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Reading achievement in Kenya: The language factor

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Declaration

I, Julie Berthet Valdois, certify that this thesis is my own work and that all the sources that I have used or quoted are referenced. Furthermore, I declare that this thesis has not been previously submitted for a degree at any other university.

February 8, 2020

Signed by candidate

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Dedication

I dedicate this thesis to African pupils from minority language groups who are taught in a language which is not their home language.

Abstract

This thesis addresses the schooling challenges posed by children living in African communities where several languages are used and where the language of instruction at school is not their home language. Its focus is the dynamic between languages spoken at home and in the school environment, particularly, how the home language may affect early reading skills. The study is situated in urban Kenya, where Kiswahili is the official language of instruction in lower grades, with English used later on, while many households use other languages at home (e.g. Kikuyu, Kikamba). This dissertation uses survey data collected in 2012 by USAID.

The study explores the extent to which the impact of being taught in Kiswahili in lower grades, depends on whether or not Kiswahili is the pupil's home language. School fixed effects are used to control for unobservable factors at the school level. Results from assessments run over a population of pupils who speak Kiswahili at home against those who do not within the same schools are compared. The Kiswahili literacy scores of pupils who speak Kiswahili at home are .206 standard deviation higher than those of pupils who do not speak it at home. The same students also achieve .247 standard deviation more in English, suggesting that speaking the same language at home and at school may also help reading acquisition in another language. The thesis then investigates reading skills' interactions between Kiswahili and English, to see if there is cross-language transfer. Seemingly Unrelated Regression is used to account for equations' cross-correlation. An interdependence is demonstrated between the two languages. The relationship between reading skills in the two languages is not constant and the transfer is stronger when tied to proficiency in English. The results further suggest that having a home language other than Kiswahili is not detrimental to language transfer once a certain proficiency is reached in English and in Kiswahili. Finally, the study examines the linguistic composition of a pupil's peer circle at school and the effect of the group's linguistic diversity on reading outcomes. The peer effect is isolated using a linguistic fractionalization index. This is done in different grades within the same school. Results show that peer effects on Kiswahili scores are mediated by linguistic diversity at school. As the peers' linguistic diversity increases, peers' Kiswahili scores decrease, which negatively affects pupils' own score. On English scores, peer effects are not found to be conditional on linguistic diversity. Findings further show that low achievers are more affected by peer effects than high achieving pupils.

Table of Contents

Table of Figures

Table of Tables

Chapter 1: Background and motivation of the study

Introduction

In 1990, at the World Conference in Jomtien, Thailand,[1] many low-income countries committed to the United Nation *Education for All* goals to ensure access to primary education for all children. Supported by donors and UN agencies, many countries in sub-Saharan Africa subsequently worked to address barriers to education. Their main purpose was to increase the enrollment rate by working on the reduction of school fees and education access policies. Several years later, enrollment rates had drastically improved. In sub-Saharan Africa, the average primary adjusted net enrollment ratio (ANER) increased from 59% to 79% between 1999 and 2012 (UNESCO, 2015). However, despite notable improvements in enrollment rates, an alarming observation was that many children remained unable to read a single word even after two or three years of schooling (UNESCO, 2015).

The initial assumption that increased enrollment and school inputs would effectively translate into improvements in pupil learning was not verified. By 2010, at the World Education Forum in Dakar,[2] the UN goal shifted from Education for All to Quality Education for All. The emphasis on quality was supported by the findings of Hanushek and Wößmann (2007) that educational quality and the role of cognitive skills are even more powerfully related to individual earnings and economic growth than are quantitative factors such as the number of years of schooling. Within the Dakar Framework for Action, many countries initiated reforms of their educational systems Amongst others, these reforms included Free Primary Education programs, affirmative action programs for girls, improving school inputs, and promoting bilingual instruction for pupils from minorities (UNESCO, 2000). Furthermore, countries committed to monitoring progress in learning outcomes through assessments. A well-known assessment used in Africa is the Southern and Eastern Africa Consortium for Monitoring Quality (SACMEQ),[3] a regional school-based assessment measuring proficiency in reading (in English) and mathematics for 6th grade pupils from 14 (Anglophone) countries in Africa. SACMEQ 2007's results showed that 18% of the enrolled pupils who had completed primary school were still functionally illiterate (Spaull, 2012), confirming the failure of these countries' education systems to provide effective learning outcomes for all. Other large-scale learning assessments undertaken by different agencies on the African continent confirm this trend. Since 2009, UWEZO[4] has been implementing large-scale household surveys including assessments of basic literacy and numeracy competencies in Eastern Africa. The

[1] http://www.un-documents.net/jomtien.htm.
[2] For more information on the World forum on education: http://www.un.org/en/development/devagenda/education.shtml.
[3] The Southern and Eastern Africa Consortium for Monitoring Quality: including 15 membership since 1997.
[4] UWEZO is an independent East African initiative supported by donors, including the Hewlett Foundation, DFID (UK), Sida, Hivos, CIFF, AJWS and the World Bank. For further details, please refer to their website: www.uwezo.net.

2013 UWEZO report states that less than a third of Grade 3 pupils in Eastern Africa possess basic literacy and numeracy skills after three years of instruction (UWEZO, 2013). Over the past ten years, the Research Triangle Institute (RTI International), supported by a range of donors including USAID, implemented numerous learning assessments in developing countries (Gove and Wetterberg, 2011). They reach the same conclusion: that many pupils on the African continent do not master basic reading skills after several years of instruction.

Explaining the roots of such low educational outcomes is not straightforward and relevant data are not always available. Many parameters must be considered when looking at pupils' achievement and data limitation often prevent the ability to control adequately for all relevant factors. Pupils come from diverse background, they have their own characteristics and they study in different school environments. Furthermore, in Africa, pupils have different home language backgrounds and most children live in communities where several languages are used, and where the language of instruction is rarely their home language (UNESCO, 1997).

The language issue in the African context

Language in Africa is a sensitive topic because of the history of colonial occupation and the potential political interests behind current language policies[5] (Benson, 2004; Neville, 2005; Omoniyi, 2003). Most African countries opted for an *early transition model* where the instruction in the first school years is given in the main local language before shifting to a foreign language (most often English or French), which is usually the language of the former colonizer, as the language of instruction at school (Alidou *et al.*, 2006). Consequently, Africa is the only continent where the majority of children start learning in a foreign language from a very early stage (Ouane and Glanz, 2010). In addition, given language heterogeneity[6], the African language used as the language of instruction in the first years might be different from the mother tongue spoken by pupils at home. Therefore, using an African language at school does not necessarily mean that all pupils receive instruction in their home language. For some children, the language of instruction is the second or third language spoken at home and therefore a language to which they have little exposure (Bunyi, 1997). For others, it is a new language which they have never been exposed to in their familial environment.

Linguists emphasize the importance of receiving instruction in a language that children are exposed to at home in order to facilitate language acquisition and reading skills (Durgunoglu and Oney, 2000; Gass and Mackey, 2002). Moreover, shifting to another language of instruction too early, before learners have developed enough proficiency in their mother tongue, may also affect the learning process and produce negative results (Cummins, 1993; Durgunoğlu, 2002; Verhoeven,

[5] Many authors argue that the language of instruction is used as a tool, by elites or dominant ethnic groups, to discriminate minorities or marginalized population, to *deny them the right to a quality education* (Benson, 2004) and to keep them out of the power sphere (Omoniyi, 2003).
[6] More than 2,149 mother tongue languages are spoken in Africa (Lewis *et al.*).

1994). Therefore, studying the language dimension and its effect on educational outcomes is crucial in African contexts.

Many studies in the education literature compares outcomes for pupils taught in an African language to pupils taught in English in the African context. They conclude that an early shift from the African language instruction to English instruction is negatively associated with learning (Alidou *et al.*, 2006; Argaw, 2016; Brock-Utne, 2007; Heugh, 1999; Vuzo, 2007). Other authors showed that speaking the school language of instruction at home is positively associated with school achievement[7] (Hungi and Thuku, 2010; Smith and Barrett, 2010; van Staden *et al.*, 2016). However, most of these studies do not control for school factors, which are of importance as several school factors, observable or not, may be confounded with educational outcomes. Recently, a few economic studies provided evidence of the negative effects of not receiving instruction in the home language while considering a possible self-selection bias at the school level in their methodology. Using changes in the language of instruction policy in South Africa as an identification strategy, several authors report that instruction in the home language (instead of English) significantly improved reading ability (Eriksson, 2014; Taylor and von Fintel, 2016). In the same line, using a difference-in-difference approach, Spaull (2016) finds a negative impact of writing and reading a test in English for students who do not speak English at home in the South African context. Still, literature evidencing the positive impact of receiving home language instruction in the African context is scarce. Furthermore, these studies compare foreign language instruction (English) to African language instruction on the assumption that all pupils speak the same African language at home. This simplistic view does not reflect the real African context, where several home languages are spoken in communities.

In addition, most studies do not look at the possible interaction between languages in a multilingual environment such as Africa, and how it may impact educational outcomes as well. In some instances, bilingual instruction has shown to have positive outcomes, with both languages developing simultaneously (Butler, 2013; Cummins, 1976; Dillon, 2009; Lambert, 1981). Evidence, mostly from developed countries, shows that languages are *interdependent* and that reading knowledge transfers between languages (Butler, 2013; Jessner, 2008; Lasagabaster, 1998; Lee and Zuze, 2011; Melby-Lervåg and Lervåg, 2011; Ramírez *et al.*, 2007; Yamashita, 2002). Furthermore, some work done lately on third language acquisition suggests that multilingualism may provide additional linguistic resources and tools, contributing positively to language transfer and to further language acquisition (Cenoz, 2003, 2013; Haenni Hoti *et al.*, 2011). Most of these studies assume that reading knowledge is first acquired in the home language. This is not always the case in the African context (Pretorius and Mampuru, 2007; Williams, 1996). Evidence is scarce on language interdependence and language transfer in Africa, and more research could be done on this topic (Asfaha *et al.*, 2009; De Sousa *et al.*, 2010; Pretorius and Mampuru, 2007). In the specific

[7] Using data across 14 African countries, Hungi and Thuku (2010) find that speaking the language of instruction at home is associated with higher scores, by .05-.16 standardized deviation. All coefficients are significant. Similarly, Smith and Barrett (2010) find higher scores when exposed to the language of instruction outside of school.

case of Africa, where instruction in the home language is interrupted or nonexistent, and where most pupils are exposed to more than one language, studying language transfer is of interest.

Lastly, other factors interfering with language acquisition and language transfer have been identified in the literature, such as motivation, age, availability of reading material, or language exposure. Language exposure, especially in the African context, may vary from one school to another based on the language of instruction in use at the school or on the language composition of a student's peers at the school. School is a social environment, with individuals interacting and peer influence in the school environment has been found to impact educational outcomes in many instance (Hanushek *et al.*, 2003; Hoxby, 2000; McEwan, 2003; Sacerdote, 2000; Van Ewijk and Sleegers, 2010a; Zimmerman, 2003). Peers' characteristics and peers' achievements have been identified as impacting pupils' own achievement. In some research, mainly in developed countries, peers' ethnicity has been identified as having an effect on school achievement as well, especially among minority groups (Hanushek *et al.*, 2002; Hoxby, 2000; Van Ewijk and Sleegers, 2010b). The literature on a possible impact of peers' language composition on school achievement is rather scarce in the economic field and in the African geographic zone. Yet the language composition of the pupils is likely to affect the language used at school by teachers or by pupils on the playground. Exploring to what extent school achievement is mediated by peers' language composition in a multiethnic and multilingual environment such as Africa could be valuable. Kenya, and its specificity as a multilingual environment, is not an exception to the rule, and the issues raised above apply to the Kenyan context as well.

The Education Sector and the language of instruction in Kenya

Education is engraved in the constitution as a government priority and a basic right for every Kenyan.[8] In line with this commitment, Kenya has been implementing the Free Primary Education Policy over the past fifteen years. The Kenyan education system includes eight years of primary education. In a normal cycle, pupils should enter primary school at the age of six and should complete primary education at the age of 13. In reality, pupils enrolled in primary schools tend to be much older than they should be owing to interruptions and repeating classes (Lewin, 2009; Nishimura *et al.*, 2009).

Primary education system in Kenya: towards free education?

In the early 1970s, Kenya was a pioneer on the continent in the implementation of a free education policy. Following a presidential decree, school fees were abolished in two waves: from grade 1 to grade 4 in 1974 and from grade 5 to grade 7 in 1978 (Sifuna, 2007). One of the main reasons for

[8] http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/EducationActCap211.pdf

this decree was the low enrollment rate in the country, especially among the poorest and most marginalized populations. This resulted in a large increase in government expenditure and schools quickly became overcrowded (Sifuna, 2007). With the deterioration of the Kenyan economy in the 1980s and the implementation of Structural Adjustment Programs to restructure the economy in Kenya, school fees were partially reinstated. This interruption of the free education policy had an immediate negative effect on enrollment rates as parents experienced difficulties in paying school fees (Nishimura *et al.*, 2009; Sifuna, 2007).

Nonetheless, education had always been a priority for Kenya, and after the Education For All conference in Dakar in 2000, a free education policy was again under discussion. At this time, many African governments agreed to work to reduce school fees and increase educational access in order to ensure that all children would "*have access to and complete free and compulsory primary education of good quality"* (World Education Forum, 2000). Following other initiator countries, Kenya enacted the Free Primary Education policy in 2003.[9] This change in policy pushed the Gross Enrollment Rate to 104.8%[10] (Nishimura *et al.*, 2009). In the years following the implementation of the Free Primary Education policy, the government's investment in education considerably increased, rising to up to 6.5% of GDP.[11] The budget currently allocated to education is still in this range. Kenya spends a larger proportion of its GDP on education than other African countries (Ojiambo, 2009). To compensate for the suppression of fees, the government allocates schools a capitation grant per pupil. According to some studies, the grant amount is insufficient to equip schools, renovate infrastructure, and provide teaching materials, and payments are often delayed (Nishimura *et al.*, 2009; Sifuna, 2007). Additional drawbacks have been related to the implementation of the Free Primary Education policy, such as overcrowded classes, an increase in under- and over-aged children, a shortage of teachers, and the inadequacy of both furniture supplies and the schools' infrastructure (Nishimura *et al.*, 2009; Sifuna, 2007; Tooley *et al.*, 2008). Pupils' parents in Kenya reported a decline in school quality after the introduction of the Free Primary Education policy (Oketch *et al.*, 2010; Tooley *et al.*, 2008; Zuilkowski *et al.*, 2018). Research tends to confirm that there has been a decline in learning outcomes and an increasing number of students repeating years after the change in policy (Bold *et al.*, 2011; Nishimura *et al.*, 2009; Oketch *et al.*, 2010; Zuilkowski *et al.*, 2018). In this context, the private sector has been flourishing in the recent years in Kenya, providing alternative schooling opportunities to parents seeking for better-quality education for their offspring.

[9] Malawi and Uganda had initiated the movement and adopted it before the conference, Malawi in 1994 and Uganda in 1997. Kenya was followed by Ghana, which ratified the FPE in 2005.

[10] The gross enrollment rate expresses the percentage of students enrolled in a given grade (irrespective of their age) out of the school-age population corresponding to this same grade level. Consequently, if under-age or over-age pupils are enrolled in a specific grade, the gross enrollment rate can exceed 100%.

[11] https://www.theglobaleconomy.com/Kenya/Education_spending/

Parents' school choice matter

The majority of schools in Kenya are public schools. Other actors operate in the sector as well, such as faith organizations, and both private for-profit and private non-profit agents (Tooley *et al.*, 2008).[12] Private schools can be divided into two main categories: the formal private schools attracting wealthy pupils from upper-class households, who form only a minority of the school-age population, and the nonformal private schools also called low-cost private schools. This latter category has been spreading in urban informal settlements over the past 10 years (Tooley *et al.*, 2008). Informal settlements are often deprived of public services, including basic school provision. Therefore, nonformal private schools are the only alternative available in these locations (Piper *et al.*, 2014). Unsurprisingly, the increase in nonformal private schools in the past years has been mainly observed in expanding urban informal settlements in big cities. For instance, informal settlements in Nairobi account for about 60% of the population and a majority of pupils are attending nonformal private schools in these locations (Piper *et al.*, 2014; Zuilkowski *et al.*, 2018).

In Kenya, public and nonformal private schools are perceived very differently by parents. After opening access to education to all pupils, public schools faced an excessive rise in demand, resulting in overcrowded classes. In addition, many pupils with no previous education, or only a very low level of education, entered public schools, impacting negatively the general level of scores in these schools (Bold *et al.*, 2011). Even though some parents kept sending their pupils to public schools because of the affordability and proximity, many parents decided to transfer their children to what they saw as better-quality options. Quality of education is what drives parents to enroll their pupils in nonformal private schools despite the additional cost (Zuilkowski *et al.*, 2018).[13] Parents report that nonformal private schools' pupils are better educated than pupils from public schools (Tooley *et al.*, 2008). In their view, nonformal private schools are more accountable to parents and teachers tend to be more committed and deliver better results because parents pay for the service. In addition, nonformal private schools have no unions, which constrains teachers to attend regularly and prevents them from going on strike (Tooley *et al.*, 2008; Zuilkowski *et al.*, 2018). Nevertheless, because these schools are located in informal settlements they often suffer from poor infrastructure, in comparison with public schools. Moreover, the evidence suggests that nonformal private schools experience a higher turnover of school staff and pupils and have less-qualified teachers (Piper *et al.*, 2014; Tooley *et al.*, 2008; Zuilkowski *et al.*, 2018).

Despite these drawbacks, parents still tend to associate nonformal private schools with a higher-quality education resulting in a drain of pupils with specific attributes from public schools. Bold *et al.* (2011) concludes that the Free Primary Education policy benefited poor households who gained access to education in public schools. However, this changed considerably the socio-economic composition of pupils between public and private schools[14], with pupils from wealthier

[12] Private schools are not owned by the state but government authorities and regulations such as national educational policy and curriculum apply to them (Zuilkowski *et al.*, 2018).
[13] Using interviews data from more than 900 parents in non-formal settlement areas of Nairobi, Zuilkowski *et al.* (2018) find that, on average, nonformal private schools cost KES 7395 (~ USD 71) annually against KES 3244 (~ USD 31) for 'free' public schools.
[14] In Bold *et al.* (2011), private schools include formal and nonformal private schools without distinction.

families being transferred to private school. According to Bold *et al.* (2011), this explains the decline observed in public school quality as a decrease in pupils' ability rather than a decrease in terms of teachers or infrastructure quality. Selection bias in the form of enrolling pupils in a specific school provides further insight on potentially unobservable factors which might explain why nonformal private schools tend to be associated with higher learning outcomes (Bold *et al.*, 2011; Oketch *et al.*, 2010; Piper *et al.*, 2014). Nonformal private schools increase the schooling options, thereby increasing potential self-selection of pupils into school. This threat needs to be considered when studying educational outcomes in the Kenyan context. Failing to account for it may lead to serious bias due to unobserved factors which are confounded with pupils' educational outcomes at the school level.

What is the language of instruction at school?

In many African countries, including Kenya, English is a colonial legacy adding complexity to the language of instruction policy in a multilingual context (Dhillon and Wanjiru, 2013). In colonial times, instruction in local languages was promoted at least in the first primary school years. However, post-independence policies brought changes. For a majority, English was seen as a means used by élites to keep the general population out of the spheres of power and politics. Therefore, English was chosen as the language of instruction from grade 1 in all schools, with Kiswahili as a compulsory subject. This policy also relegated other local languages to the background (Bunyi, 1997). It should be noted that Kenya is a multi-ethnic country with various ethnic groups speaking more than 60 different languages.[15] Kiswahili is one of the two national languages (the second is English) and is spoken in most households in urban areas. In the late 1990s, educational reforms were undertaken, and Kenya opted for an early exit model, reinstituting Kiswahili as the language of instruction in early grades before transitioning to English in grade 4 (Bunyi, 1997). In accordance with the current national curriculum, the national education language policy should be implemented as follows: between grade 1 and 3 the instruction should be in Kiswahili in urban areas and in the dominant language of the catchment area in rural schools. From grade 4 onwards, English is the language of instruction for all subjects. The question as to whether this policy is efficient or not is still open.

Evidence suggests that in practice some schools use English as a language of instruction from grade 1, especially in nonformal private schools (Begi, 2014; Trudell and Piper, 2014). For instance, Tooley *et al.* (2008) find that in the Kibera slum in Nairobi, all nonformal private schools use English as the language of instruction. Some parents prefer English instruction and deliberately enroll their children in nonformal private schools for that reason (Zuilkowski *et al.*, 2018). In Kenya, as in many other African countries, there is a general belief among parents that learning English from the beginning will help pupils to learn the language faster and will improve their

[15] https://www.ethnologue.com/country/KE

opportunities in life (Dhillon and Wanjiru, 2013). Fluency in English is highly valued and speakers of minority languages are incentivized to value English as a means to reach a higher socio-economic sphere (Trudell and Schroeder, 2007). This belief that pupils should be taught in an international language pushes some parents to look for English instruction for their children (Commeyras and Inyega, 2007; Trudell and Piper, 2014). Despite the fact that some schools may use English as language of instruction in early grades, this research assumes that Kiswahili is the main language of instruction in conformity with the official policy.

Other practical issues help to explain the predominance of English as the language of instruction. Teachers are limited by the lack of available teaching material in African languages (Begi, 2014; Bunyi, 1997; Dubeck *et al.*, 2011). Teachers are not trained to teach local languages, which discourages them from promoting local language instruction (Bunyi, 1997). In addition, teachers prefer to teach in English because it is the language in which the examinations are held (Commeyras and Inyega, 2007; Dubeck *et al.*, 2011). On the other hand, the preference for English does not take into consideration the fact that English language is not the home language of learners (Trudell and Schroeder, 2007). Pupils who speak a minority language in Kenya are unlikely to be taught in their home language at school. Even those who speak Kiswahili at home may receive instruction (partially or entirely) in English and therefore, are not in a position to develop strong reading skills in their home language. Furthermore, Kiswahili has a much more transparent orthography than English, which could facilitate reading acquisition. A high sound-symbol correspondence is known to facilitate reading acquisition at early stages and may facilitate phonological awareness (Dubeck *et al.*, 2011; Trudell and Schroeder, 2007). Lastly, the connection between both languages, Kiswahili and English does not seem to be emphasized in the Kenyan context. Yet, these two languages are intimately linked in the educational sphere and in the Kenyan urban society.

Research Questions

The lack of evidence on the impact of language on educational outcomes, especially in African contexts, raises critical questions. The purpose of this research is to examine the home-language impact on reading outcomes in the urban Kenyan context. The fundamental question that guides this thesis is: how does home language background affect reading acquisition in Kiswahili and in English in Kenya? Specifically, the thesis addresses this issue around three main axes.

First, the objective is to offer additional evidence on the impact of the language of instruction on the acquisition of early reading skills. In Kenya, pupils have different home language backgrounds. Some pupils speak Kiswahili at home, which is the language in use in early grades at school as well. Others are not exposed to Kiswahili in their home environment. Therefore, it is legitimate to ask, how does Kiswahili exposure at home affect reading outcomes in Kenya? More specifically, the effect of Kiswahili exposure at home on grade 2 reading scores in Kiswahili and in English is

examined. In contrast to previous studies, which usually compare instruction in an African language and instruction in another (foreign) language, without accounting for pupils' home language, this work compares, within the same school, pupils who speak Kiswahili at home and pupils who speak another language at home. By looking at differences between pupils within the same school, the potential self-selection bias is considerably reduced.

Secondly, because English and Kiswahili are both in use in Kenyan schools, the relationship between reading skills in Kiswahili and reading skills in English is further investigated. Is there a cross-language *transfer* between English and Kiswahili reading skills? This section contributes to the cross-linguistic literature by filling in the research gaps previously highlighted. In this regard, Kenya is an interesting case study. Even though Kiswahili is the official language of instruction up to grade 3, the use of English seems more prevalent than expected (Trudell and Piper, 2014). English is a new, second, language for pupils who speak Kiswahili at home but it is a third or fourth language for pupils who speak another home language. Drawing on the cross-linguistic literature, potential differences in the transition process are searched for between pupils who do not share the same home language background.

Thirdly, the thesis will look at another aspect of language exposure which may result from the language composition of pupils in the schools. In Kenyan schools, pupils come from a variety of home language backgrounds and the language composition from one school to another or from one classroom to another may differ considerably. The language composition at school is likely to affect the language used by pupils for daily conversation with their peers and possibly the language used by the teacher for teaching. Therefore, language diversity could possibly affect language exposure and indirectly reading outcomes. The research asks whether language diversity at school affects reading achievement. This specific aspect has not previously been investigated in the Kenyan context.

Data and methodology

To address these questions, survey data collected by USAID in Kenya in October 2012 for the Midterm impact evaluation of the Primary Math and Reading (PRIMR) Initiative are used.[16] The survey used a multistage cluster sampling strategy and included face-to-face interviews with and literacy assessments of 4,162 grade 1 and 2 pupils in 210 primary schools in urban and rural areas in Kenya. For the purpose of this research, data from the urban areas only will be used.[17] Pupils' learning outcomes were assessed using the Early Grade Reading Assessment (EGRA), consisting

[16] PRIMR, under the USAID Education Data for Decision Making (EdData II) project, is a randomized controlled trial that operates as a collaboration between the Kenyan Ministry of Education and USAID/Kenya, with technical inputs from RTI International.
[17] The sample was limited to urban observations only for two reasons: (1) important differences might be observed depending on the location of the schools and/or the households, especially in rural areas, and (2) there were only 659 observations from rural areas; when split by grade and language groups, this sample is too small to be studied separately.

of several decoding and reading subtasks administered in Kiswahili and in English to the same pupils. Further information on the survey design, on the sample, and on the EGRA assessment are provided in Chapter 2.

As previously discussed, the distribution of pupils in the different schools is a major problem in the context of this research. Disentangling the language effect on learning outcomes raises many challenges as the language effect may be confounded with other school characteristics. Parents are likely to select a school based on school quality, which is a significant factor known to affect learning outcomes (Hanushek, 1979). In such a context, where parents can decide on the choice of school, between-school differences tend to be exacerbated (Glewwe and Jacoby, 1994; Spaull, 2016; Taylor and von Fintel, 2016). Comparing pupils from different schools then becomes more complex. Failing to address the selection issue or to control for potential unobservables such as parents' choice of school may result in biased results (Hanushek, 1979). To minimize potential bias from pupil selection, the identification strategy in this research mainly relies on the use of school fixed effects. This methodology will be discussed further in Chapter 2.

Structure of the dissertation and main results

Chapter 2 gives the overall research framework, along with information on the data used and the identification strategy. Sample descriptive statistics are presented in this chapter as well. The three intermediary questions are then treated separately in three different chapters.

