is male and aged between 40 and 49 but has high expectations of his students. Other adult-child interactions, such as parental appreciation when reading, and parent-school interaction, such as parental volunteering in a committee two to three times a year, were rated by all students in the highest category. Thus, the descriptives of this exception to the financial-resources-matter rule seem to highlight good teacher-student, parent-child, and parent-school interaction.

235 African-tested schools scored above the national average of 461 points. In these schools, 3 893 students were tested in 277 classrooms. However, not a single student scored above 700 points and only 49 students scored above 600 points and they were rather solitary achievers in their schools, occurring as outliers among their peers. The rare occurrence of African-tested achievers in schools indicates that they had succeeded despite their schools, not because of it. In contrast to English-testing schools, success in African-testing schools does not seem systematic. Among the poor but achieving African-tested schools, one school excelled. Of 35 students, 12 scored above 600 points. All students had isiZulu as both test and home language. This school had a library and is not located in a rural area. Parental socio-economic background reveals 6 students of parents with a university education, but none in professional occupations. Parent-child interactions emphasize daily homework checks through parents and parental appreciation when the child reads. The female teacher is between 40 and 49 years old and received the highest qualification measured in the survey. She also adheres very strictly to the curriculum.

Thus, similar to the excelling English-tested schools, in the above average African-tested schools higher literacy skills are also associated with interpersonal parental and teacher variables. In contrast to the English-tested tier, African-tested achievers appear as positive outliers among their classmates while English-tested achievers appear in groups. Thus, it appears that weak

functionality of the African-tested tier may be preventing the emergence of a critical mass of strong student peers, while the English-tested tier exploits peer effects.

4. Conclusion

The African-tested tier of the education system tends to perform worse in literacy skills due to socio-economic and school quality disadvantages. Weak functionality of the low quality African-tested tier prevents effective transformation of conventional learning inputs into educational outcomes. Students in this tier who achieve well are positive outliers, in contrast to the English-tested group achievers.

Our analysis suggests that parental and teacher variables not conventionally included in education production functions are statistically significantly and positively linked to student achievement, even in the less functional, low quality African-tested tier. Hence, there is a case to be made for a greater shift in educational policy from a focus on the inputs conventionally observed and investigated, to interpersonal interactions. This makes a case for finding appropriate incentives to encourage parents and teachers to actively engage with their children.

Further micro-level research is needed on positive outliers among schools. Qualitative analysis can reinforce empirical findings. Interview-based surveys with principals, teachers, students and their families may provide deeper insights, capture further unobserved or unmeasured non-conventional inputs such as incentives and class atmosphere, and allow causal inferences to be drawn to validate quantitative findings.

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Appendix A. Variable Glossary

Variable Name	Description	Properties
ageStud	Students age	Numeric (double), range: [6.75, 14.92]
appreciation	Parents like when I read	Numeric (float), range: [0, 1], tabulation: 0. child does not feel appreciated by parent when reading 1. child feels appreciated by parent when reading
asset	MCA of all learning assets	Numeric (float), range: [-3.55,3.27], mean 1.0e-08, std. dev: 1.82
asset ²	Non-linearity of asset effect	Numeric (float), range: [1.180e-08,12.62], mean 3.32, std. dev: 3.64
classSize	Number of students in the class	Numeric (int), range: [13, 107]
curriculum	Teacher's degree of success in adhering to the curriculum	Numeric (byte), range: [1,4], Tabulation: 1. very high, 2. high, 3. medium, 4. low
eduT	Level of formal education completed	Numeric (byte), range: [1, 6], tabulation: 1. non-complete and upper secondary (ISCED 3) 2. post-secondary non-tertiary (ISCED 4) 3. 1st stage of tertiary, 1st or 2nd qualification (ISCED 5B) 4. 1st stage of tertiary, 1st degree(ISCED 5A, 1st) 5. 1st stage of tertiary, 2 nd degree(ISCED 5A, 2nd) 6. missing
experT	Teachers years of experience	Numeric (byte), eange: [1, 5], tabulation: 1. less than 5 years 2. 5-10 years 3. 10-20 years 4. 20 years or more 5. missing
femaleStud	Student gender	Numeric (float), range: [0, 1], tabulation: 0. boy 1. girl
femaleT	Teacher gender	Numeric (float), range: [0, 1], tabulation: 0. male teacher