In Chapter 3, the thesis estimates to what extent receiving instruction at school in a language different from the home language might potentially impact early reading skills acquisition. The objective is to compare results from assessments run over a population made up both of pupils who speak Kiswahili at home and others who do not,[18] comparing them in order to check whether this difference in home languages leads to significant differences in literacy acquisition. Using school fixed effects to control for unobservable factors at the school level, an education production function including the pupil's home language group is specified. Results show that, relative to pupils who speak Kiswahili at home, pupils whose home language is different from Kiswahili perform significantly worse on reading scores, within the same schools. This holds true for both scores, in Kiswahili and in English. Pupils whose home language differs from Kiswahili score .206 standard deviation lower on the Kiswahili total literacy score than pupils who speak Kiswahili at home. The effect of speaking a home language different from Kiswahili on the English score is .247 standard deviation lower. Furthermore, findings show that pupils who speak several home languages, including Kiswahili, are disadvantaged on English scores only. Chapter 3 provides additional evidence on how the home language can potentially disadvantage early reading skills

[18] Specifically, this refers to pupils who speak another African local language at home. Pupils who speak English at home are excluded from the sample to avoid interference.

acquisition when it differs from the language of instruction. Furthermore, it shows repercussion on reading skills acquisition in English.

Chapter 4 investigates the *transfer* mechanism between Kiswahili and English reading skills amongst a population of young learners in the urban Kenyan context. Both languages are in use in Kenyan schools; therefore, it is important to understand whether reading skills transfer from one language to the other. Based on current theory, Chapter 4 hypothesizes a non-linear relationship and a mutual influence between both languages in the Kenyan context. The research first evidences an interdependence between Kiswahili and English reading skills. The quadratic approach is shown to be the most appropriate model to fit the relationship between both languages, rather than a linear model. To account for simultaneous transfer from one language to the other, Seemingly Unrelated Regressions are used to estimate jointly the two equations and improve the estimators' efficiency. Results show that the transfer is stronger when tied to the English proficiency level and that transfer magnitude increases across the English score distribution. Results from the analysis further indicate that the magnitude of the transfer varies with the pupil's home language background. Pupils with more exposure to Kiswahili in their home environment are compared to pupils who speak a different home language. When tied to the English proficiency level, the magnitude of the transfer is significantly stronger for Swahili pupils in the first half of the distribution. At the mean, a one standard deviation increase in the English score is associated with a 1.007 standard deviation increase in Kiswahili for pupils who speak Kiswahili at home, against a .919 standard deviation for those who do not. However, at the extreme top of the distribution, transfer becomes stronger for non-Kiswahili speakers. This suggests that with a sufficient proficiency level in both languages, the home language does not impact the transfer process.

Chapter 5 examines peers' home language composition at school and whether it is related to reading outcomes. Peer influence is investigated in the urban Kenyan context, especially the linguistic diversity within school is explored as a possible factor mediating interactions between pupils and language exposure in the educational environment. Using a linguistic fractionalization index, linguistic composition of pupil's peers in grade 1 and grade 2 classrooms within the same school is used to disentangle the peer language effect. A combined effect of peers' quality and peers' diversity is found on Kiswahili score achievement. This result suggests that peers' linguistic diversity does not affect Kiswahili achievement directly, but linguistic diversity mediates the association between peers' scores and pupil's own Kiswahili score. As peers' language diversity increases in the classroom, peers' scores in Kiswahili decrease, which influences negatively pupils' own Kiswahili scores. Results further suggest that the peers' linguistic diversity does not interfere much with English achievement. Findings are robust when additional peers' characteristics are controlled for. Lastly, results show that pupils scoring below average are more affected by peer effects than their high achieving fellows.

Finally, in Chapter 6 the main results and conclusions presented in the preceding chapters are summarized and discussed. The chapter also highlights the limitations of the approach and points out areas for future research.

Chapter 2: Research framework and data

The Education Production Function

School achievement can be explained by many contextual and individual factors affecting (positively or negatively) pupils' performance. Therefore, a clear framework including different input factors at the school level and at the individual or family level is needed to explore learning achievement further. This is typically done using an Education Production Function.

The Education Production Function, elaborated by Hanushek in 1979, postulates that pupils' educational outcomes are explained by four main "vectors" identified as follows:

$$A_i = f(B_i, P_i, S_i, I_i)$$

Where A_i is the achievement of pupil i, B_i is the vector of family background, P_i is the vector of peers' influence on pupil i, S_i is the vector of school inputs, and I_i is the vector of pupil's i innate abilities.

Family background is undeniably a major factor in determining pupils' achievement (Hanushek, 1979). The parents' level of education and their ability to read and write are critical in modulating the support they can provide to their child with homework and in terms of valuing education. It will also impact the socio-economic and health conditions that the pupil is raised in, as well as the capacity of parents to afford a better school and a better education for their child. Thus, higher socio-economic status is typically associated with better physical and cognitive childhood development, higher investment in a child's human capital, and higher probability of access to quality education. A sizeable body of research shows that the socio-economic status of the household is a strong determinant of pupils' achievement (Anderson, 2000; Filmer and Pritchett, 1999; Lee and Zuze, 2011). However, the family background should not be reduced to only the household socio-economic status variable; family educational inputs should be included as well (Hanushek, 1979).

Secondly, the peer factor may also impact an individual child's school achievement, even though it is difficult to isolate its impact due to the number of potential confounding factors, such as sharing a similar background with the peers (Hanushek *et al.*, 2003). Some interesting findings from Hanushek *et al.* (2003) show that peers have an impact on a pupil's achievement growth and that having schoolmates who achieve high scores is beneficial for student learning and student performance (see also Hoxby (2000) and Sacerdote (2000)). Other interesting research in economics highlights the importance of peers' characteristics, such as peers' mothers' education, peers' socio-economic status, or peers' ethnicity, on school achievement (Hanushek *et al.*, 2002;

McEwan, 2003; Van Ewijk and Sleegers, 2010a, 2010b). Apart from school outcomes, the peer effect literature includes findings on the impact of peers on youth behavior and choices, such as alcohol and drug consumption (Duncan *et al.*, 2005; Fletcher, 2012), involvement in criminal activities, or being out of work/school (Case and Katz, 1991).[19]

Thirdly, the school inputs' role in pupils' achievement is highly contested. Discordant results have been reported. For example, class size (or pupil-teacher ratio) was reported as either significant (Case and Deaton, 1999), or unrelated to school achievement (Lee and Zuze, 2011), or related but only in lower grades, which might actually reflect familiarization with the classroom and classmates (Hanushek, 2003). Similarly, several studies found that the presence of textbooks and a library at school correlates with higher achievement (Fuller, 1987) but in contrast, Glewwe *et al.* (2009) found no reliable evidence that textbooks impact scores positively. Regarding teachers, qualified and experienced teachers usually have the most successful pupils (Hanushek, 2003; Lee and Zuze, 2011). However, the causality is often not clear, and selection effects are suspected; for instance, "good and experienced teachers choose performing schools/classes" (Hanushek, 1979, 1986). Rockoff (2004), after controlling for teacher fixed effects, still found that teacher experience affects reading test scores strongly and positively. Some of the inconsistencies previously mentioned might actually reflect estimation problems due to selection bias. The schooling choice might be influenced by school quality when it depends on parents' decision. In other words, good schools may simply attract the best pupils and the best teachers (Glewwe and Jacoby, 1994; Hanushek, 1986).

Finally, a pupil's innate ability or genetic endowment is an individual characteristic contributing to achievement (Glewwe and Jacoby, 1994). However, Hanushek (1979) emphasizes the lack of a proper definition and measurement of *initial endowment*, which is a source of bias since it typically correlates with family background. Several findings do show that this "learning capacity" is linked to family background, but the child-specific component can be isolated by using a family fixed effect (Todd and Wolpin, 2003). However, data limitations often prevent the ability to control adequately for initial endowment, leaving the door open to misinterpretation of the observable factors (Hanushek, 1986).

Within the Education Production Function framework, very little attention has been paid to the potential implications of the language of instruction at school, or to the pupil's home language, on reading outcomes. Traditionally, in the economic literature, the language dimension is not included.[20] Yet language of instruction is a part of the school attributes which falls directly under S_i in the equation above, and the pupil's home language is part of the family characteristics (B_i). The neglect of these factors is mainly due to the fact that most research has been done in the context of developed countries, where the language of instruction is the common language shared by the

[19] While some findings show positive peer effects, negative peer effects are further observed. For instance, having high achieving schoolmates tends to benefit students' performance positively. A 1 SD increase in peer scores is associated with .02 to .05 increase in own achievement ((Hanushek et al., 2003; Sacerdote, 2000; Zimmerman, 2003) However, variations in the school racial composition or in the proportion of minorities tend to be negatively associated with own scores.

[20] Out of the 42 economic papers explored for this research, only 3 include the pupil's home language.

population and spoken at home. Limited research recently done in the African context attempted to include this dimension (Spaull, 2016; Taylor and von Fintel, 2016). Indeed, multilingualism is a fundamental feature of the African context that as such should not be neglected.

Survey data

The survey data used for this research were collected for the Primary Math and Reading (PRIMR) project that was implemented by RTI International[21] in Kenya between 2011 and 2014. To improve the quality of reading and numeracy in early grades in Kenya, PRIMR's activities focused on building teacher capacity and the provision of educational materials in intervention schools.[22] The PRIMR initiative supported 502 schools between 2011 and 2014 and used a randomized controlled trial design with various staggered treatment cohorts.[23] Intervention zones were stratified by counties and districts and randomly assigned to treatment groups. For the impact evaluation, schools were randomly selected from within assessment zones. The survey used a multistage cluster sampling strategy. Interviewees were systematically sampled from grade 1 and 2 pupils in the selected schools, stratified by gender and grade. A pupil questionnaire was administered to selected pupils via face-to-face interviews and included literacy and numeracy assessments. The questionnaire provides interesting data on pupils' characteristics, including the language(s) spoken at home and other household background information. Specifically, the dataset provides information on how many languages are spoken at home and on what these languages are. Interviews with head teachers and classroom observations were also part of the survey. For further details on the project implementation and impact evaluation, please refer to Piper *et al.* (2014).

The data collection was funded by USAID/KENYA under the auspices of the Education Data for Decision Making (EdData II), which granted the authorization to use the data.[24] Specifically, cross-sectional data coming from the midterm impact evaluation data[25] set, collected in October 2012, are used for this research. The dataset provides information on 4,162 grade 1 and grade 2 pupils in 210 primary schools in urban and rural areas in Kenya. This research uses data for the 3,503 pupils enrolled in the 177 urban schools only.[26] Pupils were randomly selected at the grade level and

[21] The Research Triangle Institute - RTI International - is an independent, nonprofit research institute.
[22] Activities include teachers, coaches and tutors providing instructional support and follow-up, the provision of educational materials for teachers and students (reading materials in Kiswahili and English, and math materials), the provision of lesson plans, and continuous assessment.
[23] The first cohort started the intervention in January 2012, the second started in January 2013 after the PRIMR midterm evaluation, and the third in January 2014. A treatment variable is included in the model to control for participation in the PRIMR initiative.
[24] The views expressed in this dissertation are those of the author and do not involve USAID, The United states government or RTI international.
[25] Baseline data were not used because pupils were surveyed at the beginning of the school year, and therefore had received only limited instruction. Endline data were not used either for two reasons: (1) due to attrition the longitudinal cohort included only 707 pupils (2) to limit bias in the results due to the additional exposure to the PRIMR project.
[26] Data were initially collected for both urban and rural areas. However, it was decided to limit the sample to urban observations only for two reasons: (1) important differences might be observed depending on the location of the schools and/or the households, especially in rural areas, and (2) there were only 659 observations from rural areas; when split by grade and language groups, this sample is too small to be studied separately. In the following sections, urban data only are included.

about 10 pupils per grade and per school were surveyed. For the purposes of this research, the analysis will mainly focus on pupils who were in grade 2 at the time the data were collected (end of the school year).[27] It is worth noting that the sample in Chapters 3 and 4 is limited to respondents who do not speak English at home.[28] As the interest is in the impact of the home language on Kiswahili and English score achievement, it was essential to limit the sample in this way to remove the potential skewing of results on English tests by pupils who speak English at home. In addition, the sample size of pupils who speak English at home (as a first language or partially) is quite small (N=142 pupils in grade 2). Therefore, out of the initial 2,069 observations for grade 2 pupils in 210 schools, the final sample retained for Chapters 3 and 4 consists of 1,573 observations of grade 2 pupils from 174 urban schools.[29] Because Chapter 5 explores school composition, the 144 grade 2 pupils[30] who speak English at home and the 1,725[31] observations for grade 1 pupils in urban schools are reintegrated. The final sample retained for Chapter 5 includes 3,442 pupils in 177 schools. Further details on the sample are provided later in this chapter. Surveys weights are used in the analysis to correct for potential imbalances between sample characteristics and population parameters.

The EGRA Assessment

The datasets provide interesting resources on pupils' characteristics, including pupils' literacy outcomes as assessed through the Early Grade Reading Assessment (EGRA). The EGRA assessment "includes several individual subtasks that measure foundational skills needed for reading acquisition" (Dubeck and Gove, 2015); the most popular are letter-sound identification, invented word reading aloud, real word reading aloud, reading comprehension, and listening comprehension. The assessment is administered as a one-on-one interaction, where pupils sit individually with an examiner who is reading out the instructions. The EGRA assessment was administered to each pupil twice, with different forms (different letter order and story) for the two languages of assessment, Kiswahili and English. In accordance with the educational language policy, Kiswahili, used as the language of instruction in Grade 2, and English, which is introduced in lower grades before becoming the language of instruction in Grade 4, were both assessed.

In this research, the focus is on basic reading skills. A total literacy score was computed by conducting factor analyses on the four reading subtasks (letter sound, invented word, word reading,

[27] The dataset includes 2,093 Grade 1 pupils as well. However, the variability in literacy skills acquired in the first year of instruction is too limited. Therefore, Grade 1 pupils were dropped from the analysis in Chapters 3 and 4. The grade 1 pupils' sample is used in the analysis in Chapter 5 for methodological reasons.

[28] In Chapter 5, where the school composition is studied, all the pupils are included in the sample.

[29] In two schools only one G2 pupil was interviewed, and these 2 observations were therefore deleted. 22 observations were deleted because pupils provided no information on the language spoken at home (missing values or "do not know" answers). 330 observations from rural areas were removed. 142 observations of pupils who speak English at home were deleted.

[30] This includes the 142 English speakers and the 2 stand-alone observations that were deleted.

[31] 39 observations were deleted because pupils provided no information on the language spoken at home (missing values or "do not know" answers).

and reading comprehension) that assess basic decoding skills in each language (Kiswahili and English). Table 1 below provides for each selected subtask a description of the measure and the associated reading development phase. More details on the different EGRA subtasks are provided in Chapter 3. Following Jiménez *et al.* (2014), the principal component factor analysis with varimax rotation yielded a single factor for pupils' reading skills,[32] referred to as the total literacy score (see Appendix D for further details on the factor analysis). The total literacy scores in Kiswahili and English are the main dependent variables in the work. Given the importance of oral language comprehension in the reading process, Kiswahili listening comprehension is also explored in Chapter 3. Dubeck and Gove (2015) identify listening comprehension as a "diagnostic subtask offering explanatory information as to why a child may have struggled with a particular subtask".

Table 1: Description of selected EGRA subtasks

EGRA subtask	Description	Phase(s) of development
Letter-sound identification	Measures knowledge of letter-sound correspondences.	Partial alphabetic
Non-word reading	Measures the ability to decode individual non-words following common orthographic structure.	Partial alphabetic & alphabetic
Oral reading fluency	Measures the ability to read a grade-level passage.	Consolidated alphabetic
Reading comprehension	Measures the ability to answer questions about the grade level passage.	Consolidated alphabetic
Listening comprehension	Measures receptive language of an orally read passage with explicit and inferential questions.	Used diagnostically across various phases.

Data quality and data limitation

The dataset has several limitations. First, because literacy outcomes were assessed in Kiswahili and in English for the three language groups, no assessment was carried out in the home language of the non-Swahili group. Secondly, listening comprehension in English was not assessed in this survey. As previously mentioned, listening comprehension is an important determinant of reading outcomes. Inclusion of an English listening comprehension score would have been valuable for working with English literacy scores. Note, however, that pupils who speak English at home were removed from the sample, so that it is likely that the main exposure to English is happening at

[32] This measurement is more accurate than a simple cumulative score or index, given that several reading skills intervene in the different subtasks. Furthermore, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy confirms the factorial structure of the data.

school. Therefore, the assumption is that the exposure to English should be equivalent for pupils belonging to the same school despite their home language group. Thirdly, there is no proper measure of the pupil's IQ in the dataset. Individual IQ might be considered an important factor as it is strongly correlated with educational achievement (Deary *et al.*, 2007). Therefore, pupils with low IQ might have abnormally low results, which could potentially impact the average scores negatively. However, the size of the sample and the fact that there is no reason to believe that pupils from a specific language group would be subject to a higher prevalence of low IQ should counterbalance this limitation.

There are also some limitations with the independent variables, especially at the individual and household level. Indeed, data from the pupil's questionnaire are used in the analysis. Despite the fact that examiners enter pupils' responses, the reliability of information reported by seven-year-old pupils might be questioned. In addition, the questionnaire includes some retrospective questions which could possibly increase the reporting error. Analyzing data quality in the Kenyan Life Panel Survey, Baird *et al.* (2008) found that adolescents and young adults are characterized by the lowest response reliability. Furthermore, and as explained in Chapter 3, a wealth index is created to overcome the lack of a measurement of household income level. This wealth index is computed from assets supposedly owned by the household, as reported by pupils themselves. It is acknowledged that the wealth index measure used in this work has flaws and that several authors exposed these limitations. For instance, several limitations are mentioned by Vyas and Kumaranayake (2006), such as disparities in the quality of the assets, which is not accounted for, and the validity and reliability of the data, which is determinant. Lastly, the wealth index is the only household variable used in this work (together with the availability of books at home). Other measures of the household characteristics, such as parents' education, parents' occupations, household size, or even housing condition, are not available in the dataset. Regarding missing data, the research should not suffer from a bias on this matter. The item non-response is quite limited in variables of interest[33] and the item non-response can reasonably be assumed to be random.

Finally, the dataset does not provide information about the language of instruction used by teachers in their classroom. The school head was systematically asked whether or not Kiswahili was used as language of instruction in Grade 1 and 2 in their school. Their answers were added as additional control in the analyses. However, teachers in their classroom may act differently than what the school head said. In the end, this research assumes that Kiswahili is used as language of instruction at school in conformity with the official policy.

[33] Most variables of interest have an item response rate above 99.5%. Only one variable (Attendance interrupted the previous year) has a relatively lower response rate at 98.08% for grade 2 pupils.

Survey descriptive statistics

3,503 pupils in 177 schools in urban districts included in the dataset

The sample covers 10 districts in three different counties.[34] However, more than half (55%) of the schools and pupils are located in three districts (Embakasi, Dagoretti and Langata), all situated in Nairobi county, Kenya. Table 2 provides the number of schools and pupils per grade for each district.

Table 2: Number of schools and pupils per grade for each urban district (according to survey)

County	District name	No. of Schools	No. of Pupils	Grade1	Grade 2
Nairobi	Embakasi	46	920	460	460
	Langata	29	560	288	272
	Dagoretti	24	477	239	238
	Kasarani	22	439	222	217
	Westlands	13	255	129	126
	Starehe	9	180	90	90
	Makadara	7	141	70	71
Nakuru	Nakuru Municipality	14	278	138	140
Thika	Thika West	9	180	90	90
	Thika Municipality	4	73	38	35
	Total:	177	3503	1764	1739

Sources: Midterm evaluation data - PRIMR initiative. Notes: sample reduced to urban data only.

Distinguishing different home language groups

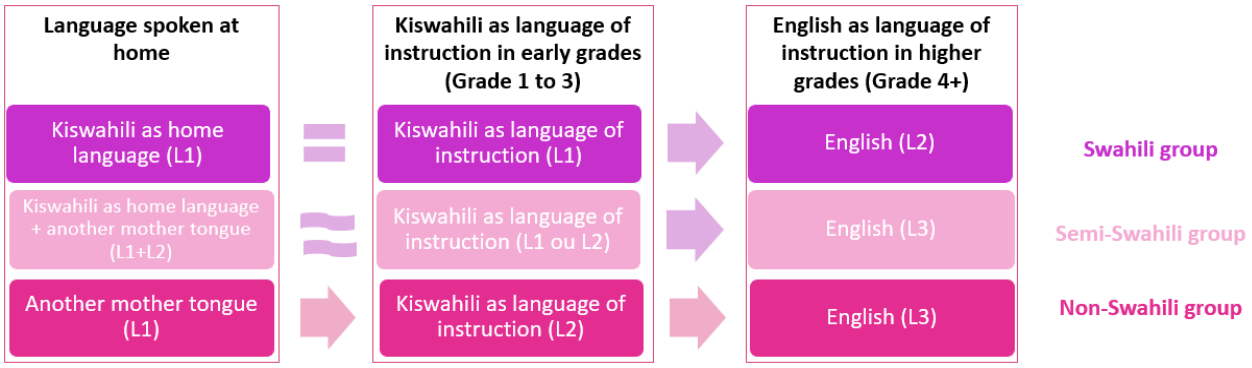
The main variable of interest in this research is that of a pupil's home language. As previously mentioned, in the early grades in Kenya the language of instruction is Kiswahili (in urban areas), with English being introduced as a subject before becoming the language of instruction from grade 4 onwards. However, the language spoken by pupils at home might be other than Kiswahili, as Kenya has a rich diversity of languages. For instance, some pupils only speak Kiswahili at home while others speak Kiswahili in addition to another mother tongue. Some pupils use both Kiswahili and English in their home environment, but others only speak their mother tongue which is different from Kiswahili. The dataset provides information on the languages spoken at home.

[34] Using 2014 DHS survey for comparison purpose, data shows that the three regions of interest, namely Nairobi, Rift Valley and Central are among the richest region in Kenya. For further details on this please refer to Appendix B.

Consequently, pupils can be classified by the degree of exposure to Kiswahili (and possibly English) in their home environment.

As explained in the previous section, in Chapters 3 and 4, the sample excludes respondents who speak English at home. Therefore, the main analysis is based on three groups of interest, composed of pupils who are differently exposed to Kiswahili: pupils whose home language is Kiswahili, that is, the language of instruction; pupils who speak several mother tongues at home including Kiswahili; and pupils who never speak Kiswahili at home, i.e. who speak another mother tongue. In the following sections, these three groups will be referred to as the Swahili group, the semi-Swahili group, and the non-Swahili group respectively. To help the reader, Figure 1 below gives the different pupils' home language groups in order to clarify their language characteristics and differences.

Figure 1: Three different pupils' home language groups



In Chapter 5, as well as the three home language groups mentioned above, two additional language groups are included for pupils who speak English at home: The Semi-English group, which includes pupils who speak both Kiswahili and English at home, and the English-only group for those who speak only English at home. In this chapter, the five language groups are used to compute the language diversity of a school.

Table 3 provides further descriptive statistics on the pupils' home language groups in the sample.[35] The percentage of pupils per home language group in each district is presented. A majority of grade 1 and grade 2 pupils (63%) speak Kiswahili as their only home language in the sample. About 10% speak several African languages at home, including Kiswahili. More than 17% speak an African language at home other than Kiswahili. The remaining 10% are pupils who speak English, with half of them speaking only English at home and the other half speaking Kiswahili and English. These averages hide disparities between districts and the home language composition

[35] 61 pupils are removed from the initial 3,503 pupils due to a lack of information on their home language in the data.

in the sample varies from one district to another. In the following chapters, descriptive statistics of the pupils' and schools' characteristics will be presented in more depth.

Table 3: Number of pupils per home language group for each urban district (according to survey)

County	District name	No. of Pupils	% Swahili	% Semi-Swahili	% Non-Swahili	% Semi-Swahili & English	% English only
Nairobi	Embakasi	894	64.54%	10.18%	16.22%	4.81%	4.25%
	Langata	555	59.82%	11.53%	17.12%	4.14%	7.39%
	Dagoretti	472	77.33%	4.03%	9.53%	5.30%	3.81%
	Kasarani	433	83.83%	3.93%	4.39%	3.46%	4.39%
	Westlands	249	63.45%	10.84%	12.05%	4.82%	8.84%
	Starehe	177	55.93%	18.08%	14.69%	2.82%	8.47%
Nakuru	Makadara	140	34.29%	30.71%	31.43%	2.14%	1.43%
	Nakuru Municipality	274	61.31%	10.58%	16.06%	8.03%	4.01%
Thika	Thika West	176	17.61%	15.91%	60.80%	5.11%	0.57%
	Thika Municipality	72	23.61%	9.72%	63.89%	1.39%	1.39%
	Total:	3,442	62.70%	10.37%	17.46%	4.59%	4.88%

Sources: Midterm evaluation data - PRIMR initiative. Notes: (1) sample reduced to pupils whose home language is observed; (2) Swahili pupils refer to pupils who speak Kiswahili at home, semi-Swahili to pupils who speak several home languages including Kiswahili, non-Swahili to pupils who speak another African language at home, Semi-English and Swahili to pupils who speak Kiswahili and English at home, and English-only pupils who speak only English at home; (3) data are not weighted.

Varieties of individual and school characteristics

Several individual and school characteristics are included in the dataset. These variables will be discussed in more details in the subsequent chapters. This sub-section provides a description of the pupils' characteristics and of the schools they are attending.

As shown in Table 4, pupils are on average 7 years old in grade 1 and 8 years old in grade 2.[36] However, there is a large disparity in age range, from 4 to 15 years old. Whether the pupil has been enrolled at school since January is a good indicator of continuous enrollment. In the sample, a majority of pupils have been enrolled since the beginning of the school-year (almost 90% are enrolled since January). Regarding the pupils' gender, the population is balanced between boys and girls. Data suggests that there is no gender discrimination towards education in the overall sample. More than 90% pupils attended nursery/ pre-school and only a limited number repeated a grade (about 6%). Interestingly, 8% grade 2 pupils reported they skipped grade 1. Skipping a class might characterize pupils with more advanced knowledge and therefore, could potentially impact learning outcomes positively. On the other hand, some pupils may skip a class while skipping was not justified by higher skills, in which case it could impact negatively their scores as they might

[36] These data are consistent with average pupils' age and sex found in other survey such as the 2012 UWEZO survey used for comparison purpose. Please refer to Appendix B for further details on this.

be taught at the wrong level. In the sample, more than 28% of pupils were absent from school for more than one week over the last school year. Lastly, a large proportion of pupils' report that they have books at home. 68% of pupils report having English books at home and 61% report having Kiswahili books at home.

The dataset provides further information on schools. In the sample, a majority of schools are public schools (57%). Teachers' absenteeism or lack of punctuality are estimated asking the school head how many teachers were absent or in late the day before the survey. These two variables are dummy variables taking the value of 1 for any teacher late or absent in the school the day before. Lastly, most schools have access to water (80%) and electricity (almost 70%). About 90% of schools have a separate girls' washroom and 65% have a program providing meals for pupils.

Table 4: Individual and school characteristics – by grade

	Full sample					Grade 1 pupils			Grade 2 pupils		
	Mean	SD	N	Min	Max	Mean	SD	N	Mean	SD	N
Individual variables											
Gender (female=1)	0.49	0.50	3442	0	1	0.48	0.50	1725	0.50	0.50	1717
Age (in years)	7.45	1.22	3437	4	15	6.94	1.08	1722	7.93	1.14	1715
Enrolled at school since January	0.88	0.33	3442	0	1	0.89	0.32	1725	0.87	0.34	1717
Attended pre-school	0.91	0.28	3427	0	1	0.93	0.26	1718	0.90	0.30	1709
Repeated	0.06	0.25	3422	0	1	0.06	0.24	1714	0.07	0.25	1708
Pupil has skipped G1	0.08	0.28	1708	0	1			0	0.08	0.28	1708
Attendance interrupted (previous year)	0.28	0.45	3352	0	1	0.30	0.46	1668	0.25	0.44	1684
English books at home	0.68	0.47	3440	0	1	0.68	0.47	1724	0.69	0.46	1716
Kiswahili books at home	0.61	0.49	3440	0	1	0.61	0.49	1723	0.61	0.49	1717
School variables											
School type (Nonformal=1)	0.43	0.50	3442	0	1	0.46	0.50	1725	0.40	0.49	1717
Teachers absenteism	0.63	0.48	3431	0	1	0.62	0.49	1715	0.64	0.48	1716
Teachers lack of punctuality	0.20	0.40	3431	0	1	0.18	0.39	1715	0.21	0.40	1716
Water available at school	0.80	0.40	3431	0	1	0.80	0.40	1715	0.80	0.40	1716
School with electricity	0.69	0.46	3431	0	1	0.67	0.47	1715	0.70	0.46	1716
Feeding program at school	0.65	0.48	3431	0	1	0.65	0.48	1715	0.65	0.48	1716
Girlwashroom facilities at school	0.89	0.32	3431	0	1	0.87	0.33	1715	0.90	0.30	1716
Library at school	0.33	0.47	3431	0	1	0.32	0.47	1715	0.34	0.48	1716

Sources: Midterm evaluation data - PRIMR initiative. Notes: (1) weighted data and (2) data incudes pupils from grade 1 and 2.

Identification strategy

There are many challenges to isolating the language effect from other factors contributing to pupils' performance. As mentioned in the introduction, the education production function includes several determining factors, such as parental education and resources, and teacher and school quality, that need to be controlled for when attempting to isolate the language effect from confounding influences. There are also much more complex interconnections that need to be accounted for. Several occurrences show that in the African context, schools may adapt the

language of instruction to the parents' will or in accordance with the pupils' language composition (Taylor and von Fintel, 2016; Zuilkowski *et al.*, 2018). In their study of schools in South Africa, Taylor and von Fintel (2016) report large variations in the quality of South African schools. They show that certain quality differences are correlated with the language choices that schools make and that the language homogeneity at a school is a potential factor determining a school's choice of language of instruction (Spaull, 2016; Taylor and von Fintel, 2016). Similarly, Zuilkowski *et al.* (2018) found that parents who send their children to nonformal private schools in Nairobi, Kenya, are more concerned by aspects of school quality and education in English than parents who send their children to public schools. Therefore, differences between pupils may come from the school selection, based on attributes that are different from the choice of the language of instruction in use at school. The selection bias is a major issue when studying educational outcomes.

The use of school fixed effects to reduce selection bias

A rigorous assessment of the impact of learning in the home language would require schools to be randomly assigned to provide instruction in the home language or in another language. This cannot be done and cannot be observed, as the policy of instruction is national, and therefore applied to all schools. In the same way, comparison across countries having different language of instruction policies includes too many regional variations, including language differences and other confounding factors, to find a proper comparison group from which to draw rigorous conclusions.

The dataset used for this research offers a unique opportunity to compare samples of pupils who are enrolled in the same schools and receive the same instruction, but with diverse home languages. Rather than comparing pupils who receive instruction in different languages, the purpose will be to look at pupils who receive instruction in the same language - the language of instruction – while taking into account that this language is the home language for some pupils but not for all of them. In addition, focusing on early-grade pupils allows controlling for other potential confounding influences. First, an early-grade cohort limits self-selection bias caused by the increasing dropout rate for a specific cohort over time, providing a more representative sample which includes potentially more fragile or marginalized pupils (Filmer and Pritchett, 1999; Lewin, 2009). It also minimizes potential self-selection problems of within-school sorting of pupils into classes by ability, which tend be more common in higher grades. Secondly, working on pupils' cohorts before they shift to a foreign language such as English as the medium of instruction limits potential confounding influences from other factors that might be highly correlated with the English language (Spaull, 2016).

As previously mentioned, controlling for school factors is of prime importance. Several school factors have been measured and are available in the dataset, including teacher and school characteristics. However, some school-level factors cannot be straightforwardly measured, either because they have been omitted or because they are unobservable, such as school quality or parents' choice of school, which could lead to considerable measurement errors (Hanushek, 1979).

This is a major issue in developing countries, where between-school differences are exacerbated and school choice is a parental decision (Spaull, 2016; Taylor and von Fintel, 2016). Many economists argue for the use of school fixed effects in order to prevent bias estimates or overestimation of other factors as a result of the sample selection (Glewwe and Jacoby, 1994; Hanushek, 2003; McEwan, 2003; Taylor and von Fintel, 2016; Todd and Wolpin, 2003).

In the sample used for this research, selection bias may operate through very different ways. For instance, parents with high achieving children may choose to send their children to schools with specific characteristics such as the type of school to be attended. The overall results of the school would then be driven by pupil's composition within schools and high achieving schools would result from the pupil's selection across-schools rather than specific attributes or instruction method specific to these schools. Similarly, the selection bias might be activated through the linguistic background of the parents. Parents belonging to a specific ethnic group or with a specific home language background may all decide to send children to the same school. Consequently, the language composition may be confounded with other selection bias. These underlying mechanisms are of importance as they may affect regression estimates. A simple OLS analysis does not account for the selection bias resulting from the selection between schools. Differences between schools are exacerbated by other factors at the school level and which are not be accounted for. Consequently, OLS estimators are overestimated by the differences between schools resulting from multiple confounding factors. School fixed effects add an additional level of control and remove cross-school selection bias. The identification approach used in this study rests on the use of school fixed effects. To reduce the selection bias as much as possible, the effect of the language on educational attainment is estimated using school fixed effects in the models to remove endogeneity bias. The OLS and school fixed effects estimators are systematically compared to highlight differences in estimates when selection bias between schools is accounted for.

While using variation in home language within schools eliminates a fair amount of selection bias, it may not purge the estimates of all forms of selection. The composition of the pupils within schools may still drive the results. For instance, in schools where the majority of pupils speak Kiswahili, the gap in scores between pupils who speak Kiswahili and those who do not might be exacerbated. Other unobserved factors may intervene within these schools such as school characteristics attracting pupils from more diverse background. In such case, results could still be biased if they are driven by these schools and by the specific composition of pupils within these schools. Different strategy such as the use of robustness check or further investigation on the school language composition will be adopted in the dissertation to mediate these possible effects. This will be discussed further in the next chapters.

Exploiting language groups variation within schools

The decision to compare differences in pupils' scores within a school is justified by the language diversity in the school sample. Indeed, there is enough within-school variation in the proportion

of non-Swahili and semi-Swahili pupils per school to allow a comparison between these groups and the Swahili group in Chapters 3 and 4. Similarly, this language diversity makes it possible to construct a linguistic fractionalization index in Chapter 5. Table 5 gives the proportion of Swahili pupils per school in the sample. As observed, a large number of schools exhibit linguistic diversity, with a proportion of Swahili pupils ranging from 0% to100%.

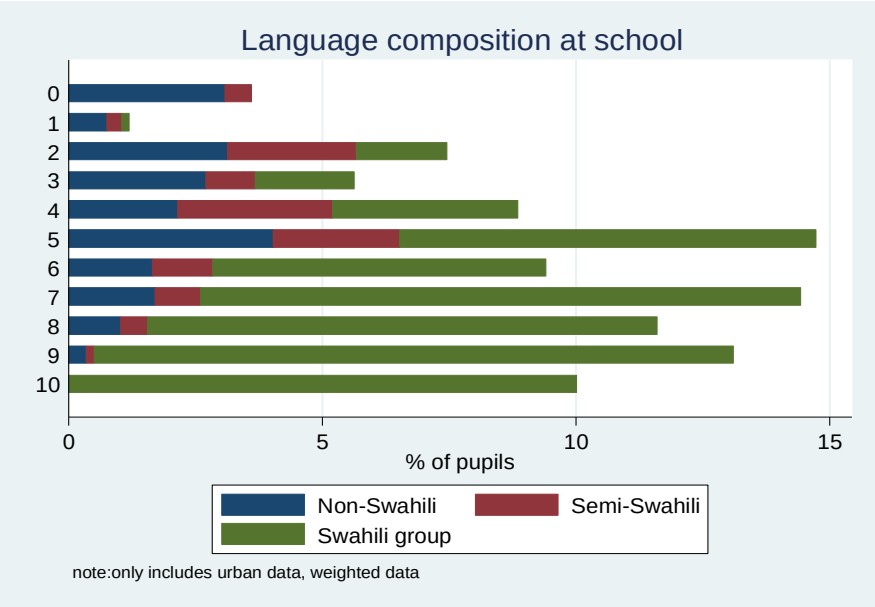
Table 5: Proportion of Swahili pupils per school

Proportion of Swahili pupils (%)	No. of Schools	%
0-10	10	5.64
11-20	7	3.95
21-30	10	5.64
31-40	12	6.77
41-50	13	7.33
51-60	22	12.42
61-70	27	15.24
71-80	24	13.54
81-90	36	20.33
91-100	16	9.03
Total	177	100

Sources: Midterm evaluation data - PRIMR initiative.

The home language group variation among grade 2 pupils within a school is of particular importance. In Chapters 3 and 4, Swahili pupils are compared to non-Swahili and semi-Swahili pupils within a school. Figure 2 further shows the grade 2 pupils' home language group distribution, i.e. the proportion of Swahili, semi-Swahili, and non-Swahili grade 2 pupils per school. The vertical axis gives the percentage of Swahili pupils in the schools, with schools with 0% Swahili pupils (0/10 pupils in the sample) at the top and schools with 100% Swahili pupils (10/10) at the bottom. The horizontal axis gives the percentage of pupils attending such schools in the sample. The figure can be interpreted as follows: 3.5% of pupils are in schools with no Swahili pupils, and in those schools consisting of semi-Swahili and non-Swahili pupils only, the majority of pupils are non-Swahili. Almost 15% of grade 2 pupils are in schools where half the pupils belong to the Swahili group, the other half consisting of semi and non-Swahili pupils. Lastly, about 10% of pupils are in schools consisting of Swahili pupils only (10 out of 10).

Figure 2: Grade 2 pupils' home language composition in the schools' sample



Sources: Own calculations based on Midterm evaluation data - PRIMR initiative. Weighted data. Notes: (1) The bar at the top gives the percentage of grade 2 pupils enrolled in schools with no Swahili pupils, the percentage can be read from the horizontal axes – 3.5%; (2) the following bars give the percentage of grade 2 pupils enrolled in schools with 1, 2, and up to 10 Swahili pupils (out of 10 pupils per school); and (3) the bar at the bottom gives the percentage of grade 2 pupils -10% enrolled in schools with Swahili pupils only.

Figure 2 confirms that there is enough variability of language groups within schools among grade 2 pupils for variation between groups to be used as a possible identification strategy to disentangle the language effect. The next chapter will provide further detail on the methodology.

Chapter 3: How does language exposure at home affect early reading outcomes?

Introduction

In Kenya, 50% of pupils have repeated at least one grade by grade 6. The low learning level is a cause for concern, with 70% of pupils in grade 3 unable to perform grade 2 work and about 10% of pupils completing grade 8 without having acquired the basic competencies expected in grade 2 (Uwezo, 2016). The proportion of pupils who do not learn basic skills is higher amongst the poorest of the population in Kenya (Spaull, 2012). This gap between poor and non-poor is even wider in the lower grades. Only 35% of grade 3 pupils from poor households can perform grade 2 Kiswahili literacy work, as opposed to 55% of non-poor pupils. For English literacy work, the percentages are 28% and 49% respectively (Uwezo, 2016). Pupils with the lowest socio-economic status often access lower quality education. In addition, Kenya has a huge language diversity and many pupils suffer from an additional language barrier since they speak a language at home that differs from the language spoken at school.

Language diversity in Africa is a complex and major challenge. Most children are exposed to several languages at home and in their school and community environments. In many African countries, for historic reasons, local African languages are used as language of instruction[37] by teachers in the first school years before shifting to the language of the former colonizer — usually English or French — as the medium of instruction. Consequently, pupils receive instruction in a language they might never have, or only to a limited degree, been exposed to at home. Pupils who are taught in a language they are not familiar with might experience more difficulties learning basic reading skills in that language. The reading process involves several independent skills. For instance, both listening comprehension and decoding skills are important components in the development of reading skills (Hoover and Gough, 1990). The association of these skills is critical for reading proficiency. Listening comprehension in the mother tongue is mainly acquired during infancy through oral communication at home, while decoding skills require formal literacy instruction. Some studies carried out in the African context suggest that speaking the language of instruction at home positively relates to reading achievement in this language (Hungi and Thuku, 2010; Smith and Barrett, 2010; van Staden *et al.*, 2016). In the economic literature, research on pupils' home language and how it might affect learning outcomes is scarce in the African context. Some research studying South African students suggests that early instruction in English or writing a test in English when English is not the student's home language negatively impacts scores (Spaull, 2016; Taylor and von Fintel, 2016).

[37] Typically, the language spoken by the majority in the catchment area, in the province or in the region is used as language of instruction.

The purpose of this chapter is to contribute to the literature on the impact of the home language in school achievement by exploring in more depth the home language effect on reading achievement, that is, how does language exposure at home affect pupils' reading outcomes? More specifically, we explore whether inequalities arise among pupils based on whether their home language differs from the language of instruction at school and whether receiving instruction in a language different from the home language might potentially impact early reading skills acquisition. To address this issue, this work focus on a dataset from Kenya that offers the opportunity to compare pupils who belong to the same schools but have different home languages. Kenya is particularly interesting in this regard, as Kiswahili is used as the language of instruction in lower grades and English only later on, while the language spoken at home may differ from both Kiswahili and English (e.g. Kikuyu or Kikamba). According to the official education policy, Kiswahili is the language of instruction in urban areas until grade 3. [38] In theory, English should only be introduced in Grade 2 as a lesson subject. In addition, using Kiswahili as the language of instruction at school does not necessarily mean that all pupils are taught in the language they speak at home. Some pupils, of course, will be exposed to Kiswahili as the main language spoken at home. For others, Kiswahili is the second or third language spoken at home, and they therefore have some degree of exposure to it. But for some pupils, Kiswahili can be completely absent from their familial environment, meaning that these pupils receive instruction in a language they have never been exposed to before and consequently a language they are not familiar with. For the specific group of pupils whose home language differs from the language of instruction used at school (Kiswahili), the acquisition of early reading skills could potentially be slowed down and be more difficult than for pupils who are receiving instruction in their home language.

This paper contributes to the literature on the test score inequalities among pupils as a result of their home language differing from the language of instruction. Specifically, it provides more evidence on the home language effect on literacy scores in the urban Kenyan context. Pupils with a home language other than Kiswahili perform significantly worse than pupils whose home language is Kiswahili. After controlling for individual factors and school observables and non-observables, pupils whose home language differs from Kiswahili score .206 standard deviation lower on the Kiswahili total literacy score than pupils who speak Kiswahili at home. The effect on the English score is .247 standard deviation lower. Pupils who speak several languages at home, including Kiswahili, achieve similar scores in Kiswahili to those pupils who speak Kiswahili only as their home language. However, they perform significantly worse in English (.203 standard deviation lower) compared to pupils who speak only Kiswahili at home.

Secondly, the language effect on the scores of the different reading subtasks assessed is explored in more detail in order to highlight potential differences in the reading process between pupils' language groups. Pupils whose home language is not Kiswahili achieve significantly lower scores on basic decoding skills in Kiswahili. On English subtasks, they achieve significantly lower on all reading subtasks. For pupils who speak several languages at home, including Kiswahili, their

[38] In rural areas, children should be taught in the language of the catchment area for early primary education (grades 1 to 3).

weakness mainly lies on reading comprehension in both Kiswahili and English. Finally, the robustness of the estimates is tested on a reduced sample, excluding schools with a majority of Swahili pupils. Results show that the gap between pupils who speak Kiswahili at home and those who do not, is not driven by schools with a majority of Swahili pupils. The estimates are confirmed in a reduced sample including schools with more linguistic diversity.

The study provides additional evidence on the impact of the language of instruction on early reading skills acquisition. Its findings confirm a global discriminatory association from receiving instruction in a language pupils have never been exposed to, i.e a language that differs from their home language. Scores are systematically lower when reading in Kiswahili and in English for pupils who do not speak Kiswahili at home. The study adds robust empirical evidence to the current debate on the language of instruction effect and provides some suggestions on potential remedial interventions to reduce the gap between language groups. It is worth noting that this chapter does not address causal relationship or why pupils who do not speak Kiswahili at home score lower. Rather, this chapter emphasizes the existing gap between pupils who speak Kiswahili at home and those who don't.

The paper is organized as follows: the first section gives an overview of the theoretical framework and previous empirical studies used to formulate the research questions and assumptions. The second section provides some relevant descriptive statistics. The third section explains the identification strategy and the methodology used to achieve the results. The fourth (result) section will include variants of the model used, in order to examine the different aspects of the reading process. The interpretation of the results is part of the discussion section. Finally, the main findings are summarized in the light of the current language of instruction policy debate.

What is the impact of the home language on educational outcomes?

The home language: an under-investigated feature in Africa

In 1979, Hanushek postulated that the pupils' educational outcomes can be explained by four main contextual and individual 'vectors' affecting pupils' performance positively or negatively. The first vector is family background, including factors such as parents' education, household socio-economic status, and health conditions (Anderson, 2000; Filmer and Pritchett, 1999; Lee and Zuze, 2011). The second is peer factors and the potential influence of the peer environment on educational outcomes (Hanushek *et al.*, 2003; Hoxby, 2000; Sacerdote, 2000). The third factor is school inputs which impact the quality of education delivered, i.e. educational environment and the quality of the teachers (Case and Deaton, 1999; Fuller, 1987; Glewwe and Jacoby, 1994;

Hanushek, 2003; Lee and Zuze, 2011; Rockoff, 2004). Lastly, the pupil's innate ability or genetic endowment is an individual characteristic contributing to achievement (Glewwe and Jacoby, 1994; Hanushek, 1979, 1986). Despite being a key characteristic of individual pupils, home language has been largely ignored in the literature on educational outcomes. There are two main reasons explaining this. First, language is not a common characteristic/variable used in the economic discipline. Secondly, most studies on the Education Production Function were conducted in developed countries where the population share a common national language which is the language used as the language of instruction at school. However, multilingualism is a fundamental feature of the African context (Bunyi, 1997; Williams, 1996), and language is therefore an important feature which cannot be neglected, especially when working on topics related to education in an African context.

Most of the literature on the impact of home language on educational outcomes is about developed countries and this literature is actually part of the literature on linguistics or education. Most available studies refer to bilingual people in developed countries where the educational system cannot be compared to that of low-income countries. In addition, the status of and the exposure to the different languages may differ substantially in comparison to developing countries. For instance, many findings from developed countries focus on immigrants or bilingual adults who received at least a few years of education in their own home language in their former country. In contrast, many African pupils receive their first instruction, including basic reading skills, in a language that they are not familiar with (Alidou *et al.*, 2006; Ouane and Glanz, 2010). Recently, a growing bilingual literature has emerged with a specific focus on bilingual Latino students in the US, i.e. native Spanish-speakers born in the US who are English Language learners at school (Hoover and Gough, 1990; Proctor *et al.*, 2005). Findings suggest that quality of instruction might be more important than the language of instruction for Spanish-dominant English learners in the American context (Cheung and Slavin, 2012). This might not be true in the African context, where school quality is very low relative to that of developed countries such as the US (Fuller and Heyneman, 1989).

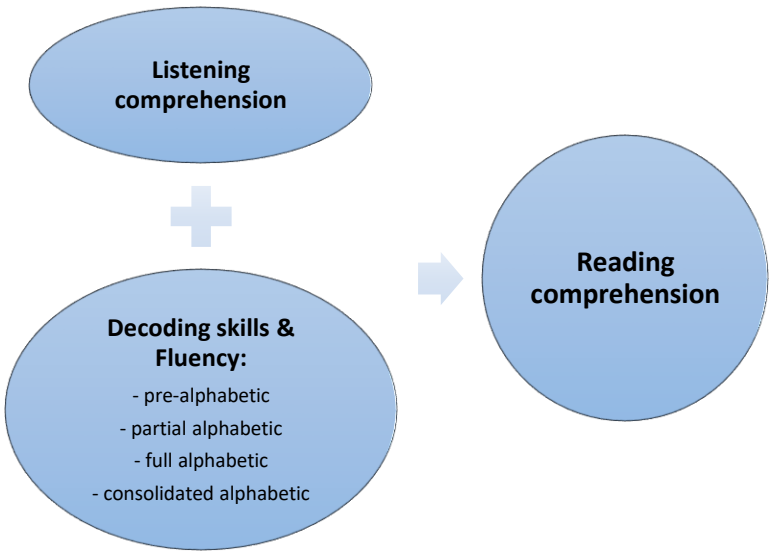
Reading is a complex process in which listening comprehension matters

The study of bilingual Latino students in the US can help to understand what is happening in the African context. Even though the context is different, in both cases pupils speak a different language at home and at school, and bilingual students' reading mechanism specificities may look alike in multilingual settings (Cummins, 1993). Several authors emphasize that bilingual pupils follow the same reading component model as monolingual pupils do, namely that reading comprehension is a linear combination of decoding skills and oral language comprehension (Curtis, 1980; Hoover and Gough, 1990; Proctor *et al.*, 2005). Reading is a complex process involving several skills growing independently through different mechanisms and different phases. For instance, general cognitive skills such as attention, perception, and thinking develop during

infancy, along with oral language which is mainly acquired through communication at home. Literacy skills in alphabetic language require more formal instruction, usually provided at school. These skills are progressively combined through different learning phases.

Ehri (1995) identifies four phases of reading development: pre-alphabetic, partial alphabetic, full alphabetic, and consolidated alphabetic. In the earliest phases, pupils learn arbitrary associations between written and oral word forms before becoming able to associate letters to sounds. Progressively, they learn to decode letter sequences and words until they reach the consolidated phase where most words can be read faster. According to the literature in the fields of linguistics and education, listening comprehension and decoding skills – the ability to associate an orthographic unit to its oral counterpart – are the two pre-requisites of reading performance, in particular of reading with comprehension (Curtis, 1980; Hoover and Gough, 1990). The two skills are not directly related, but are linked through their separate relations with phonological processing skills (for further details on this, see Sénéchal and LeFevre (2002)). Figure 3 below illustrates a model of reading inspired by these authors.

Figure 3: Model of reading



Source: Own illustration based on Hoover and Gough (1990), Curtis (1980) and Ehri (1995)

The literature emphasizes the crucial role of oral comprehension, including knowledge of vocabulary and listening comprehension. Children with higher oral language comprehension learn to read more efficiently (accuracy and speed). Similarly, Durgunoglu and Banu Öney (2000) claim that 'children acquire an awareness of phonological patterns that is specific to their home languages'. Therefore, receiving instruction in a language that the child has not been exposed to might considerably reduce language acquisition and therefore reading skills (Gass and Mackey, 2002). Listening comprehension has the strongest effect on reading comprehension and, with an

adequate level of decoding skills, produces positive reading comprehension outcomes (Proctor *et al.,* 2005). As decoding speed increases, comprehension skills are the most important predictors of reading performance (Curtis, 1980). Studies of bilingual children in developed countries also emphasize listening comprehension as a determinant of reading with comprehension (Hoover and Gough, 1990; Proctor *et al.,* 2005). Overall, this field of research emphasizes the impact of oral language on learning how to read, suggesting that a language of instruction which differs from the pupils' home language may affect reading acquisition.

Negative effect of being taught in a language different from the home language

Some case studies in education focusing on the language issue in the African context suggest that the language issue is a major barrier to education in Africa. According to these authors, an early shift from the mother tongue to the foreign language as a medium of instruction has a negative effect on learning (Alidou *et al.*, 2006; Argaw, 2016; Brock-Utne, 2007; Heugh, 1999). From classroom observations[39] in South Africa, Brock (2007) concludes that the home language may be more suitable for instruction not only for pupils who improve their comprehension and learning skills, but also for teachers who feel more comfortable teaching in a language they are more familiar with. Findings from Vuzo (2007) in two secondary schools in Tanzania show a much higher mean score, and improved teaching and learning conditions, for pupils receiving instruction in their mother tongue compared to children taught in English. However, most of these studies suffer shortcomings. They are typically based on qualitative observations or case studies using very small samples so that their findings cannot easily generalize, and have to be considered with caution as they might suffer from serious limitations in terms of sample selection.[40] Recent introduction of the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) data to the education literature provided a much more representative sample to investigate. In their paper, Hungi and Thuku (2010) use a multilevel analysis to identify the pupil and school factors that contribute to variation in reading achievement in 14 African countries. They find six significant pupil-level variables. "Speaking the language of instruction at home" is one of the variables that is positively associated with the pupils' estimated reading score.[41] Similarly, in their multilevel modelling approach, Smith and Barret (2010) find that the outside-school use of the language of instruction positively relates to pupils' reading achievement. Using the South African prePIRLS[42] data, VanStaden *et al*. (2016) investigate the differences in achievement between pupils tested in the language of instruction based on whether or not this language was their home language. They found worse results for the learners whose home language differed

[39] Observations in two classrooms only, which is one of the main limitations of this research.
[40] Sample selection bias occurs when a sample is not randomly selected. The sample selection process might introduce bias by having some members of a population more likely to be selected.
[41] Speaking the language of instruction at home increases scores by .05-.16 standardized deviation. The five other significant variables are: grade repetition, pupil socioeconomic background, meals per week, pupil sex, and pupil age.
[42] preProgress in International Reading Literacy Study (prePIRLS) 2011 makes data available for a nationally representative sample of 15 744 Grade 4 learners from 342 schools in South Africa.

from the language of instruction, even when the language of instruction was a local African language.

Despite working with larger datasets, the methodology used by these authors still fails to address potential selection effects or omitted variable bias resulting from unobservable factors at the school level. Schooling choice depends on parents' decisions that might be influenced by schools' quality, i.e. good schools may simply attract the best pupils. For instance, the schooling choice is a significant factor known to affect learning outcomes in the African context (Glewwe and Jacoby, 1994). Zuilkowski *et al.* (2018) using a combination of qualitative and quantitative data from a survey[43] implemented in Nairobi - Kenya, found that parents who send their children to low-cost nonformal private schools (instead of formal public schools) tend to be more concerned about school quality. Similarly, selection effects could occur at the school level if: 'good and experienced teachers [who] choose performing schools/classes*'* (Hanushek, 1979, 1986). More importantly, school quality might be correlated to language choices made by schools, and parents might select schools based on specific language-related characteristics such as the language used in the classroom or language homogeneity of pupils at school (Taylor and von Fintel, 2016). At the individual and household level as well, several factors are potentially inter-related with language and/or reading outcomes, such as language exposure in the family environment. Data on parental choice are typically missing, and therefore, estimates from these studies suffer from selection issues. To overcome this limitation and to minimize the selection bias, school fixed effects will be used in this research.