		1. female teacher
homework	How often parents check homework	Numeric (float), range: [0, 2], tabulation: 0. parent checks homework never, once or twice a month, missing 1. parent checks homework once a week, 2. parent checks homework every day
Lang2home	Language group home language	Numeric (float), range: [1, 2], tabulation: 1. English-speaking at home 2. African-speaking
Lang2test	Language group test language	Numeric (float), range: [1, 2], tabulation: 1. English-tested 2. African-tested
library	Existing school library	Numeric (byte), range: [0, 2], tabulation: 0. no 1. yes 2. missing
meanscoreschool	Mean test score by school	Numeric (float), range: [316.89, 671.96], mean: 447.38, std. dev.: 63.98
professional	Parents' highest occupation level	Numeric (float), range: [0, 1], tabulation: 0. occupation as small business owner, clerical, skilled worker, general laborer, never worked outside home, not applicable 1. professional
province	Province	Numeric (double), range: [1, 9], tabulation: 1. Western Cape 2. Eastern Cape 3. Northern Cape 4. Free State 5. KwaZulu-Natal 6. North West 7. Gauteng 8. Mpumalanga 9. Limpopo
Remote_rural	Location of school	Numeric (float), range: [0, 1], tabulation: 0. urban, sub.urban, medium-sized city, small town, missing 1. remote rural
schoolAsset	Student assets by school	Numeric (float), range: [-2.987, 2.721], mean: -0.348, std.dev.: 0.99

scoreAfrican	Test score of students tested in an African language	Numeric (float), range: [141.93, 699.01], mean: 424.41, std.dev.: 74.25
scoreEnglish	Test score of students tested in English	Numeric (float), range: [249.55, 796.9], mean: 527.44, std.dev.: 97.38
testscore	Plausible value: overall reading PV1	Numeric (double), range: [141.93, 807.48]
Tier	Test and home language tier	Numeric (float), range: [1, 3], tabulation: 1. English-tested (English or other home language) 2. African-tested 3. English-tested (African home language)
university	Parents' highest education level	Numeric (float), range: [0, 1], tabulation: 0. upper secondary, lower secondary, some primary, lower secondary or no school, not applicable 1. university or higher, post-secondary
youngT	Age of teacher	Numeric (float), range: [1,5], tabulation: 1. Under 30, 2. 30-39, 3. 40-49, 4. 50-59. 5. 60 or more

Appendix B. Summary Statistics of Variables

Table AB3. Cross-tabulation of home language and test language

Lang2test	Lang2home		Total
	speaks English at home	speaks an African language at home	
English-tested	620 32.72	1,275 67.28	1,895 100.00
African-tested	139 1.33	10,322 98.67	10,461 100.00
Total	759 6.14	11,597 93.86	12,356 100.00

Table AB4. Summary statistics of university

University	Freq.	Percent	Cum.
upper secondary, lower secondary, some primary, no school,not applicable	13,604	86.41	86.41
university or higher, post-secondary	2,140	13.59	100.00
Total	15,744	100.00	

Table AB5. Summary statistics of parental profession

Professional	Freq.	Percent	Cum.
occupation as small business owner, clerical, skilled worker, general laborer, never worked outside home, not applicable	14,478	91.96	91.96
occupation as professional	1,266	8.04	100.00
Total	15,744	100.00	

Table AB6. Summary statistics of library

library	English-tested		African-tested	
	Freq.	Percent	Freq.	Percent
no	655	7.82	7,717	92.18
yes	1,142	22.51	3,931	77.49
Missing information	408	48.80	428	51.20
Total	2,205	100.00	12,076	100.00

Table AB7. Summary statistics of teacher age group

	youngT		English-tested		African-tested	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Under 30	664	4.45	348	16.60	51	0.45
30-39	2,779	18.64	493	23.51	2,082	18.18
40-49	7,561	50.72	815	38.87	6,327	55.23
50-59	3,590	24.08	278	13.26	2,943	25.69
Over 60	312	2.09	163	7.77	52	0.45
Total	15,744	100.00	2,097	100.00	11,455	100.00

Note: Number of observations is reported on student level with an average student-teacher ratio of 45:1.

Table AB8. Summary statistics of teacher education

eduT	English-tested		African-tested	
	Freq.	Percent	Freq.	Percent
non-complete and upper secondary (ISCED 3)	70	3.17	1,759	14.57
post-secondary non-tertiary (ISCED 4)	652	29.57	2,832	23.45
1st stage of tertiary, 1st or 2nd qualification (ISCED 5B)	66	2.99	642	5.32
1st stage of tertiary, 1 st degree (ISCED 5A, 1st)	759	34.42	1,739	14.40
1st stage of tertiary, 2nd degree (ISCED 5A, 2nd)	197	8.93	1,455	12.05
missing	461	20.91	3,649	30.22
Total	2,205	100.00	12,076	100.00

Note: Number of observations is reported on student level with an average student-teacher ratio of 45:1.

Table AB9. Summary statistics of appreciation

Appreciation	Freq.	Percent	Cum.
Child does not feel appreciated by parent when reading	6,603	41.94	41.94
Child feels appreciated by parent when reading	9,141	58.06	100.00
Total	15,744	100.00	

Table AB10. Summary statistics of homework

homework	Freq.	Percent	Cum.
parent checks homework never, once or twice a month, missing	4,879	30.99	30.99
parent checks homework once a week	1,886	11.98	42.97
parent checks homework every day	8,979	57.03	100.00
Total	15,744	100.00	

Table AB11. Summary statistics of curriculum adherence

curriculum	Freq.	Percent
Very high	1,819	12.42
High	7,271	49.66
Medium	5,304	36.23
low	247	1.69
Total	14,641	100.00

Table AB10. Graph of aggregated coefficients of conventional versus non-conventional factors shaping literacy scores