In the Economics literature, the role of language on learning outcomes has been neglected for years in the education production function analysis, thus offering limited evidence on the impact it may have on educational outcomes. In a recent analysis of census data from South Africa, Eriksson (2014) used the change of language of instruction policy in South African schools in 1955 as an identification strategy to examine the effect of mother tongue instruction. The change in the language of instruction increased the number of years of education in the mother tongue to eight years, against four or six years before the change, depending on the province. Through a difference-in-difference model constructed on variations across time and province, she uses that exogenous change in the language of instruction to isolate the language effect by comparing cohorts affected and unaffected by the policy change. She finds that mother tongue instruction positively affects wages, reading and writing ability, and educational attainment. Similarly, but using a more contemporary change in South African school policies, Taylor & Von Fintel (2016) estimate the effect of using English as the language of instruction. Using school administrative data, they identify schools that have recently switched to English as the language of instruction from the first grade. This change in language of instruction offers within-school, cross-grade variation in the number of years pupils received instruction in English. They use school fixed effects to account for unobservables at the school level and especially for potential correlation

[43] This survey is part of the data collected for the Primary Mathematics and Reading (PRIMR) Initiative in October 2013. Their research includes data from parent and teacher samples drawn from 93 schools (public and low-cost nonformal schools) in non-formal settlement areas of Nairobi.

between school quality and the switch to English instruction. They find that accumulating several years of mother tongue instruction in the early grade significantly improves English acquisition in higher grades (grades 4 to 6). They further show that, whereas simple Ordinary Least Squares (OLS) regression results suggest a positive impact of receiving early instruction in English on English performance, opposite results are found after controlling for the school fixed effects. This demonstrates the importance of controlling for selection effects at the school level to reduce estimate bias. Angrist *et al*. (2008) found a similar pattern in Puerto Rico: "although naïve estimates suggest that English instruction increase English-speaking ability", after including cohort-specific controls they find that using English as the language of instruction is no longer correlated with English acquisition. In their work, they isolate the effects of Spanish-only schooling on English language skills by exploiting a change in the language of instruction policy (from some years of instruction in English to Spanish only) as an identification strategy. Finally, Spaull (2016) offers a unique contribution by comparing a large group of South African grade 3 students tested twice on the same test at the interval of a month in both their home language and English. Using a difference-in-difference model, the language effect is disentangled by comparing the averages on test performance in both languages. The author identifies a negative impact (between .3 and .7 standard deviation) of writing and reading a test in language which is not the student's home language.

The research in this chapter adds to the scanty literature by bringing new empirical evidence on the impact of language on educational outcomes in the Kenyan context. Pupils whose home language differs from the language of instruction used at school are compared to pupils who speak the language of instruction at home within the same schools. This work contrast with previous studies on the language issue, which usually compares instruction in an African language of instruction to instruction in English without accounting for pupils' home language. Moreover, studies which include the "Speaking the language of instruction at home" factor usually refer to higher grade pupils who use English as the language of instruction. These studies work on post-switching samples, i.e. after transition to English, which may induce potential bias. When working with older pupils who have switched to instruction in English, it is difficult to isolate the language effect because of additional confounding factors interacting with language, such as the teacher's proficiency in English or the exposure to English in the community and at home (Spaull, 2016). To limit bias, a pre-switching sample, with focus on the pupils' home language, is used for this research. The originality of this work is that it focuses on potential test score inequalities among pupils resulting from both their home language and how language exposure at home affects their reading outcomes. School fixed effects are used to disentangle the language effect from other unobserved school factors so as to highlight the consequences of learning in a language other than the pupils' home language. Even tough, the selection bias is not eradicated, school fixed effects considerably minimize it.

Data source and summary statistics

The survey data used were collected by USAID in Kenya in October 2012, as part of the Primary Math and Reading (PRIMR) Initiative midterm impact evaluation, as described in Chapter 2. This research tests the language effect on reading achievement by comparing reading skills in a large population of Grade 2 urban children (N=1573) according to their home language group.

Three language groups with different individual backgrounds

In the dataset, the average pupil is 8 years old, attended pre-school (almost 90% of them), has been enrolled in Grade 2 in his/her school since the beginning of the school-year and has never repeated a grade. Regarding the pupils' gender, the population is balanced between boys and girls (49%). More than a quarter of pupils were absent from school for more than one week over the last school year. A majority (more than 95%) declare that both their mother and their father can read and write and about 75% of pupils have books in Kiswahili or in English (or both) at home. However, this general picture hides disparities amongst the different language groups, as discussed further below.

Table 6 shows summary statistics for the individual and family control variables for Grade 2 pupils only. The statistics are reported for Grade 2 pupils by home language group (Swahili, semi-Swahili, and non-Swahili), with information on the statistical significance (t-test) of the observed differences between the three home language groups. Overall, the results show that many variables differ significantly between the three language groups. The semi-Swahili group and the non-Swahili group are quite similar; they only differ on one measure (the order of assessment), whereas the Swahili group differs from the two other groups on several measures. To improve the analysis and isolate the effect of using Kiswahili as home language, several individual and family characteristics which could potentially influence total literacy scores will be controlled for. These variables are described below.

Table 6: Individual and family control variables - differences in means between the three language groups

	Total			Non-Swahili group			Semi-Swahili group			Swahili group			Non-Swahili vs. Semi-Swahili	Swahili vs. Semi-Swahili	Swahili vs. Non-Swahili
	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	Difference	Difference	Difference
Gender (female=1)	0.49	1573	0.25	0.45	305	0.25	0.50	184	0.25	0.51	1084	0.25	-0.054	0.007	0.06 *
Age (in years)	7.93	1571	1.29	8.23	305	1.80	8.07	184	1.64	7.82	1082	1.03	0.166	-0.25 **	-0.416 ***
Enrolled at school since January	0.87	1573	0.11	0.85	305	0.13	0.89	184	0.10	0.88	1084	0.11	-0.044	-0.015	0.029
Attended pre-school	0.90	1565	0.09	0.90	301	0.09	0.92	184	0.07	0.90	1080	0.09	-0.028	-0.027	0.002
Repeated G2	0.06	1564	0.06	0.09	300	0.08	0.11	184	0.10	0.04	1080	0.04	-0.02	-0.068 **	-0.049 **
Pupil has skipped G1	0.09	1564	0.08	0.07	300	0.07	0.13	184	0.12	0.08	1080	0.08	-0.061	-0.05	0.011
Attendance interrupted (previous year)	0.26	1542	0.19	0.28	291	0.20	0.21	183	0.17	0.26	1068	0.19	0.066	0.048	-0.019
Kiswahili assessment administered 1st	0.36	1573	0.23	0.40	305	0.24	0.26	184	0.19	0.37	1084	0.23	0.141 **	0.119 **	-0.022
English assessment administered 1st	0.26	1573	0.19	0.23	305	0.18	0.30	184	0.21	0.27	1084	0.20	-0.071	-0.038	0.033
Both parents can read and write	0.96	1530	0.04	0.94	294	0.05	0.94	179	0.06	0.96	1057	0.04	0.003	0.021	0.019
English books at home	0.69	1573	0.22	0.60	305	0.24	0.68	184	0.22	0.71	1084	0.21	-0.085	0.028	0.112 ***
Kiswahili books at home	0.60	1573	0.24	0.54	305	0.25	0.52	184	0.25	0.63	1084	0.23	0.019	0.109 **	0.09 **
Wealth index	0.02	1562	2.24	-0.18	301	2.55	-0.18	183	1.88	0.12	1078	2.19	-0.003	0.296 **	0.299 **

*Sources: Own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) weighted data, (3) the Wealth index is calculated using the PCA analysis and includes several assets owned by the household (radio, phone, electricity, TV, refrigerator, toilet inside, bicycle, motorcycle, car or truck) and (4) Grade 2 pupils data only, English speakers being excluded.*

Swahili pupils are younger and experienced less grade repetition

Pupils' gender is an important parameter in education. In many developing countries, there is gender discrimination with regard to education, with families investing more in boys' education. This is not the case in the overall sample. However, while the Swahili and the semi-Swahili group count 51% and 50% of girls respectively, the non-Swahili group includes, on average, fewer girls (45%). The female ratio difference between the Swahili and the non-Swahili group is statistically significant.

At the individual level, pupils from the Swahili group are on average younger (less than 8 years old) than in the two other language groups. The difference is highly significant. Controlling for pupils' age is important as it usually reflects the educational background. An over-aged pupil is usually a sign of late enrollment in school, previous grade repetition, or schooling interruption, all of which are negatively correlated to educational outcomes (Lewin, 2009). Following Lee & Zuze (2011), repetition at school is included as a proxy of past school history. On this variable as well, the results show that the Swahili group experienced significantly less grade repetition than the two other groups (less than 5% of pupils against more than 9% and 11% for the non-Swahili and the semi-Swahili groups respectively). Additional variables controlling for pupils' schooling background are included in the study, such as pre-school enrollment, grade 1 skipping, enrollment since the beginning of the school year, and a pupil's past absenteeism from school. No significant differences are observable on these variables between the three language groups.

Lastly, the dataset provides details on the language order of the EGRA administration, making it possible to identify whether pupils received the EGRA form in English or the EGRA form in Kiswahili first. The assumption is that the order of the assessment could potentially bias the scores, as the pupils were not familiar with the assessment at the first administration and might feel more at ease with the second.[44] Administration order will be controlled for in the analysis. The semi-Swahili group differs significantly from the two other groups (Swahili and non-Swahili) on the order of the Kiswahili EGRA assessment administration. On average, the Kiswahili EGRA form was administered first to about 26% of semi-Swahili pupils, against 37% and 40% of pupils in the Swahili and non-Swahili language groups respectively. No significant differences are observed between the three language groups regarding the administration order of the English form.

Swahili pupils are better off and have more books at home

To control for the pupils' household socio-economic status, an asset index[45] using the principal component analysis (PCA), which is used by several authors as a relevant proxy for wealth (Filmer

[44] A math assessment was part of the battery of assessments administered to the pupils', which is why the two EGRA assessments do not add up to 100%.

[45] Unfortunately, the data does not provide information on household income level. However, the datasets provide a list of assets (radio, phone, electricity, TV, refrigerator, toilet inside, bicycle, motorcycle, car or truck) and for each respondent the number of assets owned by the household is given. This information is reported by pupils with no evidence as to whether these assets are owned or rented. For further information on the construction and limitation of the PCA approach please refer to Vyas and Kumaranayake (2006).

and Pritchett, 1999), was created. The asset index is based on a number of household assets, such as a television, a cellphone, a refrigerator, a car, etc. Pupils from the Swahili group are significantly wealthier than pupils from the semi-Swahili and the non-Swahili groups.

The availability of Kiswahili and/or English books at home are given as two other variables, which are of interest as they might interact positively with educational outcomes. Pupils from the Swahili group are more likely to have Kiswahili books at home than pupils from the semi-Swahili and the non-Swahili groups (63% against 52% and 54% respectively). Both differences are significant at 95%. Similarly, pupils from the Swahili group are more likely to have English books available at home than the non-Swahili pupils (about 71% against fewer than 60% in the non-Swahili group). This difference is highly significant and might partially reflect a wealth effect, wealthier household being more likely to buy books and to be part of the Swahili group.[46]

In addition, the dataset includes a variable asking pupils about their parents' ability to read. A dummy variable was generated to identify pupils' whose parents can both read and write as a potential indicator of parental education. The analysis shows no inter-group differences on the variable 'parents read and write'. Actually, most of the parents were reported as being able to read in all groups (between 94% and 96%).[47]

Three language groups attending schools with different characteristics

The dataset offers additional information on schools through the school survey administered to the head teacher. Several variables are retained at the school level, as they provide information on the school's characteristics, class environment, and teachers' assiduousness. On average, about 30% of the schools in the dataset are part of the Primary Math and Reading (PRIMR) Initiative. A majority of schools are public schools (60%). According to the head teachers, most schools have access to water and have a separate girls' washroom (80% and 90% respectively). Most head teachers (70%) declared that their school has electricity and 66% that their school has a program providing meals for students. However, school characteristics are not equally shared between the language groups.

Table 7 shows summary statistics for the school control variables. The statistics are reported by Grade 2 pupils' home language group. The results show that the three language groups attend schools which differ in their characteristics. The semi-Swahili group and the non-Swahili group tend to attend similar schools, whereas the schools attended by the Swahili group on average differ significantly from those attended by the two other groups.

[46] Correlation coefficients between the wealth index and the availability of Kiswahili and/or English books are .20 and .16 respectively ($p<0.001$).

[47] This variable has been removed from our analysis given that it brings no additional information. Moreover, we have no specification about the languages that parents can read and write. Furthermore, pupils' perception of their parents' reading ability may be prone to measurement error.

Table 7: School control variables - differences in means between the language groups

	Total			Non-Swahili group			Semi-Swahili group			Swahili group			Non-Swahili vs. Semi-Swahili	Swahili vs. Semi-Swahili	Swahili vs. Non-Swahili
	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	Difference	Difference	Difference
PRIMR school (treatment=1)	0.31	1573	0.22	0.28	305	0.20	0.35	184	0.23	0.32	1084	0.22	-0.064	-0.032	0.032
School type (Nonformal=1)	0.40	1573	0.24	0.25	305	0.19	0.25	184	0.19	0.47	1084	0.25	0.005	0.223 ***	0.217 ***
School has shifts	0.35	1573	0.23	0.38	305	0.24	0.43	184	0.25	0.32	1084	0.22	-0.043	-0.109	-0.065
Multigrade class	0.01	1573	0.01	0.01	305	0.01	0.02	184	0.02	0.02	1084	0.02	-0.012 *	-0.003	0.009
LOI Kiswahili (according to HT)	0.65	1573	0.23	0.76	305	0.18	0.70	184	0.21	0.60	1084	0.24	0.064	-0.094	-0.158 ***
Teachers absenteism	0.64	1573	0.23	0.71	305	0.21	0.77	184	0.18	0.59	1084	0.24	-0.061	-0.182 ***	-0.121 **
Teachers lack of punctuality	0.20	1573	0.16	0.26	305	0.19	0.23	184	0.18	0.18	1084	0.15	0.023	-0.05	-0.073
Water available at school	0.80	1573	0.16	0.72	305	0.20	0.85	184	0.13	0.82	1084	0.15	-0.124 ***	-0.024	0.1 **
School with electricity	0.70	1573	0.21	0.61	305	0.24	0.68	184	0.22	0.73	1084	0.20	-0.075	0.05	0.125 **
Feeding program at school	0.66	1573	0.23	0.54	305	0.25	0.58	184	0.24	0.71	1084	0.21	-0.05	0.124 **	0.174 ***
Girlwashroom facilities at school	0.90	1573	0.09	0.87	305	0.12	0.90	184	0.09	0.91	1084	0.08	-0.037	0.008	0.045
Library at school	0.35	1573	0.23	0.30	305	0.21	0.41	184	0.24	0.35	1084	0.23	-0.103	-0.055	0.048

*Sources: Own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Weighted data, and (3) Grade 2 pupils data only, English speakers being excluded.*

Swahili pupils typically attend nonformal schools experiencing less teacher absenteeism

The data used are from a USAID project impact evaluation. Consequently, in the sample, some schools were supported by the PRIMR program at the time of the survey administration. This program includes a specific intervention aimed at improving reading skills. [48] Therefore, it is of crucial importance to account for the participation of schools in such a program. A 'Treatment' variable is included in the database in order to identify the schools supported by the project. No significant differences are observed between the three language groups regarding their participation in the program.

Public versus nonformal private schooling is another important parameter, as the quality of schools and teachers may vary substantially depending on the school's status. In the Kenyan context, public schools are supported by the government and nonformal schools are part of the private sector. A majority of semi-Swahili and non-Swahili pupils attend public schools (about 75%), whereas the proportion is more balanced between public and nonformal private schools in the Swahili group (53% vs. 47% respectively). The differences between the Swahili group and the two other groups are highly significant.

In the dataset, teachers' absenteeism and teachers' lack of punctuality are measured by two variables asking the school head how many teachers were absent or late the day before the survey. These two variables were recoded as a dummy variable, so that for any teacher late or absent in the school the variable takes the value of 1. On average, the Swahili pupils' schools are characterized by a lower rate of teacher absenteeism, with less than 60% of schools having at least one teacher absent against 71% and 77% of schools in the semi-Swahili and non-Swahili groups respectively.

Finally, other control variables potentially affecting schooling are included, such as whether the classes are organized in shifts (morning vs afternoon classes), and whether they include Grade 2 pupils only or have multi-grade classrooms. However, the Swahili group and the two other groups do not differ significantly on any of these control variables.

Swahili pupils attend higher quality schools

Other school characteristics such as the availability of water, electricity, a feeding program, girls' washroom, or library are factors of interest that potentially contribute positively to the school environment. In the sample, more schools are characterized by the availability of a feeding program for the Swahili group (71%) than for the semi-Swahili group (58%) and the non-Swahili group (54%). The differences are significant between the Swahili group and the two other groups. Moreover, the non-Swahili group is the worst off, with 28% of non-Swahili pupils attending schools with no access to safe water in the school facility, in comparison to 15% and 18% in the semi-Swahili and the Swahili group respectively. Similarly, a higher proportion of non-Swahili

[48] PRIMR provided training on reading (Kiswahili and English), combined with full sets of lesson plans and school materials to teachers and head teachers in January 2012. In addition, reading books were provided to schools in March 2012.

pupils are enrolled in a school with no access to electricity (40% against 26% in the Swahili group). A majority of schools (from 86% to 91%) have a girls' washroom at school, with no significant difference between the three language groups. Finally, the proportion of schools having a library is rather low (on average less than 35%) and similar between the three groups.

Swahili pupils attend school with lower use of Kiswahili as language of instruction

As previously discussed, and in accordance with official educational policy, Kiswahili is the main language of instruction in urban areas in Kenya. English should only be introduced in Grade 2 as a lesson subject. However, evidence suggests that English is often used as the sole or main medium of instruction in Grade 2 (Trudell and Piper, 2014). The head teacher questionnaire asked whether or not Kiswahili was used as the language of instruction in Grade 2. Unfortunately, what the head teacher reports may not reflect what teachers actually do in their classrooms. Nevertheless, this variable was retained as a proxy of the schools that predominantly used Kiswahili as the language of instruction. On average, about 65% of the head teachers confirmed that Kiswahili is used as the language of instruction in Grade 1 and Grade 2 in their school (in conformity with the language of instruction policy in Kenya). However, a lower proportion of Swahili (60%) than non-Swahili pupils (more than 75%) are enrolled in schools where Kiswahili is used as the language of instruction. The difference is highly significant.[49]

Three language groups with high Kiswahili and English scores disparities

Swahili group scores are significantly higher on all the reading subtasks and in both languages

Table 8 gives the mean scores and their variance for each reading subtask of the EGRA assessment (including the total literacy scores) according to language sub-groups. Moreover, Table 8 includes results of the t-tests performed, to highlight significant differences between the reading outcomes of the three groups of interest. In the first subtask, pupils were asked to provide the sound corresponding to printed letters for 100 letters. In the second subtask, pupils have to read invented words out of a list of 50 invented words. In the third subtask, pupils were asked to read a short story of 60 words in Kiswahili and 61 words in English. These first three subtasks were timed, and pupils only had 1 minute per subtask to identify or read a maximum of letters or words. Pupils scored one point for each letter or word read accurately in the assessed language. Following the story reading subtask, pupils were asked questions about the story they had just read to measure their reading comprehension in both languages, English and Kiswahili. The questions are asked proportionally to the length of the text the pupil could read (up to 5 questions).

[49] This result may seem counter-intuitive. However, a possible explanation would be that Swahili pupils' parents prefer schools using English as language of instruction. The next section will present the methodology used to control for potential selection bias.

Table 8: Reading outcomes - differences in means between the three language groups

	Total			Non-Swahili group			Semi-Swahili group			Swahili group			Non-Swahili vs. Semi-Swahili Difference	Swahili vs. Semi-Swahili Difference	Swahili vs. Non-Swahili Difference
	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR			
Kiswahili - letter sound score	39.52	1573	500.06	29.36	305	447.49	38.57	184	377.59	42.83	1084	497.37	-9.209 ***	4.256 **	13.466 ***
Kiswahili - invented word score	19.41	1573	167.62	15.88	305	170.73	17.97	184	143.20	20.77	1084	165.52	-2.083	2.802 **	4.884 ***
Kiswahili - oral reading score	31.70	1573	285.81	27.05	305	302.56	28.57	184	245.60	33.72	1084	276.19	-1.525	5.15 ***	6.675 ***
Kiswahili - reading comp. score	2.19	1573	1.66	1.81	305	1.83	1.85	184	1.53	2.37	1084	1.54	-0.04	0.514 ***	0.554 ***
Kiswahili - total literacy score	-0.08	1573	0.92	-0.43	305	0.97	-0.25	184	0.76	0.07	1084	0.87	-0.171	0.319 ***	0.49 ***
Kiswahili - listening comp. score	2.73	1573	2.33	2.33	305	2.33	2.69	184	2.26	2.87	1084	2.29	-0.363 *	0.172	0.536 ***
English - letter sound score	32.71	1573	586.08	25.83	305	502.81	29.09	184	455.51	35.52	1084	612.51	-3.259	6.428 ***	9.687 ***
English - invented word score	26.02	1573	204.71	20.84	305	215.47	23.28	184	200.18	28.13	1084	188.48	-2.441	4.856 ***	7.297 ***
English - oral reading score	40.80	1573	372.59	32.90	305	426.31	35.89	184	373.09	44.17	1084	321.57	-2.99	8.274 ***	11.263 ***
English - reading comp. score	1.62	1573	1.50	1.08	305	1.10	1.33	184	1.40	1.84	1084	1.50	-0.253 *	0.505 ***	0.759 ***
English - total literacy score	-0.06	1573	0.94	-0.52	305	0.97	-0.32	184	0.83	0.13	1084	0.83	-0.203 *	0.445 ***	0.648 ***

*Sources: Own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Weighted data.*

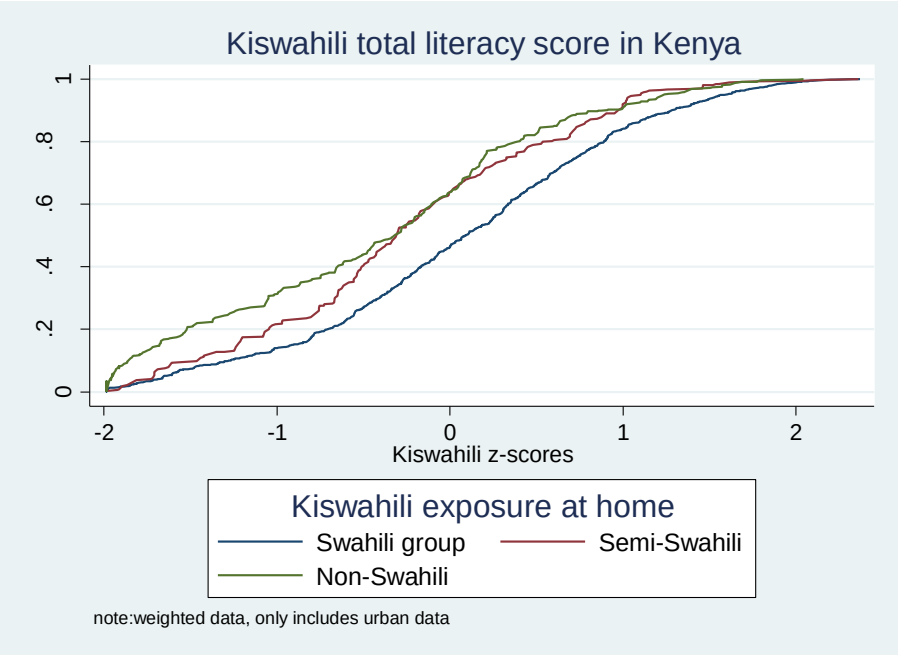
Lastly, in the Kiswahili form the examiner read another short story to the pupil twice, and then asked 5 questions about the story to evaluate the pupils' listening comprehension in Kiswahili.

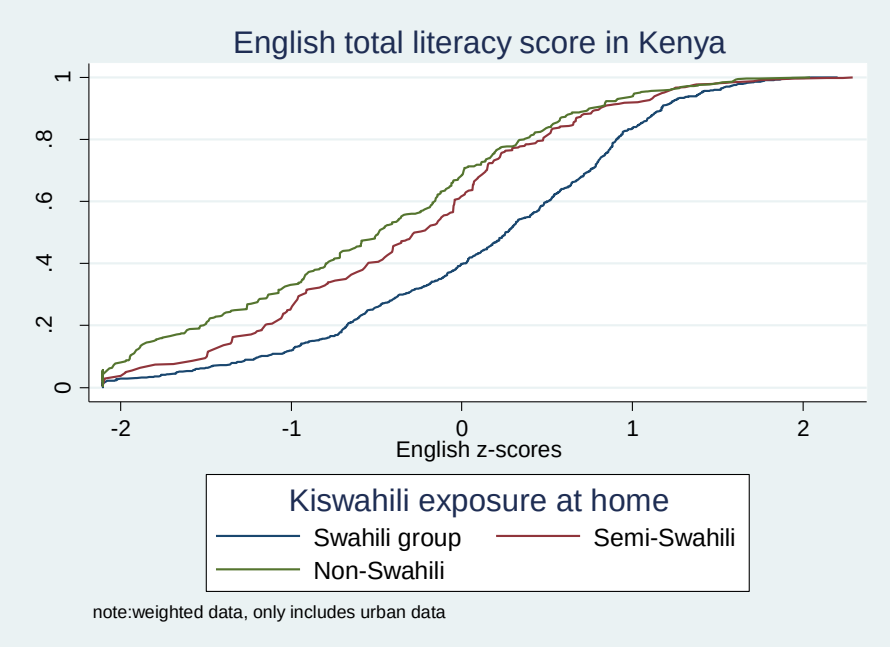
As can be seen in Table 8, the Swahili group systematically achieves higher scores than the semi-Swahili and the non-Swahili groups. For each literacy subtask, the differences are statistically significant between the Swahili group and the two other groups. For instance, a Swahili pupil could read correctly an average of 34 words of a short story in Kiswahili in one minute, against 27 and 29 words in the non-Swahili and semi-Swahili groups respectively. Similarly, Swahili pupils could read an average of 44 words of a short story in English in one minute against 33 and 36 words in the two other groups respectively. On average, Swahili pupils could read 5 more Kiswahili invented words than non-Swahili pupils in one minute and almost 3 more invented words than the semi-Swahili pupils. Both differences are significant. The gap is even larger in English, with Swahili pupils being able to read an average of 7 more invented words per minute than non-Swahili pupils, and 5 more in comparison to semi-Swahili groups. Unsurprisingly, reading comprehension scores follow the same pattern as reading scores. For both reading comprehension subtasks, in Kiswahili and in English, the differences are highly significant between the Swahili group and the two other groups. Reading comprehension reflects basic reading skills as well as oral language comprehension. While Swahili pupils scored on average 2.3 out of 5 in reading comprehension in Kiswahili, non-Swahili and semi-Swahili pupils only achieved 1.8 on average. Similarly, in English comprehension, Swahili pupils scored on average 1.8 out of 5, and the non-Swahili and semi-Swahili groups scored 1 and 1.3 respectively. It is worth noting that, despite the fact that pupils can read more words in English than in Kiswahili, their reading comprehension is higher in Kiswahili. For most subtasks, significant differences between the three language groups are observed. Swahili pupils tend to perform the best and are significantly different from the two other groups. Non-Swahili pupils perform the worst, with the semi-Swahili tending to be in between. The semi-Swahili and non-Swahili groups only differ on a limited number of subtasks (mainly on Kiswahili letter sound). Listening comprehension in Kiswahili is the only subtask where semi-Swahili pupils achieve similar scores to Swahili pupils whereas non-Swahili pupils achieve significantly lower scores. On average, non-Swahili pupils score 2.3 out of 5, semi-Swahili and Swahili pupils score 2.7 and 2.9 respectively.

On standardized total literacy scores, for both Kiswahili and English, the Swahili pupils are far ahead of the two other groups. The differences between Swahili pupils and the others are highly significant. On the total Kiswahili literacy score, the Swahili pupils score .065 standard deviation above the average, against -.425 and -.254 below the average for non-Swahili pupils and semi-Swahili pupils respectively. The difference between the non-Swahili and the semi-Swahili groups for the total Kiswahili literacy score is not significant. On the total English literacy score, the Swahili pupils score .127 standard deviation above the average against -.318 for the semi-Swahili group and -.521 for the non-Swahili group. The difference between the non-Swahili and the semi-Swahili group on the total English literacy score is significant as well. In summary, the three language groups are significantly different from each other on the total literacy score in English, whereas in Kiswahili only Swahili pupils are significantly different.

Figure 4 presents the standardized[50] total literacy scores' cumulative density function per home language group in the two languages (Kiswahili and English).

Figure 4: Total literacy scores in Kiswahili and English per home language group





Sources: Own calculations based on Midterm evaluation data - PRIMR initiative.

[50] Standard scores (commonly referred to as z-scores) are scores normalized to have a mean of zero and a standard deviation of 1. The procedure of normalization consists in subtracting the mean score from individual scores and to divide by the standard deviation.

Figure 4 shows clearly the stochastic dominance of the Swahili group over the two other groups for the two languages, Kiswahili and English. The same pattern is observed for the three different reading subtasks (see Appendix E for further details). The first approximation reveals obvious differences between pupils from the three groups, highlighting a potential discriminating effect which seems to affect pupils' performance adversely in the non-Swahili group and to a lesser extent in the semi-Swahili group. However, to isolate the language effect from other confounding factors associated with each language group (i.e. differences in home background or school quality) multivariate regression analysis is needed.

Swahili pupils have a lower likelihood of scoring zero on the different subtasks

For each subtask, a certain percentage of pupils scored zero, i.e., they did not score any points for the specific subtask because they were unable to identify a single letter or to read a single word. Table 9: Zero scores - differences between the three language groupsTable 9 gives the total percentage of pupils who scored zero on the different subtasks, the mean per language sub-group, and t-tests results, in order to highlight significant differences in the likelihood of scoring zero between the three groups. Following the previous observations on the score differences between the three language groups, similar conclusions can be drawn regarding the likelihood of scoring zero on the different subtasks. Whatever the subtask or the language of assessment (Kiswahili or English), a lower number of pupils in the Swahili group scored zero.

In summary, the three language groups differ on many individual and school characteristics. Consequently, the groups are not homogeneous, which may raise concerns about a potentially endogenous selection of pupils at the school level. In particular, the Swahili group differs from the two other groups on many variables. Disparities are observed at the school level as well. It is therefore critical to use a strong identification strategy to account for these specific characteristics and properly isolate any language effect from other confounding factors. The next section illustrates the econometric model used in this work.

Table 9: Zero scores - differences between the three language groups

	Total			Non-Swahili group			Semi-Swahili group			Swahili group			Non-Swahili vs. Semi-Swahili Difference	Swahili vs. Semi-Swahili Difference	Swahili vs. Non-Swahili Difference
	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR			
Kiswahili - letter sound score = 0	0.047	1573	0.045	0.104	305	0.093	0.035	184	0.034	0.032	1084	0.031	0.069 **	-0.003	-0.072 ***
Kiswahili - invented word score = 0	0.145	1573	0.124	0.253	305	0.19	0.154	184	0.131	0.111	1084	0.098	0.099 **	-0.043	-0.142 ***
Kiswahili - oral reading score = 0	0.063	1573	0.059	0.128	305	0.112	0.062	184	0.058	0.043	1084	0.042	0.066 *	-0.018	-0.084 ***
Kiswahili - reading comp. score = 0	0.143	1573	0.123	0.235	305	0.18	0.193	184	0.157	0.105	1084	0.094	0.042	-0.088 **	-0.13 ***
Kiswahili - listening comp. score = 0	0.081	1573	0.075	0.119	305	0.105	0.086	184	0.079	0.069	1084	0.064	0.033	-0.017	-0.05 *
English - letter sound score = 0	0.139	1573	0.12	0.182	305	0.149	0.073	184	0.068	0.138	1084	0.119	0.109 ***	0.065 ***	-0.043
English - invented word score = 0	0.082	1573	0.076	0.158	305	0.133	0.095	184	0.086	0.057	1084	0.054	0.063	-0.038	-0.101 ***
English - oral reading score = 0	0.055	1573	0.052	0.095	305	0.087	0.069	184	0.065	0.039	1084	0.038	0.026	-0.03	-0.056 **
English - reading comp. score = 0	0.213	1573	0.168	0.367	305	0.233	0.287	184	0.206	0.152	1084	0.129	0.079	-0.135 ***	-0.215 ***

*Sources: Own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Weighted data.*

The model estimation strategy

The work is based on the Education Production Function (Hanushek, 1979) discussed in Chapter 2, which defines learning outputs as a result of several individual and contextual vectors. The output of the Education Production Function can be measured by student test scores and is hypothesized to depend on pupil, family background and school characteristics. The functional form of the Education Production Function can be expressed as:

$$Y_{is} = \beta_0 + \beta_1 I_{is} + \beta_2 F_{is} + \beta_3 S_s + \varepsilon_{is} \quad (1)$$

Where the score (Y_{is}) of pupil i in school s is a function of pupil's characteristics (I_i), family background (F_i) and school inputs (S_s). The language spoken by the pupil at home falls under F_i. Unobserved determinants of achievement are captured in an error term ε .

Following Jiménez *et al.* (2014), the main dependent variable in the model is a total literacy score, comprised of four EGRA subtasks (letter identification, invented word, word reading, and reading comprehension) described in the data section. The data reduction yielded a single standardized literacy score with a mean of zero and variance equal to one. In the results section, separate regressions are run for the total literacy scores in both languages, Kiswahili and English. As part of the determinants of literacy scores, the variable of interest - the home language effect - is estimated. A set of individual and family characteristics are controlled for. Lastly, to isolate the effect of the home language variable on the literacy scores, school fixed effects are used to control for observable and unobservable factors at the school level.[51] The model is specified as:

$$Y_{is} = \alpha + \beta L_{is} + \delta X_{is} + \lambda_s + \varepsilon_{is} \quad (2)$$

where Y_{is} is the standardized total literacy score of pupil i in school s. The impact of the home exposure to Kiswahili (as home language) is estimated by L_i, the language characteristic dummy (non-Swahili/semi-Swahili/Swahili with Swahili as the omitted category) of pupil i. The model also includes X_i, a vector of controls for the pupil's household and individual characteristics and λ_s the school fixed effects (including school observable and non-observable variables possibly correlated with X_i) and ε is the error term.

[51] School fixed effects allow for control for any unobservables at the school level; this also includes potential geographical differences between schools.

First, the model is estimated using school fixed effects to isolate the language effect. In Kiswahili and in English, regressions on the total literacy scores are presented together to facilitate cross-language comparison. Because Kiswahili and English are both used as language of instruction in urban Kenya and because the data does not provide clear information about the language used in each classroom, the language effect on both scores is investigated. The Ordinary Least Squares (OLS) regression with clustered standard errors at the school level while including school level factors is presented along with the school fixed effects model for comparison. This highlights the interaction between pupils' characteristics and school level factors. As discussed in the literature section, some authors used a multi-level approach to isolate the language effect. However, this approach fails to control for school selection. Therefore, this approach is not used here.

Secondly, the different reading subtasks are analyzed individually (and for both languages) so as to understand better the trends associated with the complexity of the different tasks. To ensure a normal distribution of scores, standardized scores are used for each subtask, with a mean of zero and variance equal to one. The OLS and the school fixed effects model are run on each subtask score separately in the two languages, Kiswahili and English. The model for each subtask is presented in the results section, along with the total literacy score. The Kiswahili section includes the listening comprehension subtask as well.

As previously discussed in the literature review, a language effect resulting from a differential exposure to Kiswahili in the family sphere is expected in the regressions of both scores, Kiswahili and English. Reading acquisition should be facilitated for pupils who speak Kiswahili at home. As oral comprehension is a crucial component in the reading process, a positive effect is expected on Kiswahili score for pupils who receive instruction in their home language (i.e. Kiswahili). They are in a better position to associate word sounds with meaning and to understand the teacher's explanations. Similarly, a positive effect is expected on English scores because the skills acquired in Kiswahili may help to activate the reading process faster in English. Furthermore, it cannot be excluded that the teacher may use Kiswahili to explain or teach English reading concepts. In all specifications, significant differences on literacy outcomes are expected between the three language groups. Following the identification strategy and after controlling for school unobservables (i.e. school fixed effects) and other family and individual factors, the Swahili group should perform the best, followed by the semi-Swahili group that should in turn perform better than the non-Swahili group, for both Kiswahili and English scores.

In conclusion, the sample offers the unique opportunity to compare pupils from different home language backgrounds who receive the same instruction in the same schools. After removing potential self-selection bias at the school level and controlling for other individual characteristics, one can be confident that the identification strategy removes a fair amount of bias from the estimates, allowing the language effect on literacy outcomes to be disentangled.

Results

This section provides the results of the model, focusing first on the language variables' impact on Kiswahili and English literacy achievement. Secondly, the full OLS model, including the school control variables is presented, together with the fixed effects model evidencing selection effects at the school level. [52] The interaction between individual and school level factors is discussed with an emphasis on language group differences between and within schools. Finally, the full OLS and school fixed effects models are run on the different EGRA subtasks to isolate the specific language effect on each subtask in order to understand better how the home language impacts the different reading mechanisms involved in reading performance.

Non-Swahili pupils score worse than Swahili pupils in both Kiswahili and English

This sub-section explores the results on the two variables of interest: the semi-Swahili and non-Swahili language variables (the Swahili group is the omitted category). Table 10 below provides the OLS model estimates, excluding the school level factors, for Kiswahili and English total literacy scores in columns 1 and 4 respectively. Columns 2 and 5 provide the results of the OLS model including school control variables. The school fixed effects estimates are provided in columns 3 and 6.

As expected, the non-Swahili group coefficients are negative and highly significant in all specifications. Table 10 shows that pupils in the non-Swahili group have worse total literacy scores than Swahili pupils on average, even when school unobservables are controlled for. This holds true for the two languages of assessment, Kiswahili and English. After controlling for school unobservable factors, belonging to the non-Swahili group is associated with a lower Kiswahili total literacy score by .206 standard deviation. Similarly, the English total literacy score is lower by .247 standard deviation.

Interestingly, after the inclusion of school fixed effects, the 'semi-Swahili group' coefficient on the Kiswahili total score is not significant anymore. The coefficient on the English literacy total score remains significant (coefficient = -.203). Therefore, the difference between the semi-Swahili group and the Swahili group on Kiswahili scores, can be mostly attributed to school unobservable factors, given that the 'semi-Swahili' coefficient is not significant when the school's unobservable factors are properly controlled for by using school fixed effects. Nevertheless, it should be noted that the introduction of school fixed effects increases measurement error bias (Krueger and Ashenfelter, 1992; Sevestre and Matyas, 2008; Wooldridge, 2002). Therefore, the school fixed effects estimators potentially reflect this bias, which could mean that the coefficients are less likely to be significant in the school fixed effects model.

[52] For comparison purposes, the results are controlled at the District level. These results are presented in Appendix H.

Table 10: OLS and FE regressions – Total literacy scores in Kiswahili and in English

	Kiswahili total literacy score			English total literacy score		
	(1)	(2)	(3)	(4)	(5)	(6)
Non-Swahili	-0.398***	-0.225***	-0.206**	-0.536***	-0.330***	-0.247***
	0.079	0.074	0.09	0.073	0.071	0.09
Semi-Swahili	-0.312***	-0.181**	-0.185	-0.405***	-0.247***	-0.203*
	0.097	0.09	0.115	0.086	0.078	0.103
Female	0.100*	0.091*	0.09	0.121**	0.115**	0.112*
	0.053	0.053	0.059	0.055	0.054	0.067
Age	0.267	0.385**	0.471**	-0.106	-0.003	0.177
	0.167	0.159	0.199	0.18	0.153	0.175
Age squared	-0.016*	-0.021**	-0.026**	0.003	-0.001	-0.011
	0.009	0.009	0.011	0.01	0.009	0.01
At school since January	0.049	0.091	0.044	0.051	0.096	0.025
	0.079	0.072	0.081	0.077	0.069	0.078
Attended pre-school	0.02	-0.018	0.034	-0.048	-0.045	0.035
	0.102	0.09	0.139	0.104	0.093	0.138
Repeater	-0.213*	-0.151	-0.123	-0.276*	-0.222*	-0.141
	0.127	0.122	0.127	0.142	0.131	0.129
Pupil has skipped G1	0.052	0.061	0.181	0.066	0.055	0.135
	0.101	0.116	0.14	0.102	0.117	0.125
Attendance interrupted	-0.176**	-0.170**	-0.113	-0.295***	-0.298***	-0.149*
	0.069	0.066	0.087	0.066	0.061	0.082
Wealth index	0.057**	0.028	0.009	0.090***	0.047**	0.022
	0.022	0.022	0.023	0.02	0.02	0.027
Kiswahili books at home	-0.04	-0.032	-0.043	-0.056	-0.052	-0.081
	0.066	0.063	0.073	0.063	0.059	0.061
English books at home	0.152**	0.164**	0.07	0.107	0.110*	0.039
	0.067	0.064	0.067	0.066	0.063	0.068
Kiswahili assessment 1st	-0.142**	-0.141***	-0.139**			
	0.057	0.053	0.056			
English assessment 1st				-0.101	-0.069	-0.091
				0.064	0.06	0.068
PRIMR Treatment school		0.378***			0.353***	
		0.075			0.07	
Nonformal school		0.509***			0.458***	
		0.076			0.063	
Multigrade class		-0.076			-0.139	
		0.164			0.188	
Kiswahili as language of instruction		-0.079			-0.299***	
		0.076			0.06	
Teacher was absent the previous day		-0.009			-0.064	
		0.075			0.061	
Teacher was late the previous day		-0.227***			-0.361***	
		0.085			0.084	
Water available at school		0.004			-0.014	
		0.07			0.066	
School with electricity		0.265***			0.245***	
		0.067			0.069	
Feeding program at school		0.106*			0.125**	
		0.064			0.061	
Girlwashroom at school		-0.064			-0.013	
		0.101			0.104	
Library at school		0.009			-0.092	
		0.07			0.065	
No. of Obs.	1519	1519	1519	1519	1519	1519
R-Squared	0.07	0.18	0.37	0.13	0.25	0.42
Individual control variables	Y	Y	Y	Y	Y	Y
School control variables	N	Y	N/A	N	Y	N/A
School controls	N	N	Y	N	N	Y

*Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 shows results from the OLS model including individual and household variables only with Kiswahili scores as the outcome variable, column 2 shows the full OLS model including school level factors and column 3 is the school fixed effect model (3) column 4 to 6 give the corresponding results with English scores as the outcome variable (4) Standards errors are indicated below the coefficients, (5) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative, (6) Data on the EGRA total literacy scores are independently presented for Kiswahili and English.*

Regression results confirm the differences observed between the three language groups in the summary statistics section. When all the determinants, including the school fixed effects, are accounted for, pupils from the non-Swahili group still have significantly lower scores on both the Kiswahili and English assessments. In contrast, when school fixed effects are included, the semi-Swahili group achieve similar scores to Swahili pupils in Kiswahili. This result was not foreseen but is not surprising. Given that Kiswahili is one of the languages spoken at home by semi-Swahili pupils, one might expect that these pupils receive enough exposure to oral language in Kiswahili to support the reading process in this language.

Within schools, variability in individual and family factors is considerably reduced

This sub-section discusses further the OLS and school fixed effects models. In the OLS model, individual, family and school control variables are regressed in two steps for the total literacy scores in Kiswahili and in English. When comparing the OLS model without school control variables (column 1 and 4) with the other two specifications, some individual factors identified as determinants in the OLS model are no longer significant after controlling for school variables or for fixed effects. This indicates that most variability in pupils' characteristics is associated with the "school factor", including school unobservable factors such as parents' school choice, difference in the quality of schools, teachers, etc., all of these school variables being captured by the school fixed effects.

As observed in Table 10, when school fixed effects are included most of the individual and household factor coefficients are diminished and only a few determinants at the individual and family level are still significant. This is not surprising given that school fixed account for differences between schools. For instance, the socio-economic status and having English books at home are no longer significantly correlated with total literacy scores when school fixed effects are included. Similarly, after controlling for school factors, having repeated grade 2 is not a factor significantly impacting total literacy scores anymore. Interestingly, when school fixed effects are included, pupils' gender is not a significant determinant of Kiswahili total literacy scores but it has a significant impact on the total literacy scores in English. After controlling for school fixed effects, girls have .112 standard deviation higher scores than boys in English. Lastly, there is a significant quadratic relationship between pupils' age and the Kiswahili total literacy score. Age positively impacts the Kiswahili total literacy score, up to a point where older pupils (for the grade)

are likely to be weaker than their fellows. Pupils' age is not a significant determinant on the English total literacy score.

With respect to school level variables, Table 10 (columns 2 and 5) shows that being part of a school supported by the PRIMR program is positive and strongly significant for the two assessment languages. Similarly, pupils' attending nonformal private schools achieve much higher scores in Kiswahili and in English (coefficients .509 and .458 standard deviation higher respectively and p-value<0.001) than pupils from public schools. Being in a school using Kiswahili predominantly as the main language of instruction negatively impacts the English literacy score (coefficient -.299, at a 99% level). Surprisingly, teachers' absenteeism is not identified as a determinant of the total literacy scores for any of the language assessments. Nevertheless, there was a negative and statistically significant impact on the Kiswahili and English literacy scores of pupils who attend schools where at least one teacher arrived after the start of classes the previous day. Finally, other school facilities, such as electricity and feeding programs, positively impact scores.

These results suggest that the determinants of the total literacy scores at the individual and at the school level are constant across the two languages. Secondly, the introduction of school control variables, and especially of the school fixed effects, considerably reduces the size and the significance of the individual and household estimates. This supports the assumption that potential unobservable factors at the school level are involved. It suggests that the schooling options are diverse and that pupils' backgrounds, including potentially their language groups, are tightly linked to the quality and characteristics of the school they are attending. In this way, the results validate the decision to include school fixed effects in the model in order to control for all the school observables and non-observables and to reduce bias in the estimates.

Results from the school fixed effects model confirm that within schools there are considerably fewer variations in individual and family factors. For instance, the wealth index is not significantly different between pupils within schools. Therefore, individual and family-level differences between the three language groups are substantially diminished when looking at differences within schools (i.e. using school fixed effects). Nevertheless, even within a single school the pupil's home language matters and is a significant determinant of literacy total scores in Kiswahili and in English.

In comparison to Swahili pupils, non-Swahili pupils mainly struggle on basic decoding skills in Kiswahili

This sub-section presents the OLS and the school fixed effects model for each EGRA subtask so as to understand better to what extent the different tasks are impacted by the pupils' home language. Results of the OLS and school fixed effects models using each different reading subtask

(letter sound identification, invented word, reading a story, reading comprehension) as a dependent variable are presented in Table 11 and Table 12. For clarity, the variables of interest alone are presented (Swahili pupils is the comparison group). Refer to Appendix F and Appendix G for the full set of results, including the coefficients for each control variable. The total literacy scores coefficients (from Table 10) are provided in Table 11 and Table 12 for comparison purpose.

In the OLS regressions, the non-Swahili coefficients are statistically significant on all subtasks in Kiswahili. However, after controlling for school fixed effects, only basic decoding skills remain significant (letter sound and invented word). Interestingly, non-Swahili pupils achieve similar reading and listening comprehension scores to Swahili pupils after accounting for school unobservables. In the fixed effects specifications, the semi-Swahili group coefficients are not significant, except in reading comprehension. Semi-Swahili pupils achieve significantly lower scores than the Swahili group in reading comprehension in Kiswahili. Surprisingly, on this specific subtask semi-Swahili pupils appear as more disadvantaged than non-Swahili pupils. Overall, these results confirm previous findings.

Table 11: OLS and FE regressions per subtasks - Kiswahili scores

	Kiswahili scores per subtasks											
	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Listening comp.	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Listening comp.
Non-Swahili	-0.385***	-0.159**	-0.133*	-0.155*	-0.225***	-0.200**	-0.303***	-0.160**	-0.116	-0.172	-0.206**	-0.08
	0.064	0.074	0.078	0.087	0.074	0.09	0.075	0.081	0.102	0.117	0.09	0.117
Semi-Swahili	-0.146*	-0.097	-0.144	-0.240**	-0.181**	-0.036	-0.122	-0.089	-0.189	-0.228*	-0.185	0.101
	0.078	0.087	0.093	0.096	0.09	0.113	0.084	0.104	0.127	0.123	0.115	0.142
No. of Obs.	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519
R-Squared	0.27	0.12	0.16	0.15	0.18	0.07	0.5	0.32	0.34	0.31	0.37	0.3
Individual control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A	N/A
School fixed effects	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y

*Note: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Standards errors are indicated below the coefficients, (3) Data are from the G2 pupils survey, (4) Data are presented for the EGRA scores in Kiswahili: Column 1 to 6 show OLS results and column 7 to 12 show FE results, (5) The total literacy score doesn't include listening comprehension and (6) "Other controls" includes all the individual and school variables previously described.*

Table 12: OLS and FE regressions per subtasks – English scores

	English scores per subtasks									
	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score
Non-Swahili	-0.229***	-0.262***	-0.264***	-0.312***	-0.330***	-0.111*	-0.237**	-0.214**	-0.215**	-0.247***
	0.063	0.08	0.078	0.072	0.071	0.067	0.099	0.091	0.092	0.09
Semi-Swahili	-0.183**	-0.201**	-0.206**	-0.209**	-0.247***	-0.164	-0.2	-0.117	-0.183**	-0.203*
	0.081	0.092	0.089	0.081	0.078	0.101	0.123	0.117	0.087	0.103
No. of Obs.	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519
R-Squared	0.27	0.15	0.24	0.23	0.25	0.48	0.31	0.4	0.42	0.42
Individual control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A
School fixed effects	N	N	N	N	N	Y	Y	Y	Y	Y

*Note: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Standards errors are indicated below the coefficients, (3) Data are from the G2 pupils survey, (4) Data are presented for the EGRA scores in English: Column 1 to 5 show OLS results and column 6 to 10 show FE results, (5) listening comprehension was not tested in English and (6) "Other controls" includes all the individual and school variables previously described.*

In English, Non-Swahili pupils do worse on all subtasks whereas semi-Swahili pupils are only disadvantaged on reading comprehension

Results of the OLS and school fixed effects model, using each different English reading subtask as a dependent variable, together with the total literacy score in English, are presented in Table 12. Across all specifications, the non-Swahili group achieves significantly lower scores than the Swahili group in English. All the coefficients are statistically significant, ranging from -0.111 to -0.312 standard deviation. On the other hand, even though the semi-Swahili coefficients are significant for all the English subtasks in the OLS model, the semi-Swahili variable is not significant in the school fixed effects model, except on reading comprehension in English. This suggests that within schools, non-Swahili pupils achieve significantly lower scores than Swahili pupils on all English subtasks. Semi-Swahili pupils mainly do worse than Swahili pupils due to their lower scores in English reading comprehension.

In conclusion, these results confirm that non-Swahili pupils achieve systematically lower than Swahili pupils in both languages (Kiswahili and English). All the coefficients are negative and significant in most of the specifications. In Kiswahili, non-Swahili pupils are especially disadvantaged on decoding skills while in English they do worse on all subtasks. This suggests that having some Kiswahili exposure at home in comparison to no exposure at all makes a difference on reading skills acquisition. Secondly, results support the argument that there is an interaction between language group and several unobservable factors at the school level. Indeed, after controlling for school unobservables (i.e. including school fixed effects), the language variable coefficients are no longer significant for semi-Swahili pupils. On most subtasks, the semi-Swahili group appears roughly equivalent to the Swahili group. The only exception is reading comprehension in both, English and Kiswahili. Moreover, the English total literacy score seems to be driven by the negative reading comprehension coefficients. It must be kept in mind that, by solving the unobservable heterogeneity, the school fixed effects transformation might in fact aggravate the measurement error problem (Krueger and Ashenfelter, 1992; Sevestre and Matyas, 2008), potentially impacting coefficient significance. Lastly, the difference between the Swahili group and the two other groups is more extreme for English scores than for the Kiswahili scores. In other words, after controlling for school unobservable factors, English scores seem more affected by the pupils' home language group than do the Kiswahili scores. In the next section, further investigation is undertaken to determine if the results are robust when working on a reduced sample of schools where no more than half of the pupils are Swahili pupils. As the initial sample included many schools with a majority of Swahili pupils, the purpose of the next section is to test whether our estimates are driven by schools where non-Swahili pupils are in minority.

Results are robust in schools where Swahili pupils are in minority

This final sub-section explores sensitivity of the results when the sample is limited to schools including a maximum of 50% of Swahili pupils. As described in Chapter 2, the sample includes many schools with a majority of Swahili pupils. A possible assumption would be that the gap between Swahili and non-Swahili pupils is exacerbated in schools where non-Swahili pupils are in minority. For instance, unobserved factors may intervene within these schools such as non-Swahili pupils being more marginalized. Furthermore, these schools attracting Swahili pupils in majority may have different characteristics than school attracting pupils from more diverse background. Thus, pupils within these schools may be quite different from pupils within more linguistically diverse schools. School fixed effects were used to overcome this bias in the previous sections; however, results could be biased if driven by these schools. The robustness check addresses this issue to validate our results within linguistically diverse schools. If the estimates are driven by schools with a majority of Swahili pupils, the estimates based on the restricted sample are expected to be different from previous estimates.

The robustness of the results is tested on a reduced sample including schools where the proportion of Swahili pupils does not exceed 50%. This reduced sample includes 475 pupils, that being 31% of the initial sample. The school fixed effects model is run for each different reading subtask in both languages (Kiswahili and English). Results are presented in Table 13. Estimates from the robustness check are similar to previous findings. When looking at the estimates for non-Swahili pupils, the results are robust on Kiswahili subtasks with non-Swahili pupils achieving significantly lower scores than Swahili pupils on decoding skills. On English subtasks, results are robust except for the letter sound identification subtask. Compared to Swahili pupils, non-Swahili pupils achieve similar scores on this specific subtask in the reduced sample. When limiting the sample to schools with a lower proportion of Swahili pupils, the difference between Swahili pupils and semi-Swahili pupils is not significant anymore on reading comprehension in Kiswahili. Both language groups achieve similar reading comprehension scores in Kiswahili. On English scores, results are robust with previous findings, semi-Swahili pupils achieving significantly lower scores than Swahili pupils in reading comprehension and on the total score in English. It is worth noting that this sub-sample may suffer from a loss of statistical power because of its size.

Nonetheless, this robustness check tends to confirm the impact of pupils' home language group on reading outcomes. It strengthens previous observation that non-Swahili pupils are strongly disadvantaged in comparison to Swahili pupils. This holds true in schools with more home language diversity, i.e. were Swahili pupils are not in majority. The linguistic diversity at school and its possible interaction with scores will be further discussed and investigated in Chapter 5.

Table 13: FE regressions per subtasks for Kiswahili and English scores - reduced robustness check sample

	Kiswahili scores per subtasks					English scores per subtasks				
	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score
Non-Swahili	-0.300***	-0.269**	-0.144	-0.165	-0.247*	-0.13	-0.239*	-0.244**	-0.218*	-0.264**
	0.109	0.105	0.163	0.125	0.128	0.086	0.12	0.108	0.113	0.106
Semi-Swahili	-0.133	-0.147	-0.194	-0.196	-0.197	-0.17	-0.17	-0.123	-0.238**	-0.213*
	0.116	0.143	0.139	0.132	0.137	0.112	0.157	0.152	0.107	0.113
No. of Obs.	475	475	475	475	475	475	475	475	475	475
R-Squared	0.43	0.34	0.36	0.37	0.4	0.43	0.35	0.43	0.41	0.44
Individual control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

*Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Standards errors are indicated below the coefficients, (3) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative, (4) Data on the EGRA total literacy scores are independently presented for Kiswahili and English: Column 1 to 5 show FE results with Kiswahili subtasks as the outcome and column 6 to 10 show FE results with English subtasks as the outcome.*

Discussion

This section discusses in greater depth some of the results in terms of future research and potential political implications and contributes to the current language of instruction policy debate.

As expected, many confounding factors interact with pupils' home language. Pupils' language groups are not homogeneous and children's characteristics, as well as the specificities of the school they are attending, are different. Consequently, many factors are involved in pupils' educational outcomes. School factors are important elements in explaining the gap between language groups. This confirms that the choice of school is a determinant in terms of pupils' achievement. In addition, the use of school fixed effects improves the precision of the estimates and considerably reduces bias for confounding factors at the school level. An illustration of this appears in the semi-Swahili group, whose coefficients are statistically significant in the OLS model but not in the school fixed effects model when Kiswahili is the outcome. In other words, the Swahili group and the semi-Swahili group tend to attend schools with different characteristics, which affects their scores differently. However, when properly controlled for school qualities and characteristics, the two groups (Swahili and semi-Swahili) achieve similar scores in Kiswahili, meaning that the language factor is not determinant between these two groups. This does not hold true for the non-Swahili groups. Despite large differences in the schools attended by non-Swahili and Swahili pupils, within a school the difference in scores between the two language groups is still significant. The conclusion therefore is that language-related research work needs to adopt a rigorous methodology accounting for the self-selection of pupils at the school level, especially in developing contexts.

A lesson learnt from the results is that, when working with aggregate scores (i.e total scores), some disparities might be hidden. The study highlighted that, despite the fact that the non-Swahili variable was a determinant factor, especially on total literacy scores, this does not hold true for every subtask. For instance, the major disadvantage for the non-Swahili pupils in Kiswahili is the fact that they strongly lag behind the two other language groups, especially in terms of decoding skills (letter sound identification and invented word reading). Interestingly, on the 'reading a story' and comprehension subtasks, the pattern is slightly different. Indeed, within schools, the non-Swahili pupils are not achieving significantly lower scores on these subtasks. A possible assumption is that, despite lower scores in decoding skills, to a certain extend non-Swahili pupils can fill in their decoding gap by sufficient Kiswahili comprehension skills. The linguistic literature supports this result with evidence that oral comprehension is a strong determinant of reading skills and to a certain extent might counterbalance weakness in decoding skills (Curtis, 1980). Working on the different subtasks individually gives a better overview of the weakness and strength of the different language groups in terms of decoding and reading mechanisms. For future research, and when available, it is strongly recommended that all the subtasks available are used and the model run for each subtask separately in order to understand fully the reading process step by step.

In terms of political implications, the findings suggest that several factors need to be taken into account to improve pupils' reading scores in Kenya. The results support the argument that receiving instruction in the home language is preferable as it is positively associated with higher literacy outcomes. One might question the feasibility of providing home language instruction to all pupils at school. Indeed, the multitude of home language in Kenya is a real challenge and systematic home language instruction might be difficult to implement logistically. Even when instruction is given in an African local language (i.e. Kiswahili), some of the pupils are not exposed to that language at home. A more realistic alternative to home language instruction would be to identify pupils at risk, that is pupils who do not speak the language of instruction at home. Providing supplemental instruction, and especially oral instruction in Kiswahili, to non-Swahili pupils could partially compensate for the lack of exposure to Kiswahili at home. Finally, instruction should focus on pupils' weaknesses and make sure that pupils master decoding skills before moving on to more complex reading tasks or to another (new) language of instruction. Discrepancies between decoding skills and comprehension level often translate into poor readers (Catts *et al.*, 2003; Curtis, 1980). Consequently, pupils' strengths and weaknesses in the reading component model need to be identified in order to offer remedial solutions (Aaron, 1997; Catts *et al.*, 2003).

In conclusion, the results in this chapter support the contention that receiving home language instruction tends to have a positive impact on the acquisition of reading skills. The analysis confirmed that an essential component in pupils' literacy outcomes is the school they attend. School factors strongly contribute to pupils' achievement and explain some of the gap between the different language groups. Ultimately, the pupil's language group is tied to school choice. Even after controlling for differences at the school level, pupils who do not speak the language of instruction at home are still disadvantaged on both languages assessed. The next chapter will analyze in greater depth the interaction between achievement in Kiswahili and in English in order to contribute to early reading skills transfer between languages.

Chapter 4: Cross-language transfer in Kenya

Introduction

Mastering literacy skills in Kiswahili is not enough in the context of Kenya. From grade 4 onwards, English becomes the official language of instruction and pupils need to shift to that language and to master it to succeed at school. Although some schools choose to use English as the language of instruction from early grades, the transition to English in grade 4 is compulsory for all. Therefore, pupils have to switch to a new, unfamiliar, language, and which for some is their third language. In this setting, it is legitimate to ask how the transition works in Kenya. More specifically, can we observe a transfer of literacy knowledge between Kiswahili and English? If yes, is it a two-way transfer, or not? Chapter 3 results showed that receiving home language instruction is positively associated with acquisition of reading skills both in the home language (Kiswahili) and in English. These results may suggest that some transfer does occur between the two languages. Another issue is whether the transfer between Kiswahili and English is the same for pupils who speak Kiswahili at home and for those who do not?

In the academic literature, numerous studies have examined the relationship between a first and a second language. Two main hypotheses have been proposed to describe the transfer from one language to another: the *linguistic interdependence* and the *linguistic threshold* hypothesis (Alderson, 1984; Carrell, 1991; Clarke, 1988; Cummins, 1979; Yamashita, 2001). The first states that languages are interrelated and that there is a transfer of reading abilities between the first and the second language (or further languages). The second hypothesis is that the level of transfer changes after reaching a certain language proficiency threshold.[53] Research on the relationship between the first and second languages primarily relies on correlations or on estimation approaches such as ANOVA or Ordinary Least Squares. Based on strong and significant correlations between proficiency in reading skills in the first language and reading skills in the second language, several studies draw conclusions on the interdependence between languages (Lee and Schallert, 1997; Melby-Lervåg and Lervåg, 2011; Ramírez *et al.*, 2007; Yamashita, 2002). Findings from regression approaches further show that first language reading is a significant factor of reading in the second language (Carrell, 1991; Pretorius and Mampuru, 2007; Ramírez *et al.*, 2007). Yet, the underlying threshold assumption is that the magnitude of transfer is not constant, which questions the linearity of the relationship between two languages (Feinauer *et al.*, 2017). Some authors suggest using non-linear approaches to account for the hypothesized acceleration or jump in transfer when one reaches a certain level of proficiency in the second language (Feinauer *et al.*,

[53] Regarding the language proficiency threshold, two schools of thought can be identified. One school of thought argues that a minimum language proficiency threshold is required in the first language before knowledge can transfer to a second language (Cummins, 1979). The other school of thought supports that the transfer differs depending on the level of proficiency in the second language (Alderson, 1984; Clarke, 1988; Yamashita, 2001).

2017). They call for further exploration using discontinuous and non-linear models. Besides, the literature suggests that the transfer mechanism does not limit itself to bilingualism. Some work done lately on third-language acquisition supports transfer between languages among third-language learners (Butler, 2013; Cenoz, 2013; Haenni Hoti *et al.*, 2011).[54] Moreover, multilingual individuals benefit from extra-linguistic system references, they have previous experience of learning more than one language and they benefit from greater metalinguistic awareness (Butler, 2013; Cenoz, 2013; Dillon, 2009; Jessner, 2008; Ransdell *et al.*, 2006). Lastly, most evidence in the cross-linguistic field comes from developed countries and adult populations. Only a few empirical studies focused on young bilingual pupils, most of them dealing with bilingual programs (immersion classes) in the US or in Canada. Evidence of transfer is scarcer in the African context whereas the transfer issue is of particular interest in this context (Asfaha *et al.*, 2009; De Sousa *et al.*, 2010; Kim and Piper, 2019; Pretorius and Mampuru, 2007; Wawire and Zuilkowski, 2020). The African continent offers unique language diversity and is the only continent where most pupils are instructed in a language which differs from their home language (Ouane and Glanz, 2010). Furthermore, several factors identified as mediating the transfer mechanism, such as language exposure, multilingualism, social and cultural background or the similarity between the first and second language are likely to be ubiquitous in Africa (Pretorius and Mampuru, 2007; Williams, 1996).

Investigating the transfer mechanism between Kiswahili and English in early grades in Kenyan primary schools is this chapter's main goal. More specifically, this study intends to evaluate (i) whether transfer between Kiswahili and English can be observed and if it can, how can it be modeled, and (ii) whether the transfer discriminates between pupils on the basis of their home language background. Based on the cross-language transfer literature, the study first looks at the interdependence between Kiswahili and English. Using a set of descriptive statistics and regressions, a relationship between scores in Kiswahili and in English is identified in the data. A linear and a non-linear model are compared to investigate further the relationship between the two languages and to identify the best fit: a simple fixed effects model and a quadratic regression approach model. In agreement with previous findings, the non-linear approach (the quadratic approach) appears as a better fit, suggesting that transfer is happening across the distribution but not at a constant rate. Because in a multilingual context, transfer has been observed as simultaneous and bidirectional (Butler, 2013; Kim and Piper, 2019; Pretorius and Mampuru, 2007), including in the case of Kenya, a mutual influence between Kiswahili and English is suspected. The effect of the variation in Kiswahili scores on English scores is examined, and vice versa. A correlation between the two regressions is found (r=.7525, p-value <.001). To account for the cross-equation correlation, Seemingly Unrelated Regression are used to estimate jointly the two regressions. Further, results show that the transfer is stronger when tied to the English proficiency level rather

[54] Among multilingual individuals, the acquisition pattern is much more diverse. The relationship between languages cannot be summarized to a linguistic transfer from the first to the second and then to the third language. In some instances, transfer occurrences have been observed between the second and the third language without interference from the first language. Similarly, third language acquisition may influence the first or the second language acquisition.

than when tied to the Kiswahili proficiency. Interestingly, while the magnitude of transfer is increasing across the English score distribution, the magnitude of transfer is decreasing when tied to the Kiswahili proficiency level.

Lastly, the analysis focuses on whether transfer variations can be observed based on pupils' home language. In the sample, Swahili pupils are more exposed to Kiswahili in their home environment than semi- and non-Swahili pupils. However, semi- and non-Swahili pupils speak another language at home and are, therefore, multilingual. Moreover, semi- and non-Swahili pupils experience a different kind of multilingualism given that semi-Swahili pupils are exposed to some Kiswahili in the home environment. Interestingly, the variation in English scores for a one-unit change in Kiswahili scores is significantly stronger for non-Swahili pupils in comparison to Swahili pupils in the first half of the Kiswahili score distribution. At the mean, a 1 SD increase in Kiswahili is associated with a .926 SD increase in English for Swahili pupils, a .990 increase for semi-Swahili pupils and 1.008 SD for non-Swahili pupils. Towards the top of the Kiswahili score distribution, slopes converge and all three home language groups perform similarly.

When tied to the English proficiency level, the variation in Kiswahili scores for a one-unit change in English scores shows a different pattern. At the mean, the magnitude of the transfer is significantly stronger for Swahili pupils. A 1 SD increase in English is associated with a 1.007 SD increase in Kiswahili for Swahili pupils (against .929 SD increase for semi-Swahili and .919 SD increase for non-Swahili pupils). However, higher in the distribution, the transfer magnitude converges for all three home language groups and at the extreme top of the distribution the transfer becomes stronger for non-Swahili pupils. These results suggest that the more pupils gain in English proficiency, the higher the transfer between Kiswahili and English. This is especially true for pupils who have more exposure to Kiswahili in the home environment (Swahili pupils). However, in spite of this relative transfer advantage for pupils who speak Kiswahili at home, speaking a language other than Kiswahili at home becomes more favorable in highest level of the English score distribution. Overall, results suggest that having a home language different from Kiswahili is not detrimental to language transfer between English and Kiswahili, as long as a certain proficiency level is reached in the two languages.

This study makes three main contributions. First, this paper brings additional evidence of cross-language transfer bidirectionality in the Kenyan context. Secondly, it uses quadratic regressions to fit the results and Seemingly Unrelated Regression to improve the estimators. Doing so is important because evidence suggests that the transfer mechanism is not a one-way linear process. Thirdly, when looking in depth at the dynamics underlying the transfer process between literacy skills in Kiswahili and in English, potential differences between bilingual and multilingual pupils are accounted for.

The next section introduces the topic by reviewing the literature related to the cross-language transfer mechanism and second and third language reading acquisition. In the second section, descriptive statistics are provided. Section three presents the conceptual framework and the

estimation strategy. Results are provided in section four. In the last section, the main results and the conclusions arising from them are discussed.

From one language to multilingualism

Reading skills are correlated between languages

In the literature, two theoretical concepts are imposed to explain the relationship and the interaction between two or more languages. The first is the *linguistic interdependence* theory, postulating that languages are interconnected and that reading skills in one language *transfer* to the others. The second is the *linguistic threshold* theory which suggests that proficiency levels mediate the rate of *transfer*. In the literature on the topic, many researchers show correlations between reading skills in the first language and in the second language, concluding that there is interdependence between the two languages. In their literature review of cross-linguistic transfer of early reading skills from the first to the second language, Melby-Lervåg and Lervåg (2011) report moderate to large meta-correlation between the first and second language for phonological awareness, i.e., a reading-related skill (r=.44, 95% CI .27-.59) and decoding skills (r=.54, 95% CI .41-.65). Moreover, these authors show that decoding skills in the two languages correlate more strongly (indicating, according to them, a stronger transfer mechanism) in samples receiving instruction in both languages than in samples taught in the second language only. This interdependence between languages is observed among adults and young primary school bilingual pupils. The results of several studies suggest that transfer occurs on pre-literacy skills as well, such as phonological awareness and literacy strategy (De Sousa *et al.*, 2010; Durgunoglu and Oney, 2000; Verhoeven, 1994), and even orthographic knowledge when the two languages share orthographic similarity (Koda, 1988). Along the same lines, Ramírez *et al.* (2007) investigate the cross-linguistic relationship between reading in Spanish and in English amongst native Spanish students learning English in bilingual classrooms. They show that reading skills strongly correlate in the two languages (r ranges from .71 to .79) and that Spanish reading skills predict English reading skills.

Although evidence is scarce in the African context, the language interdependence hypothesis tends to be supported. Indeed, Asfaha *et al.* (2009) found that reading skills in the first language are significantly correlated[55] with reading skills in the second language in the Eritrean context. Moreover, pupils' reading comprehension in their first language significantly predicts reading

[55] Reading comprehension scores and school marks (computed from grade marks that students earn after a series of assignments and exams) are correlated between the first language (African) and the second language (English). All correlations are significant at the 0.01 level. Correlations coefficients range from .34 to .64.

comprehension in the second language and vice versa.[56] Their work provides no insight on the causality issue but shows that variables are significant in the regression both ways. Similarly, using data from Grade 7 students in South Africa, Pretorius and Mampuru (2007) ran multiple regressions to predict reading skills in one language from reading skills in the other language. They found that reading in the first language is significantly associated with reading in the second language, and vice versa. They conclude in support of a *bidirectional* transfer of reading skills between the two languages, meaning that the two languages mutually contribute to each other. Moreover, their work shows that reading in the second language contributes more to reading in first language than does reading in first language to the second. Owing to the fact that pupils read more in the second language and that they develop stronger reading skills in the second language than in the first, the authors conclude that reading skills transfer is stronger from the second language to the first language rather than the other way around. Two studies also provide support for language transfer in the Kenyan context. While exploring the role of vocabulary and decoding skills on reading comprehension in Kiswahili and English, Wawire and Zuilkowski (2020) found evidence that decoding skills in English strengthen reading comprehension in Kiswahili among Grade 1 pupils in Kenya. However, their results didn't show evidence of bidirectionality. On the other hand, Kim and Piper (2019) specifically studied the bidirectionality of literacy skills transfer in the Kenyan context and whether the nature of the relation vary as a function of the literacy environment. Using longitudinal data from Grade 1 and 2 pupils, their results supported a bidirectionality of the relationship between literacy skills in Kiswahili and English over time. Their results further show that the relation from Kiswahili to English was found only among children who had received explicit instruction in Kiswahili.

The cross-language transfer is mediated by language proficiency

Turning now to the threshold hypothesis, the concept is much more complex to grasp and to evidence. Several authors qualify this hypothesis as a "vague notion" ambiguously defined, which may vary from one group of pupils to another, or from one reading task to another (Carrell, 1991; Yamashita, 2001). Cummins (1976) was the first to conceptualize the idea of linguistic threshold to explain contradictory outcomes in the bilingual literature. In some cases, bilingualism has positive outcomes and even produces a cognitive advantage over monolingualism when the two languages develop simultaneously (Cummins, 1976, 1979; Lambert, 1981). In contrast to this "additive" bilingualism, "subtractive" bilingualism is characterized by negative outcomes and is usually experienced by minority groups who are constrained by educational policy or social pressure to adopt another dominant language. The framework for a bilingual education model set by Cummins in 1979 states that second-language competence is a function of competence in the

[56] Multiple regression analyses are run separately with African language reading comprehension scores as the outcome and English as predictor and vice versa. In all regressions, reading scores in one language significantly predict reading scores in the other language. No claim is made for causality.

first language and the exposure to both languages. If there is enough stimulation in or out of school to maintain the first language, then intensive exposure to the second language at school should lead to a successful bilingual development with no detrimental effects on the first language (i.e knowledge will transfer, and the two languages will develop simultaneously). However, in cases of limited exposure to the first language, an intense exposure to the second language would hamper the development of the first language, which would potentially result in an impediment to the development of the second language as well (Cummins, 1976, 1979; Verhoeven, 1994). Cummins (1976) suggests that for minority language pupils, whose linguistic knowledge in their first language may not be fully developed yet, instruction in the first language should be continued until a minimum level is achieved in order to produce positive bilingualism. Failing to achieve this minimum level or "threshold" would impede benefits of bilingualism and would result in negative outcomes. Other authors supported that idea of a prerequisite level in the first language, and therefore, advocate for building up elementary skills in the pupils' strongest language first (Durgunoğlu, 2002; Verhoeven, 1994). Nonetheless, this threshold is neither clearly defined nor evidenced.

Besides, another school of thought argues that the transfer depends on an "achievement threshold" in the second language. Within this framework, a level of second language proficiency is needed to support the transfer of first language literacy skills to the second language (Alderson, 1984; Clarke, 1988; Yamashita, 2001). According to these authors, reading difficulties in the second language may result from a language issue rather than a reading issue. A good reader in the first language may experience difficulties in reading in the second language because of low level of second language proficiency. These authors describe the cross-linguistic transfer as a non-constant mechanism with a rate of transfer which accelerates beyond a certain threshold in second language proficiency (Lee and Schallert, 1997; Yamashita, 2001). Empirical research sought to demonstrate the linguistic threshold hypothesis by comparing correlations between the first and the second language skills and using multiple regressions for different levels of proficiency in the second language. Observing higher correlations and steeper regression slopes in pupils with higher level of proficiency in the second language, many authors concluded on the existence of a threshold without measuring it.

Stronger transfer in higher level of proficiency in the second language

Carrell (1991) investigated the effect of both reading ability in the first language and proficiency in the second language on second language reading skills. She used data from two groups of participants, one group of Spanish speakers learning English and one group of English native speakers studying Spanish. In both groups, participants were categorized by proficiency levels in their second language. Globally, Spanish native speakers had higher proficiency levels in their second language than English native speakers. Using multiple regression, she showed that the first language was a stronger predictor of reading ability in the second language for Spanish than for

English native speakers. She concluded that a reasonable assumption to explain this result is the higher level of English proficiency of Spanish native speakers, which supports the linguistic threshold hypothesis. Similarly, Lee and Schallert (1997) used data from middle and high school students in Korea to analyze the relationship between Korean, their first language, and English. Students were classified by proficiency grade level. Authors find that Korean reading ability is a significant predictor of English reading ability. In addition, the two languages are significantly correlated at higher proficiency grade levels, whereas no significant relationship is found in beginner groups. Using the slopes of the regression lines of Korean scores on English scores, they concluded that there is a higher degree of transfer at a higher level of second language proficiency. According to them, this "provides support for the existence of a threshold level of language proficiency". While available findings suggest that proficiency level in the second language modulates the rate of transfer, no study measured the threshold hypothesis. Moreover, previous studies rely on the hypothesis of linearity of cross-language transfer, which seems contradictory with the threshold assumption and which has been recently questioned by some authors (Feinauer *et al.*, 2017). According to these later studies, the theoretical assumptions underpinning the threshold hypothesis suggest that the transfer cannot be modeled as a constant slope but rather should accelerate or jump at some point. Indeed, if the rate of transfer between the first and the second language is supposed to vary as a function of proficiency, it is likely not a linear process. Consequently, Feinauer *et al.* (2017) tentatively use a discontinuous linear regression approach to model and test the threshold hypothesis. They assume that the rate of transfer depends on the second language oral ability and that transfer increases when students reach a certain threshold. Using 174 young Spanish–English grade 1 bilingual learners' data, they showed that a discontinuous change-point regression model provided a better fit than linear regression models, suggesting that cross-linguistic transfer is not a constant phenomenon. Their work suggests that further research using non-linear approach should be done.

Multilingualism and context-dependent factors mediate cross-language transfer

Multilingualism adds to the complexity. Research on third language acquisition is scarce and often closely linked to second language acquisition research. Correlations between reading skills in the three languages are reported, which tends to confirm between-language interdependence among third-language learners (Cenoz, 2003, 2013; Haenni Hoti *et al.*, 2011). In addition, Lasagabaster (1998) analyzed data from 252 grade 5 and grade 8 students in the Basque Country, where instruction is received in the two official languages (Basque and Spanish) and English is taught as a foreign language. After controlling for background information and language proficiency for the three languages, he reported that a higher level of bilingualism is positively related to higher scores in English. He thus concluded that the "threshold level hypothesis can also apply to a trilingual situation". In many studies multilingualism and bilingualism are used interchangeably. However, an increasing number of scholars call for a differentiation between multilingual and bilingual

individuals as growing evidence shows that the language acquisition process of multilinguals may differ from that of bilinguals (Butler, 2013; Jessner, 2008).[57] According to some authors, bilingual individuals refer to their first language as their base language, whereas multilingual individuals might be advantaged as they are able to refer to two different linguistic systems (Cenoz, 2003, 2013; Haenni Hoti *et al.*, 2011). Several findings show that in many instances third-language learners produce inter-language mixing, showing occurrence of words from the third and the second language in the same sentence (Murphy, 2003). Moreover, the positive cognitive advantage of additive bilingualism (compared to monolingual students) seems applicable to third-language acquisition as well. If bilingualism developed properly, some strategies might be re-used as a basis for third language acquisition (Cenoz, 2003). Third language learners have specific skills and knowledge that second learners do not have. For instance, prior language learning experience provides them with greater metalinguistic awareness and larger cross-linguistic influences (Dillon, 2009; Jessner, 2008; Ransdell *et al.*, 2006). Overall, research tends to show that multilingualism may offer additional cognitive advantage in comparison to bilinguals.

Lastly, increasing attention has been paid recently to other factors mediating cross-language transfer. Several factors enhancing or hindering transfer have been identified. For instance, individual factors such as age, the motivation to learn a language, or language aptitude may interfere (Butler, 2013; Jarvis, 2000). Language exposure and the linguistic proximity between two languages, i.e. the degree of similarity between the first and second languages, may facilitate transfer (Butler, 2013; Jarvis, 2000; Koda, 1988). Similarly, socio-environmental factors such as parental influence, cultural background, or whether the language is dominant in the community can all possibly affect the transfer (Butler, 2013; Jarvis, 2000). These factors add to the complexity of understanding cross-language transfer and have to be controlled for. Unfortunately, some of them, such as motivation, might be difficult to capture.

In sum, the literature shows that cross-language transfer is a complex and multidimensional process involving many factors. While some determinant factors can facilitate a smooth transfer, others might prevent it, and differences in the context of second or third language acquisition may result in very different outcomes. Moreover, identifying reading skills' transfer between the first and the second language in the African context raises many challenges. In many instances, reading level is low or absent in the first language (Pretorius and Mampuru, 2007; Williams, 1996) whereas the transfer literature based on Western contexts assumes good reading skills in the mother tongue (Asfaha *et al.*, 2009). In Africa, reading skills are often higher in the second (foreign) language. Furthermore, in a multilingual context, the language of instruction may differ from the pupils' mother tongue, implying that reading skills are acquired in a language which is not the pupil's first language (Kim and Piper, 2019; Pretorius and Mampuru, 2007; Williams, 1996). Given lack of evidence for language transfer in the African context, this chapter primarily intends to bring further

[57] Linguistic transfer is a complex multi-directional and multi-dimensional process and the inter-relation between languages is even more complex among multilingual individual (Butler, 2013).

evidence of the interdependence between Kiswahili and English in the Kenyan context. In Kenya, both Kiswahili and English are official languages and in use at school. Therefore, it is expected that the two languages influence each other. The purpose in the current study is to investigate the non-linearity of the relationship between Kiswahili and English literacy skills amongst grade 2 pupils in Kenya. Secondly, this research explores whether the relationship between Kiswahili and English scores is uniform across the distribution. Lastly, given that some pupils use Kiswahili at home while others use another mother tongue, the study will explore differences in the cross-language transfer process between pupils who speak only Kiswahili at home and pupils having an additional language at home (i.e. multilinguals).

Descriptive statistics

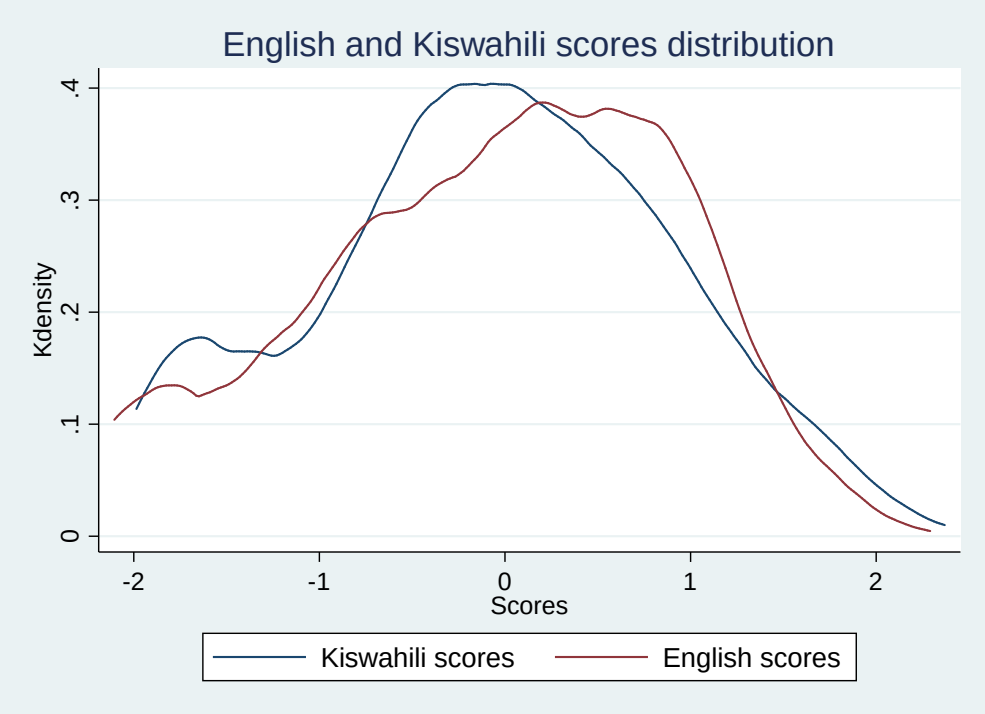
To estimate the relationship between Kenyan pupils' performance in Kiswahili and English, the analysis is based on a sample consisting of 1,573 Grade 2 pupils,[58] which is presented in Chapter 2. This section provides sample descriptive statistics with a specific focus on the relationship between Kiswahili and English scores. The study also compares total score means by home language group (Swahili, semi and non-Swahili). As discussed in the previous section, the level of exposure to Kiswahili is an important mediating factor in the cross-linguistic transfer literature. For instance, Swahili and semi-Swahili pupils are exposed to Kiswahili in their home environment; non-Swahili pupils are not. In addition, several studies showed that multilingualism is likely to result in higher outcomes in comparison to bilingualism. In the sample, semi and non-Swahili pupils speak another language at home which is different from Kiswahili and English. Therefore, semi and non-Swahili pupils are multilingual, and Swahili pupils – who speak Kiswahili at home and English as second language at school - are not. Different outcomes for different home language groups are expected. Consequently, specific attention will be paid to potential differences in the cross-linguistic transfer between these three language groups.

Interdependence between Kiswahili and English scores

The score variables are the Kiswahili total literacy score and the English total literacy score computed in the previous chapter. Figure 5 shows the Kiswahili and English scores across the distribution (all home language groups confounded). As shown, there is a strong overlap between the two score plots and very similar distribution patterns.

[58] As a reminder: all pupils who reported that they spoke English at home were removed from the sample.

Figure 5: Kiswahili and English scores distribution plot



Sources: Own calculations based on Midterm evaluation data - PRIMR initiative.

Second, the average scores in Kiswahili and English are examined by quartile. Table 14 provides summary statistics for Kiswahili quartiles and English quartiles separately for comparison. Correlations between English and Kiswahili scores per quartile are provided in Table 14.

As expected, both scores follow the same pattern, i.e. the higher the score in Kiswahili, the higher the score in English. This trend is reflected when looking at the English score quartiles. In addition, Kiswahili and English scores per quartile are significantly correlated. This holds true across the distribution and regardless of Kiswahili or English score quartiles. Overall, these results tend to confirm the interdependence of Kiswahili and English scores in the Kenyan context. Interestingly, the correlation coefficients in the first quartiles are significantly different from the coefficients in the other quantiles (p-value < .001). This means that Kiswahili and English scores correlations are stronger at the bottom of the distribution. In the literature, several authors observed an increase in correlation coefficients in higher level of proficiency (Lee and Schallert, 1997). An antagonistic trend is observed in the present sample. Moreover, the correlation coefficients are significantly stronger (except in the third quartile) for English score quartiles distribution in comparison to the Kiswahili score quartiles distribution. This suggest that the relationship between Kiswahili and English scores is stronger when tied to the English proficiency level.

Table 14: English and Kiswahili total scores summary statistics per quartile

		Total score	N	Mean	Std. Dev.	correlation
Kiswahili score quartiles	Quartile 1	English score	394	-1.22	0.68	0.72 ***
		Kiswahili score	394	-1.34	0.43	
	Quartile 2	English score	393	-0.16	0.60	0.26 ***
		Kiswahili score	393	-0.28	0.20	
	Quartile 3	English score	393	0.43	0.52	0.26 ***
		Kiswahili score	393	0.37	0.19	
	Quartile 4	English score	393	0.95	0.54	0.33 ***
		Kiswahili score	393	1.25	0.39	
English score quartiles	Quartile 1	English score	394	-1.38	0.47	0.63 ***
		Kiswahili score	394	-1.20	0.62	
	Quartile 2	English score	393	-0.25	0.24	0.43 ***
		Kiswahili score	393	-0.15	0.58	
	Quartile 3	English score	393	0.46	0.18	0.33 ***
		Kiswahili score	393	0.39	0.57	
	Quartile 4	English score	393	1.18	0.33	0.45 ***
		Kiswahili score	393	0.97	0.63	

*Sources: Author's own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01 (2) data not weighted.*

Table 15 gives the distribution per quartile for both Kiswahili and English scores. The sample is mainly located around the diagonal, confirming an interdependence between the two languages. Nonetheless, a deeper look at the diagonal shows that the proportion of pupils belonging to the same quartile in English and in Kiswahili is limited, suggesting a nonlinear pattern. Only pupils in the first quartile mainly belong to the first quartile in the two languages. To a certain extent, this strong immobility in the first quartile points to pupils with limited reading abilities rather than a language transfer issue.[59]

Table 15: Kiswahili and English scores distribution per quartiles

		English score quartiles				
		1	2	3	4	Total
Kiswahili score quartiles	1	19.52	4.64	0.64	0.25	25.05
	2	4.83	12.08	6.48	1.59	24.98
	3	0.57	6.74	10.81	6.87	24.98
	4	0.13	1.53	7.06	16.27	24.98
		25.05	24.98	24.98	24.98	100

[59] Further details on this can be found in Appendix K. Amongst the 19.52% of pupils belonging to the first quartile in the two languages, more than 30% of them are in the first quartile for each Kiswahili and English literacy subtask.

Sources: Author's own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) data not weighted, (2) each cell gives the percentage of pupils belonging to each quartile in both languages, and (3) colored cells highlight the sample concentration.

Table 16 further highlights the differences between the English and Kiswahili scores. In both languages, in the bottom and top quartiles (quartile 1 and 4) a sample majority belong to the same quartile.[60] In the other quartiles, the trend is not as clear. Less than 50% of pupils belonging to the second or third quartile in Kiswahili (or in English) belong to the same quartile in the other language. Rather, a given level in one language (Kiswahili or English) tend to translate into lower or higher scores in the other language, suggesting that the relationship is not linear.

Table 16: Distribution of English scores relative to Kiswahili quartiles and vice versa

		English score quartiles		
		Below	Same	Above
Kiswahili score quartiles	1	0.0%	77.9%	22.1%
	2	19.3%	48.3%	32.3%
	3	29.3%	43.3%	27.5%
	4	34.9%	65.1%	0.0%

		Kiswahili score quartiles		
		Below	Same	Above
English score quartiles	1	0.0%	77.9%	22.1%
	2	18.6%	48.3%	33.1%
	3	28.5%	43.3%	28.2%
	4	34.9%	65.1%	0.0%

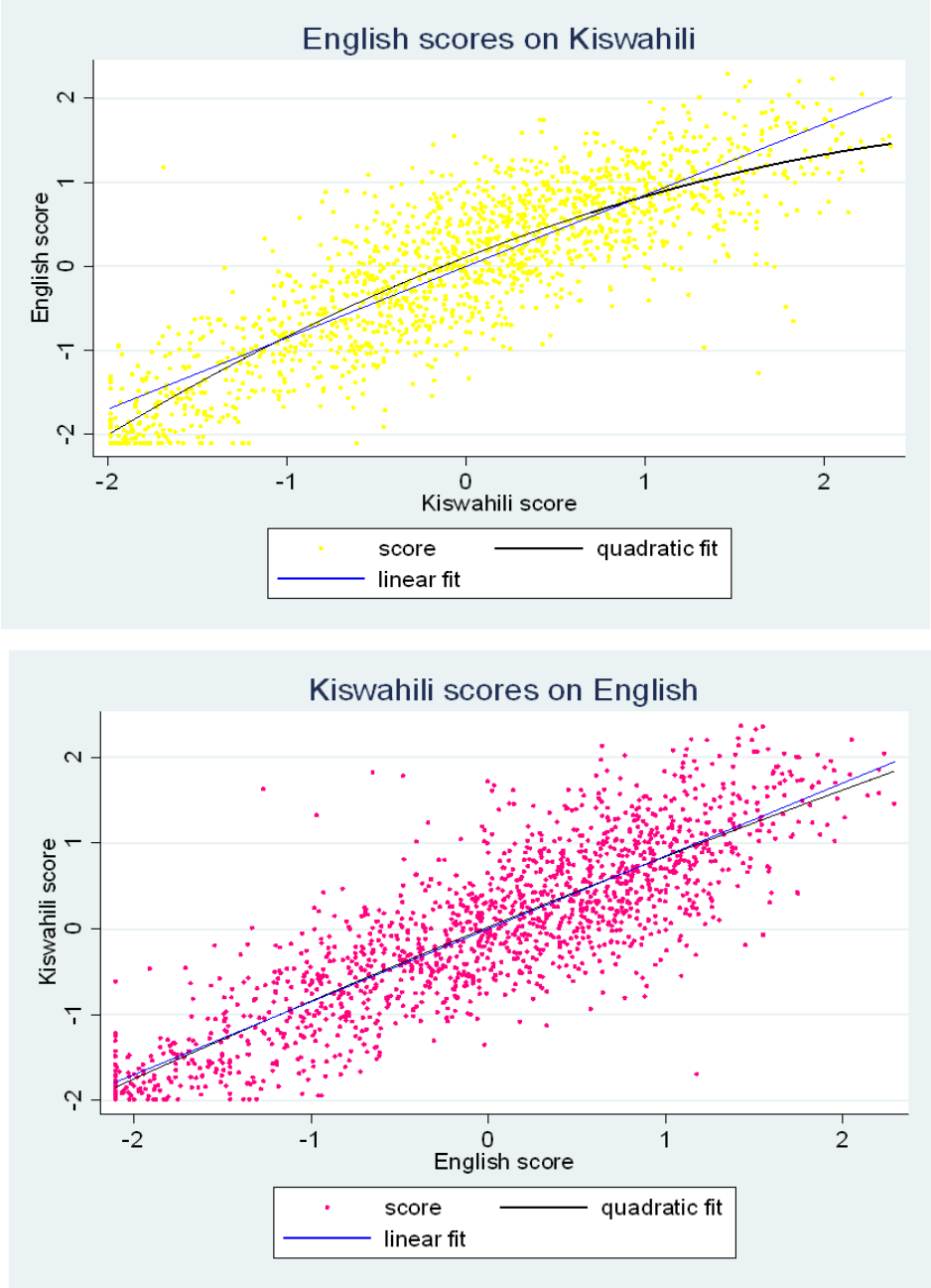
Sources: Author's own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) data not weighted and (2) the first three columns give for each Kiswahili quartile at far left, whether pupils' scores in English are below, in the same quartile, or in a quartile above and (3) the last three columns on the right indicate for each English quartile, whether pupil's Kiswahili scores are below, in the same quartile, or in a quartile above.

Non-linear relationship between Kiswahili and English scores

Secondly, the relationship between Kiswahili and English scores across the distribution is analyzed. Figure 6 shows the scatter plot for Kiswahili and English scores. It gives a graphic representation of the interdependence between the two scores and confirms that these scores are inter-related. A quadratic approach was tested to identify the best fit. Figure 6 shows that with English as the outcome, for a given Kiswahili score the relationship with the corresponding English score tends to follow a quadratic curve (figure at the top). With Kiswahili as the outcome, the relationship between Kiswahili and English scores appear as linear.

[60] By design, in the first and fourth quantile respectively, the percentage below and above must be at 0%

Figure 6: Kiswahili and English scores scatter plot



Notes: (1) the figure at the top provides the scatter plot of English and Kiswahili scores and the linear and quadratic fit for English scores as the outcome variable and (2) the figure at the bottom provides the scatter plot, the linear and quadratic fit when Kiswahili is the outcome variable.

Three home language groups with different trajectories

Third, quartile average scores are further disaggregated per pupils' home language group in Table 17 and in Table 18. The average scores are reported with information on the statistical significance

(t-test) of the observed differences between the three home language groups' average scores in English and in Kiswahili per quartile.

When scores are tied to the Kiswahili scores distribution, semi-Swahili pupils have similar average scores to those of Swahili pupils in most quartile. The only exception is in the second quartile where Swahili pupils achieve .32 SD significantly higher than semi-Swahili pupils in English. Average scores tend to be much more different between Swahili and non-Swahili pupils. Non-Swahili pupils' average scores are significantly lower in the three first quartiles, especially in English (between .22 and .31 SD lower). Pupils at the top of the Kiswahili distribution achieve similar average scores, irrespective of their home language group. This suggests that the gap between the three home language groups tends to diminish in higher levels of the Kiswahili scores distribution.

Table 17: English and Kiswahili average total scores per Kiswahili score quartile and per home language group

			Swahili pupils		Semi-Swahili		Non-Swahili		Swahili vs. Semi	Swahili vs. Non
		Variable	N	Mean	N	Mean	N	Mean	Difference	Difference
Kiswahili score quartile	Quartile 1	English total score	229	-1.14	50	-1.06	115	-1.45	-0.08	0.31 ***
		Kiswahili total score	229	-1.30	50	-1.24	115	-1.47	-0.05	0.17 ***
	Quartile 2	English total score	256	-0.07	56	-0.39	81	-0.31	0.32 ***	0.24 ***
		Kiswahili total score	256	-0.28	56	-0.32	81	-0.26	0.04	-0.02
	Quartile 3	English total score	289	0.47	38	0.44	66	0.25	0.03	0.22 ***
		Kiswahili total score	289	0.39	38	0.34	66	0.33	0.05	0.06 **
	Quartile 4	English total score	310	0.95	40	0.97	43	0.96	-0.02	-0.01
		Kiswahili total score	310	1.26	40	1.21	43	1.25	0.04	0.00

*Sources: Author's own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) data not weighted, and (3) Swahili pupils refer to pupils who speak Kiswahili at home, semi-Swahili refers to pupils who speak several languages at home including Kiswahili and non-Swahili refers to pupils who speak a different home language.*

Remarkably, when scores are tied to the English score quartile distribution, Swahili and non-Swahili pupils achieve similar average scores, except in the first quantile. On the other hand, semi-Swahili pupils tend to slightly overachieve Swahili pupils (except in the third quantile). Moreover, both semi-Swahili and non-Swahili pupils overachieve Swahili pupils in the fourth quantile of the English score distribution. The difference between Swahili and semi-Swahili pupils is significant.

To summarize, speaking a home language different from Kiswahili does not affect Kiswahili and English scores for higher achieving pupils. In fact, in the highest level of the English scores' distribution, semi-Swahili pupils and non-Swahili pupils achieve similar scores as pupils who speak Kiswahili at home. This suggests that the cross-language transfer pattern may be different between the three home language groups and that multilingual pupils may be advantaged when they achieve strong level of English and Kiswahili. Second, the gap between Swahili pupils and the two other home language groups is more pronounced when the distribution is tied to Kiswahili

scores, suggesting that the transfer mechanism may follow a different pattern both ways (from English to Kiswahili and from Kiswahili to English).

Table 18: English and Kiswahili average total scores per English score quartile and per home language group

			Swahili pupils		Semi-Swahili		Non-Swahili		Swahili vs. Semi	Swahili vs. Non
		Variable	N	Mean	N	Mean	N	Mean	Difference	Difference
English score quartile	Quartile 1	English total score	214	-1.36	54	-1.29	126	-1.47	-0.07	0.11 **
		Kiswahili total score	214	-1.17	54	-1.08	126	-1.31	-0.09	0.14 **
	Quartile 2	English total score	253	-0.26	56	-0.21	84	-0.24	-0.05	-0.02
		Kiswahili total score	253	-0.18	56	-0.04	84	-0.13	-0.15 *	-0.05
	Quartile 3	English total score	296	0.46	41	0.46	56	0.44	0.00	0.02
		Kiswahili total score	296	0.42	41	0.18	56	0.38	0.24 **	0.04
	Quartile 4	English total score	321	1.16	33	1.31	39	1.20	-0.15 **	-0.03
		Kiswahili total score	321	0.95	33	1.04	39	1.04	-0.09	-0.09

*Sources: Author's own calculations based on Midterm evaluation data - PRIMR initiative. Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01 and (2) data not weighted.*

This section shows the way in which descriptive statistics emphasize the strong relationship between scores in English and Kiswahili. Interestingly, the relationship between Kiswahili and English scores is stronger when tied to the English proficiency level. Furthermore, differences can be observed across the distribution, indicating that different levels of Kiswahili are correlated with different levels of English and vice versa. This suggests that the transfer is not a linear process and may vary depending on the level of proficiency. Notably, for a given Kiswahili score the relationship with the corresponding English score tends to follow a quadratic curve. Moreover, this relationship is not constant between the three home language groups, suggesting that the transfer may not operate similarly for all pupils. In the Kiswahili scores' distribution, non-Swahili pupils tend to do worse, i.e. for a similar Kiswahili score, they score significantly lower in English. However, at the top of the distribution, all three language groups converge up to the fourth quantile. Similarly, there is no home language group effect at the top of the English scores' distribution. As previously discussed in the literature section, the transfer is complex and can be mediated by many factors. Indeed, individual factors such as age or social and educational background can affect the transfer (Butler, 2013; Cummins, 1979; Jarvis, 2000). The school environment can possibly affect language transfer as well. Therefore, further investigation is needed to confirm and explain these patterns. The next section presents the econometric model used to understand the relationship between English and Kiswahili scores.

Econometric model and estimation strategy

The research in this section is based on the Education Production Function defined in Chapter 2. However, it takes this further in light of the cross-transfer literature. Especially, it focuses on the relationship between Kiswahili and English and a potential transfer between them in the Kenyan context.

Theoretical framework

As discussed in the literature section, the threshold hypothesis suggests that the transfer between a first and a second language is not a linear process. In the Kenyan context, several factors are likely to influence the transfer magnitude across the distribution such as the exposure to languages and the motivation to learn English. Moreover, differences between the three home language groups (Swahili, semi- and non-Swahili) are expected. Indeed, the literature emphasizes the role of language exposure and the potential advantages of multilingualism in transfer. Swahili pupils have more exposure to Kiswahili in their home environment but they only use two languages in total, Kiswahili and English. On the other hand, semi and non-Swahili pupils use another mother tongue at home which is different from Kiswahili or English, making them multilingual. These differences are likely to affect the transfer mechanism, thus resulting in different home language groups' transfer patterns. To study the relationship between English and Kiswahili scores, this chapter compares a linear approach with a non-linear one. Theoretical work suggests that shifting to instruction in a second language before acquiring sufficient reading skills in the home language can negatively affect language acquisition - also called "subtractive" bilingualism. In the Kenyan context, this may happen when pupils are not taught in their home language at school. Conversely, if the bilingualism or multilingualism is "additive", better outcomes should be expected and may translate into increasing marginal effects. Based on this, a quadratic approach could be a good fit. Furthermore, descriptive statistics presented in the previous section provide some insight for a possible quadratic curve. Quadratic regressions are therefore used to investigate further the variations of pupils' performance in one language (Kiswahili or English) on their performance in the other. Other possible factors which affect transfer are controlled for, such as individual level variables and school fixed effects, to remove any potential bias at the school level. To examine potential differences between home language groups, interaction terms are used between home language variable (semi-Swahili and non-Swahili) and the predicting score.[61] Finally, because the transfer can be shown in several instances to be bidirectional, especially in bilingual context, it is likely that this is the case in the present sample. English and Kiswahili are the two official languages in Kenya. Furthermore, English and Kiswahili are used concomitantly at the primary school level, though some schools focus more on one or the other. Living in an environment with exposure to both languages and where both are used may accentuate the contribution of one to the

[61] When English is the outcome variable, Kiswahili is the predicting score and vice versa.

other during the reading skills acquisition process. To account for this assumption and provide better estimates, Seemingly Unrelated Regressions (SUR) are performed. SUR combines estimation results from the regression models for each score used as the outcome variable, allows for possible correlations in errors, and tests for cross-equation correlations.[62] This chapter will not use the Three-Stage Least Squares (3SLS) approach which is a SUR model further generalized into a system equation model. Further explanations on this methodological choice can be found in Appendix I. The econometric model used in this chapter is presented in the sub-section below.

Econometric model

Quadratic regressions are used to estimate how pupils' achievement in English changes, for a one-unit change in Kiswahili. The same regressions are then done the other way around. The relationship is hypothesized as non-linear, and the scores should influence each other. The English and the Kiswahili total literacy scores computed in the previous chapter[63] are used successively as outcome and predicting variables. The model is adapted to include the total Kiswahili score and the quadratic term as part of the explanatory variables when English is the outcome variable and vice versa. Other variables of interest at the individual level are included as a control. The intention is to remove potential bias due to unobservable variables at the school level, such as choice of school, which might be correlated with the language spoken by pupils at home, by using school fixed effects. Subsequently, interaction terms are included to account for potential interactions between pupils' home language groups and the predicting scores. The model is specified as:

$$Y_{is} = \alpha + \mathrm{J}_{is} + \mathrm{J}_{is}^2 + \mathrm{L}_{is} + \mathrm{J}_{is} \times \mathrm{L}_{is} + \mathrm{J}_{is}^2 \times \mathrm{L}_{is} + \mathrm{X}_{is} + \lambda_s + \varepsilon_{\mathrm{is}}$$

Where Y_{is} is the standardized outcome score variable (English or Kiswahili) of child *i* in school *s*. J_{is} is the standardized predicting score (in alternate language) of child *i* in school *s*. J_{is}^2 is the quadratic term. L_i is the pupils' home language group dummy variable (with Swahili pupils as the omitted category). $\mathrm{J}_{is} \times \mathrm{L}_i$ and $\mathrm{J}_{is}^2 \times \mathrm{L}_i$ are the interaction terms between home language groups and predicting scores. X_i represents the controls for the child's characteristics, λ_s is the school fixed effects and ε *is* the error term.

Both English and Kiswahili scores are standardized scores. Therefore, the regression coefficients are interpreted in standard deviation units. Moreover, using centered variables limits the correlation between the quadratic term and the non-quadratic one. Quadratic approximation is presented along with linear regressions for comparison purpose.

[62] SUR is a method for estimating parameters in a system of equations. It allows for cross-equation correlations. This approach is relevant in cases where correlations in errors as suspected.
[63] For more details on the measure included in the total score, please refer to Chapter 2. Appendix D provides more details on the computation of the total score as well.

Seemingly Unrelated Regressions are next used to understand the transfer dynamic between English and Kiswahili better. Empirical results suggest that the scores are mutually related, therefore a cross-correlation is suspected between the two equations. Estimating the full system using SUR in which a "measurement error in one equation can also influence errors in the remaining equations" (Zellner, 1962), allows testing for the correlation of residuals and providing an adjusted coefficient. The higher the cross-equation correlations of residuals, the greater is the adjustment in the estimates. Statistical testing of the equivalence of coefficients is also possible when using SUR. The model is specified as:

$$y_i = \mathrm{X}_i\beta_i + \varepsilon_i , \qquad i = 1, \dots, M$$

where y_i is the ith equation's dependent variable, (in this case $M = 2$). X_i is a matrix with T rows for the number of observations and V_i columns for the number of regressors in each equation. The number of the regressor may vary from one equation to the other. ε_i is the vector of error terms, each with a mean of zero and a covariance matrix of Ω. Error terms in different equations can be contemporaneously correlated for any two error vectors $\Omega=\Sigma \otimes \mathrm{I}$, where $\otimes$ denotes the matrix Kronecker product.

It is worth noting that the findings may have some limitations. Cross-sectional data are used for this analysis and even though school unobservable and family factors are controlled for, other potential unobserved factors such as the length of exposure to English might be correlated with the achievement scores or with the language variables. Although estimates might be affected by these unobservable factors, their influence is likely only to be slight.[64] Chapter 3 concluded that the inclusion of school fixed effects considerably improved the estimates and reduced bias. Another potential bias comes from mediating factors mentioned in the literature section, such as the pupils' motivation or language aptitude. Unfortunately, the data set does not include such variables and they cannot consequently be controlled for. This limitation should be considered when considering the results. Finally, it is necessary to be cautious when interpreting the results not to assume a causal relationship but rather to describe a relationship between English and Kiswahili scores.

[64] Using school fixed effects, Taylor and von Fintel (2016) find that 2 years of instruction in English (in comparison to mother tongue instruction) impact scores significantly and negatively by .081 SD, whereas, 1 year of instruction in English impact scores by -.063 SD.

Results

The transfer is stronger when tied to English proficiency

First, the transfer is investigated by running regressions without controlling for home language groups. Table 19 displays linear and quadratic model results run for English scores and Kiswahili scores as outcome separately. Family and individual background variables based on the pupils' reported responses in a questionnaire are included and reported in Table 19. All specifications include school Fixed effects.

In the first set of regressions on Kiswahili scores (with English as the outcome), the quadratic term coefficient is big and highly significant. Interestingly, the quadratic term coefficient is negative suggesting decreasing marginal effects. When looking at the regressions of Kiswahili on English scores (i.e. scores are tied to English proficiency), the quadratic term coefficient is small and non-significant, suggesting that the relationship is linear and not quadratic.

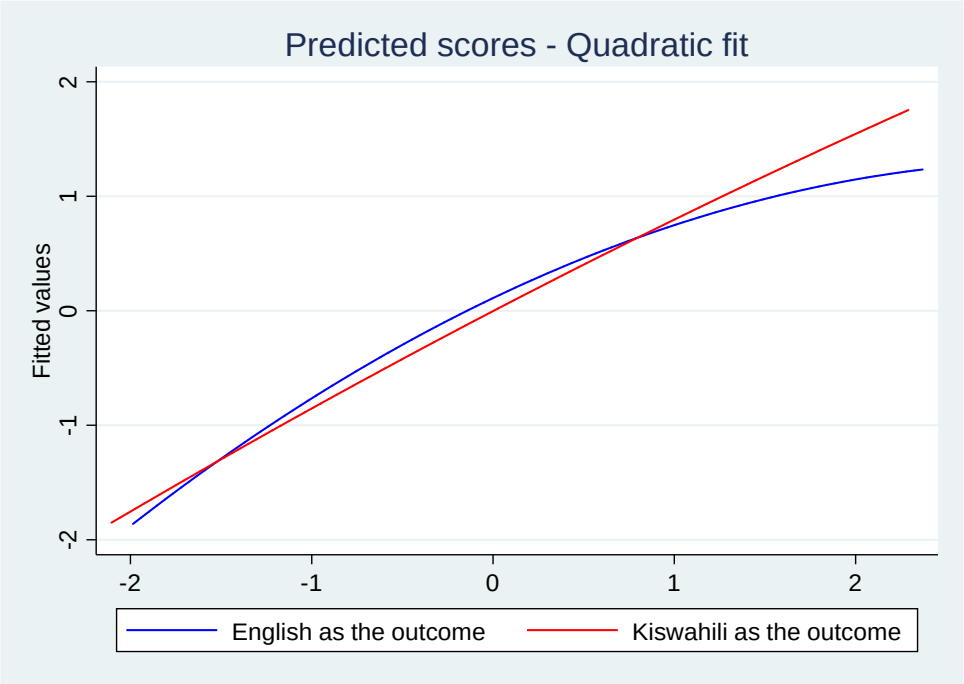
Table 19: FE and quadratic regressions of English and Kiswahili scores

	English score outcome		Kiswahili score outcome	
	(1)	(2)	(3)	(4)
Kiswahili total score	0.785***	0.749***		
	0.029	0.031		
Kiswahili total score squared		-0.117***		
		0.021		
English total score			0.843***	0.830***
			0.026	0.028
English total score squared				-0.027
				0.018
Female	0.043	0.053	-0.005	-0.005
	0.044	0.04	0.04	0.04
Age	-0.200**	-0.211**	0.333***	0.339***
	0.098	0.096	0.112	0.112
Age squared	0.010*	0.011**	-0.017***	-0.018***
	0.006	0.005	0.006	0.006
At school since January	-0.001	0.008	0.014	0.015
	0.043	0.042	0.047	0.047
Attended pre-school	-0.004	-0.02	0.022	0.011
	0.061	0.051	0.059	0.059
Repeater	-0.041	-0.045	-0.015	-0.013
	0.087	0.086	0.083	0.082
Pupil has skipped G1	-0.042	-0.004	0.102	0.105
	0.107	0.106	0.107	0.105
Attendance interrupted	-0.06	-0.06	0.016	0.017
	0.042	0.039	0.048	0.048
Wealth index	0.017	0.02	-0.013	-0.012
	0.019	0.017	0.016	0.016
Kiswahili books at home	-0.041	-0.033	0.021	0.02
	0.029	0.028	0.038	0.038
English books at home	-0.01	-0.01	0.033	0.032
	0.033	0.029	0.033	0.033
No. of Obs.	1519	1519	1519	1519
R-Squared	0.8	0.81	0.78	0.78
School FE	Y	Y	Y	Y
Squared term included	N	Y	N	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show results from the linear and the quadratic model respectively with English score as outcome variables, and columns 3 and 4 show the same models with Kiswahili score as outcome variables (3) Standard errors are indicated below the coefficients, (4) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative.*

Figure 7 provides the predicted scores for quadratic regressions on Kiswahili and on English scores (column 2 and 4 in Table 19) to further highlight the two different patterns. Remarkably, while the relationship between English and Kiswahili tend to decelerate when English is the outcome, the trend is different with Kiswahili as the outcome. Indeed, the slope becomes steeper in higher level of the English score distribution.

Figure 7: Predicted scores - quadratic regressions of English and Kiswahili scores



Notes: (1) the blue curve provides quadratic predicted scores with English score as outcome variables, (2) the red curve provides quadratic predicted scores with Kiswahili score as outcome variables and (3) home language variables are not included as controls in the models.

In conclusion, the relationship between English and Kiswahili scores is not linear. Regression results confirm that the relationship between English and Kiswahili scores varies across the distribution. Furthermore, higher scores in Kiswahili are not associated with relatively higher scores in English. Whereas, higher scores in English are associated with relatively higher scores in Kiswahili.

The languages' relationship is not linear across the distribution

Table 20 provides the regression results including the home language variables. Fixed effects results from Chapter 3 are provided in column 1 and 2 for comparison. Column 3 shows the regression of English scores on Kiswahili scores including school fixed effects, and column 4

presents the corresponding results for the quadratic model with school fixed effects. Interaction terms are included between the Kiswahili score and the home language group. Columns 5 and 6 provide the fixed effects model and the corresponding quadratic regressions of Kiswahili scores on English score variation. As shown, the quadratic estimation is more effective to explain the variation of Kiswahili on English scores when language variables are included. Furthermore, the quadratic term coefficient is negative for all three home language groups (Columns 4 and 6). At the mean and when all other factors are held constant, a one unit increase in the Kiswahili score is associated with a .744 SD[65] increase in the English score for the reference group (Swahili pupils). For semi-Swahili and non-Swahili pupils the increase in the English score is .811 SD and .824 SD[66] respectively. A post-estimation Wald test was performed on these coefficients. Results show that the three coefficients are not significantly different from each other. This means that, at the mean, a one unit increase in the Kiswahili score is associated with an increase of the same magnitude in English scores for all three language groups. The negative coefficient of the quadratic term shows that the marginal effect of an additional unit increase in Kiswahili is associated with a higher variation in the English score at the bottom of the distribution than at the top. This suggests that when scores are tied to Kiswahili proficiency, the transfer decreases in higher level of the Kiswahili scores distribution. For non-Swahili pupils, the decreasing marginal effects are sharper compared to Swahili pupils.

In the second set of regressions (with Kiswahili as the outcome), the variation of English scores on the Kiswahili score shows a different pattern. Even though, the quadratic term is not significant for the reference group (Swahili pupils), the significance of interaction term coefficients indicates that English scores considerably mediate the variation in Kiswahili scores for non-Swahili and semi-Swahili pupils. At the mean, transfer to Kiswahili is significantly stronger for Swahili pupils in comparison to semi-Swahili and non-Swahili pupils. A one-unit increase in English is associated with an .826 SD[67], an .599 SD and an .610 SD increase in Kiswahili score for Swahili, semi-Swahili and non-Swahili pupils respectively. However, the positive quadratic interaction term coefficients suggest that the marginal effect is increasing across the distribution for semi-Swahili and non-Swahili pupils.

Turning now to the non-Swahili and semi-Swahili home language variables (first two rows at the top of Table 20), results show that the impact of the home language is mediated by scores in the alternate language. In all specifications (column 3 to 6), home language coefficients are much smaller in comparison to results from Chapter 3 (column 1 and 2). This suggests that the interaction

[65] With English as the outcome, the quadratic model is the best fit. Therefore, coefficients are calculated from the Kiswahili total literacy coefficients in column 4 (the quadratic equation). The derivative for the reference group is calculated as follow: .744 + 2 * (-.126) * *x*. At the mean, *x*=0, therefore, the derivative = .744

[66] Derivatives for semi- and non-Swahili include language group interaction terms as follow: .744 +.067 + 2*(-.126-.006) * *x* for Semi-Swahili and .744 + .080 + 2* (-.126-.047) **x* for non-Swahili. At the mean, *x*=0, therefore, the derivative = .811 for semi-Swahili and .824 for non-Swahili.

[67] With Kiswahili as the outcome, coefficients are calculated from the English total literacy coefficients in column 6. The derivative for the reference group is calculated as follow: .826 + 2 * (.009) * *x*. At the mean, *x*=0, therefore, the derivative = .826

between scores and home language group matters more than belonging to a specific home language group.

Table 20: FE and quadratic regressions of English and Kiswahili scores – with home language group variables

	Results from Chapter 3		English score outcome		Kiswahili score outcome	
	(1)	(2)	(3)	(4)	(5)	(6)
Non-Swahili pupils	-0.206**	-0.247***	-0.07	-0.084*	0.02	0.038
	0.09	0.09	0.052	0.048	0.052	0.049
Semi-Swahili pupils	-0.185	-0.203*	-0.055	-0.073*	-0.012	0.003
	0.115	0.103	0.043	0.04	0.051	0.046
Kiswahili total literacy			0.763***	0.744***		
			0.037	0.036		
Kiswahili total literacy x Non-Swahili			0.041	0.08		
			0.052	0.077		
Kiswahili total literacy x Semi-Swahili			0.087	0.067		
			0.057	0.082		
Kiswahili total literacy squared				-0.126***		
				0.022		
Kiswahili total literacy squared x Non-Swahili				-0.047**		
				0.021		
Kiswahili total literacy squared x Semi-Swahili				-0.006		
				0.025		
English total literacy					0.826***	0.826***
					0.032	0.032
English total literacy x Non-Swahili					0.088**	-0.216***
					0.04	0.053
English total literacy x Semi-Swahili					-0.013	-0.227**
					0.058	0.093
English total literacy squared						0.009
						0.018
English total literacy squared x Non-Swahili						0.133***
						0.015
English total literacy squared x Semi-Swahili						0.135***
						0.034
No. of Obs.	1519	1519	1519	1519	1519	1519
R-Squared	0.37	0.42	0.8	0.82	0.79	0.79
School FE	Y	Y	Y	Y	Y	Y
Other control variables	Y	Y	Y	Y	Y	Y
Squared term included	N	N	N	Y	N	Y

*Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 and 2 show results from the FE model run in Chapter 3, columns 3 and 4 show the FE and quadratic FE model with English as the outcome variable, and columns 5 and 6 give the corresponding results when the model is run with Kiswahili as the outcome variable (3) Standard errors are indicated below the coefficients, (4) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative.*

Because the scores are significant on one another, results from this sub-section suggest that the transfer is bidirectional. However, the relationship between Kiswahili and English scores seems to be more straightforward and stronger when tied to the English proficiency level. Moreover, the relationship between the two scores is not linear, the slope is not constant across the distribution. Similarly, the magnitude of the transfer seems to differ by pupil's home language as well. Consequently, variations in the transfer coefficients between the three home language groups can be expected across the distribution. Nevertheless, if both scores mutually impact each other it would imply that the two equations are cross-correlated. In such a case, the results could be biased owing to the correlation of errors, which is not considered in the quadratic fixed effects model. Therefore, in the following section SUR estimation will be used to confirm the results and possibly to adjust coefficients.

Seemingly Unrelated Regressions to account for correlations across equations

In the final sub-section, SUR estimations are applied to the previous model. SUR makes it possible to account for correlations across equations and adjust coefficients accordingly. This will test the correlation between the two equations and should improve the efficiency of the estimators since error terms across equations might be contemporaneously correlated. Table 21 provides the SUR results of English and Kiswahili scores for the full sample. Home language variables and interaction terms are included. The correlation matrix of residuals between the equations is displayed at the bottom of Table 21. As can be seen, residuals are strongly correlated and highly significant. This indicates that the two equations are highly correlated and that adjusted SUR estimates must therefore be used. SUR results mirror trends previously observed but with a stronger magnitude.

At the bottom of the distribution, a higher score in English is associated with a relatively higher scores in Kiswahili for non-Swahili pupils

In accordance with what was found in the previous section, when tied to Kiswahili proficiency level, the relationship between Kiswahili and English scores follows a quadratic negative curve for all pupils. At the mean, a 1 SD increase in Kiswahili is associated with a .926 SD, a .990 SD and a 1.008 SD[68] increase in Kiswahili for Swahili pupils, semi-Swahili and non-Swahili pupils respectively. However, and quite surprisingly, the increase is significantly stronger for non-Swahili in comparison to Swahili pupils. Looking at the slope coefficients at different points of the distribution (i.e not at the mean), Table 22 indicates that towards the top of the distribution, all three home language groups' slopes tend to converge and are essentially the same. However, at the bottom of the distribution, the difference in slopes between non-Swahili and Swahili pupils

[68] The derivative for the reference group is calculated as follow: .926 + 2 * (-.045) * *x*. At the mean, *x*=0, therefore, the derivative = .926. For semi and non-Swahili pupils, interaction terms are added in the derivative.

gets sharper. With a Kiswahili score equal to -1, a one-unit increase in the Kiswahili score is associated with a 1.214 SD[69] increase in the English score for non-Swahili pupils against a 1.016 SD[70] increase for Swahili pupils. The increase for semi-Swahili pupils is 1.130 SD. For clarity purpose, coefficients per home language groups are summarized in Table 22.

Table 21: Seemingly Unrelated Regressions of English and Kiswahili scores

	English score outcome	Kiswahili score outcome
	(1)	(2)
Non-Swahili pupils	-0.065*	0.061
	0.035	0.037
Semi-Swahili pupils	-0.043	0.033
	0.04	0.042
Kiswahili total literacy	0.926***	
	0.013	
Kiswahili total literacy x Non-Swahili	0.082*	
	0.05	
Kiswahili total literacy x Semi-Swahili	0.064	
	0.054	
Kiswahili total literacy squared	-0.045***	
	0.009	
Kiswahili total literacy squared x Non-Swahili	-0.058***	
	0.018	
Kiswahili total literacy squared x Semi-Swahili	-0.025	
	0.024	
English total literacy		1.007***
		0.015
English total literacy x Non-Swahili		-0.088**
		0.043
English total literacy x Semi-Swahili		-0.078*
		0.047
English total literacy squared		0.026***
		0.01
English total literacy squared x Non-Swahili		0.068***
		0.017
English total literacy squared x Semi-Swahili		0.045*
		0.024
No. of Obs.	1519	1519
R-Squared	0.8	0.8
School FE	Y	Y
Other control variables	Y	Y
Squared terms included	Y	Y
Correlation matrix of residuals:	-0.7524***	

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 shows SUR results with English as the outcome variable and column 2 gives SUR results with Kiswahili as the outcome, (3)Standard errors are indicated below the coefficients and (4) the correlation matrix of residual between the two equations is given at the bottom of the table.*

[69] If *x*= -1, the derivative including non-Swahili pupil's interaction terms equals: .926 +.082 + 2* (-.045-.058) *-1 = 1.214
[70] If *x*= -1, the Swahili pupils' (reference group) derivative equals: .926+ 2 *(-.045) *-1 = 1.016

At higher level of the English proficiency distribution, the transfer is stronger for non-Swahili pupils

Turning now to the relationship when scores are tied to the English proficiency level, Swahili pupils transfer significantly more in comparison to the two other home language groups in the first half of the distribution (first row, column 4b and 5b in Table 22). At the mean, while the variation in Kiswahili scores for a one-unit change in English is 1.007 SD[71] for Swahili pupils, the variation is .929 SD and .919 SD for semi-Swahili and non-Swahili pupils respectively. However, the results give a different picture at the top of the distribution. For pupils with an English score of 1, the variation in Kiswahili scores for a one-unit change in English is 1.107 SD for non-Swahili pupils, semi-Swahili pupils come second (1.071 SD) and Swahili pupils come last (1.059 SD). The three coefficients are not significantly different from each other, meaning that the transfer magnitude is the same for all three home language groups. Because the quadratic interactions terms coefficients are significant and positive for semi-Swahili pupils and non-Swahili pupils, transfer becomes higher for them in comparison to Swahili pupils (in higher levels of the English score distribution). At the extreme top of the distribution, the transfer from English to Kiswahili becomes stronger for non-Swahili pupils.[72]

Testing the equality of total literacy score coefficients between the equations further confirms that the magnitude of the transfer is significantly stronger at higher levels of English proficiency. Indeed, Table 22 shows that the English total literacy variation coefficient is significantly higher for all three language groups in comparison to the Kiswahili variation coefficient (third row, column 1c, 2c and 3c). For instance, for Swahili pupils having a score of 1 in English, a 1 unit increase in English is associated with a 1.059 SD increase in Kiswahili (column 1b). Conversely, for Swahili pupils scoring 1 in Kiswahili, a 1 unit increase in Kiswahili is associated with a 0.836 SD variation in English score (column 1a). The difference between the two coefficients equals .223, which is significant. This suggests that Kiswahili proficiency is contributing fewer and fewer to English scores, whereas, the English proficiency is contributing more and more to Kiswahili scores across the distribution. This is true for all three home language groups.

Surprisingly, at the bottom of the distribution, the Kiswahili coefficient is significantly stronger than the English coefficient for semi- and non-Swahili pupils (first row, column 2c and 3c in Table 22). For instance, for non-Swahili pupils scoring -1 in Kiswahili, a 1 unit increase in their score is associated with a variation of 1.214 increase in English (column 3b), whereas a 1 unit increase in English is associated with a variation of .731 increase in Kiswahili (column 3a). This suggests that, while transfer is of the same magnitude two-ways for Swahili pupils with lower level of proficiency, for semi-Swahili and non-Swahili pupils, Kiswahili contributes significantly more to English than the other way around. These patterns will be further discussed in the conclusion section.

[71] The derivative equals: 1.007 + 2 * (.026) * *x*. If x=0, the derivative = 1.007

[72] For pupils scoring above 1.01 in English, the English coefficient becomes significantly higher for non-Swahili pupils in comparison to Swahili pupils. This result is not displayed in Table 22 because less than 8% of the non-Swahili (about 24 pupils) scored above 1.01.

Table 22: Equality of literacy coefficients in SUR

	Swahili pupils				Semi-Swahili pupils				Non-Swahili pupils				Swahili vs. non		Swahili vs. semi		Non-Swahili vs. semi	
	Kiswahili coeff.	English coeff.	Diff.		Kiswahili coeff.	English coeff.	Diff.		Kiswahili coeff.	English coeff.	Diff.		Kiswahili coeff.	English coeff.	Kiswahili coeff.	English coeff.	Kiswahili coeff.	English coeff.
	1a	*1b*	*1c*		*2a*	*2b*	*2c*		*3a*	*3b*	*3c*		*4a*	*4b*	*5a*	*5b*	*6a*	*6b*
x = -1	1.016	0.955	-0.061		1.130	0.787	-0.34	**	1.214	0.731	-0.5	***	-0.198 **	0.224 ***	-0.114	0.168 *	0.084	-0.056
x = 0	0.926	1.007	0.081	***	0.990	0.929	-0.06		1.008	0.919	-0.1		-0.082 *	0.088 **	-0.064	0.078 *	0.018	-0.010
x = 1	0.836	1.059	0.223	***	0.850	1.071	0.221	***	0.802	1.107	0.31	***	0.034	-0.048	-0.014	-0.012	-0.048	0.036

*Notes: (1) The first set of columns give the Kiswahili coefficient 1a), the English coefficient 1b) and the difference between both coefficients 1c) for Swahili pupils, (2) the second and third set of columns give corresponding results for semi-Swahili and non-Swahili pupils, (3) level of significance in difference: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (4) column 4a) and 4b) give the difference on Kiswahili and English coefficients between Swahili pupils and non-Swahili pupils, (5) column 5a) and 5b) give the difference between Swahili and semi-Swahili pupils' Kiswahili and English coefficients and (6) column 6a) and 6b) give the difference between non-Swahili and semi-Swahili pupils' Kiswahili and English coefficients.*

More similar transfer between language groups in schools where Swahili pupils are in minority

As a final robustness check and using a similar approach as in Chapter 3, SUR are run on a reduced sample limited to schools including a maximum of 50% of Swahili pupils. The purpose of this robustness check is to verify whether results remain consistent in schools with more linguistic diversity. Indeed, as discussed in the literature section, many context-dependent factors interfere with cross-language transfer. Whether a language is dominant in the community is one of these factors. Therefore, it is worth investigating the transfer process in a sub-sample of schools with more diversity. Robustness check results are presented in Table 23. Column 1 provides the SUR results of English scores for the reduced robustness check sample and Column 2 provides respective SUR results when Kiswahili score is the outcome variable. The correlation matrix of residuals can be found at the bottom of Table 23.

Table 23: SUR of English and Kiswahili scores - reduced robustness check sample

	English score outcome	Kiswahili score outcome
	(1)	(2)
Non-Swahili pupils	-0.046	0.041
	0.048	0.047
Semi-Swahili pupils	-0.054	0.042
	0.049	0.049
Kiswahili total literacy	0.984***	
	0.033	
Kiswahili total literacy x Non-Swahili	0.075	
	0.061	
Kiswahili total literacy x Semi-Swahili	0.002	
	0.068	
Kiswahili total literacy squared	-0.021	
	0.016	
Kiswahili total literacy squared x Non-Swahili	-0.062***	
	0.02	
Kiswahili total literacy squared x Semi-Swahili	0.002	
	0.031	
English total literacy		0.966***
		0.032
English total literacy x Non-Swahili		-0.087*
		0.05
English total literacy x Semi-Swahili		-0.037
		0.055
English total literacy squared		0.018
		0.016
English total literacy squared x Non-Swahili		0.074***
		0.017
English total literacy squared x Semi-Swahili		0.02
		0.026
No. of Obs.	475	475
R-Squared	0.83	0.83
School FE	Y	Y
Other control variables	Y	Y
Squared terms included	Y	Y
Correlation matrix of residuals:	-0.7690***	

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 shows SUR results with English as the outcome variable and column 2 gives SUR results with Kiswahili as the outcome, (3) The sample is limited to schools including a maximum of 50% of Swahili pupils, (4) Standard errors are indicated below the coefficients and (5) the correlation matrix of residual between the two equations is given at the bottom of the table.*

This robustness check allows to confirm previous findings. The estimates based on the restricted sample are similar to previous estimates from Table 22. However, the significance of the coefficients is slightly different. In the reduced sample, squared terms in Kiswahili and English literacy are not significant anymore. Similarly, several interaction terms between language groups and literacy scores lose significance. Moreover, when the same SUR are run without squared variables and squared interaction terms, none of the interaction terms is significant (the linear SUR model is not displayed here but can be found in Appendix J). Interestingly, this suggests that in schools with more language group diversity, the cross-language transfer is more linear and of the same magnitude for all three home language groups. Chapter 5 will investigate further how linguistic diversity at school relates to reading scores.

In conclusion, since Kiswahili and English scores are mutually related, Seemingly Unrelated Regressions are used to improve the efficiency of the estimators. Findings confirm that the quadratic approach is more effective to explain the relationship between Kiswahili and English scores. Overall, results show that the transfer is stronger when tied to English proficiency level. For all three home language groups, the transfer magnitude is decreasing in higher levels of Kiswahili proficiency, while it is increasing across the English scores' distribution. Furthermore, results show that the transfer is significantly stronger for Swahili pupils in the first half of the English scores' distribution. This may contribute to further explain findings from Chapter 3. Semi-Swahili and non-Swahili pupils were both found as achieving significantly lower in English (in comparison to Swahili pupils). The lower transfer magnitude may explain why these two home language groups lag behind Swahili pupils in English. Lastly, results show that in higher level of the score distribution or in school with higher language diversity the transfer pattern between the three home language groups tends to be much more homogeneous. These latter results will be further discussed in the next section and in Chapter 5.

Discussion and conclusion

In this section, the results and trends found are discussed further in light of the cross-language transfer literature. Chapter 4 investigated whether literacy skills in one language (Kiswahili or English) is associated with reading skills in the other. The purpose was to identify the nature of the relationship between the two languages and potential differences between pupils' home language background. Having more exposure to Kiswahili at home or speaking more than one language are factors that may facilitate the transfer of literacy skills. English is a new language for

all pupils in the sample (i.e they don't speak English at home), whereas Kiswahili is a home language for some pupils. Some pupils speak their mother tongue at home and therefore, add languages up. In the literature, many studies have shown interdependence and strong correlations between a first and a second (or further) language. Moreover, it is acknowledged that the transfer between languages is mediated by several factors, such as the level of proficiency, language exposure, language distance, multilingualism and other background factors. Therefore, the objective was to compare the relationship between Kiswahili and English scores among pupils who have different home language background. Most of the research done in the cross-language field has focused on bilingual populations in developed countries, mainly adult ones. In Chapter 4, the transfer between Kiswahili and English was examined for a young population in the multilingual context of Kenya.

Several aspects were investigated. First, the interdependence between Kiswahili and English was explored. Results showed that Kiswahili and English scores are closely related and mutually influence each other. This is in line with previous findings in African multilingual contexts (Kim and Piper, 2019; Pretorius and Mampuru, 2007). It was also found that the relationship between the two scores is not linear, which supports Feinauer *et al.* (2017)'s call for further exploration using non-linear approach. In agreement with several authors describing the transfer as a non-constant mechanism with a rate accelerating beyond a certain threshold in second language proficiency (Lee and Schallert, 1997; Yamashita, 2001), results show that the higher the level in English, the higher the magnitude of the transfer. However, this work does not show evidence supporting a threshold per se. Rather increasing marginal effects through the quadratic modeling approach are found. The relationship between Kiswahili and English scores, when tied to the English proficiency level, follows a quadratic curve with increasing slope across the distribution. Moreover, results confirmed that the relationship between Kiswahili scores and English scores is stronger when tied to English proficiency (compared to when scores are tied to Kiswahili proficiency). Somehow surprisingly, when tied to Kiswahili level of proficiency, the relationship follows a negative quadratic curve with decreasing marginal effects across the distribution. This means that the higher the proficiency in Kiswahili, the lower the transfer between Kiswahili and English. This holds true for all home language groups.

There are previous reports that reading in the second language contributes more to reading in the first language than does reading in the first language to the second. According to Pretorius and Mampuru (2007), this could indicate that pupils receive more reading instruction in English than initially expected, or that they are more exposed to teaching and reading materials in English. Similarly, Kim and Piper (2019) attribute it to the instructional approach employed in the treatment condition in their sample, whereby instruction was centered on Kiswahili and then explicitly linked to English instruction. However, the decreasing marginal effects on Kiswahili scores raise new issues. This has not been observed before. However, the literature may bring some insight to explain this result. As previously discussed, in cases of limited exposure to the first language, an intense exposure to the second language may result in a "subtractive" bilingualism where the two languages do not develop simultaneously (Cummins, 1976, 1979). In the Kenyan context, this is a

possibility given the interest for English and the provision of teaching and reading materials in this language. Under this assumption, the "subtraction" of Kiswahili could plausibly result in decreasing marginal effects. Another possible explanation is that Kiswahili having a more transparent orthography than English, reading in English is more difficult. Consequently, reading in a more transparent orthography such as Kiswahili may help to better associate sounds with letters and therefore, may facilitate applying basic letter-sound correspondences in English up to a certain level. However, reading in Kiswahili reach a ceiling effect while reading in English (which is a much less transparent orthography) requires more complex processing. Conversely, reading a more complex orthography should facilitate even more the reading of a transparent orthography. Consequently, a one-unit gain in English might translate into higher gains in Kiswahili. Further research would be needed in the Kenyan context to confirm these possible assumptions.

Potential differences between home language groups were then investigated to see whether pupils' home language background may influence the transfer mechanism. In the initial assumption, it was expected that Swahili pupils would transfer better than the two other home language groups, as they have more exposure to Kiswahili at home. Findings only partially support this assumption. In the first half of the English score distribution, Swahili pupils are advantaged compare to semi- and non-Swahili pupils. This means that improvement in English translates into higher contribution to Kiswahili scores for Swahili pupils. Nonetheless, at higher level of English proficiency, semi-Swahili and in particular non-Swahili pupils transfer most readily. This suggests that when semi-Swahili and non-Swahili pupils achieve a sufficient level of proficiency in both languages, they are not disadvantaged compared to Swahili pupils. A possible explanation comes from the third-language acquisition literature, which argues that pupils with more than two languages may have an advantage in comparison to bilingual pupils because they can refer to a greater language lexicon, which positively impacts transfer. When both Kiswahili and English proficiencies develop successfully, this can be assimilated to an additive bilingualism situation. In such cases, multilingual pupils may have additional skills in comparison to bilingual pupils (Butler, 2013; Cenoz, 2003). This could explain why the transfer becomes more favorable to semi-Swahili and non-Swahili pupils and their relative advantage in comparison to Swahili pupils. Further research is needed to confirm this assumption.

Turning now to the relationship between Kiswahili and English scores when tied to the Kiswahili proficiency, all three home language groups converge in the second half of the distribution. However and unexpectedly, at lower levels of the Kiswahili score proficiency, the transfer produces higher outcomes for non-Swahili pupils than for Swahili pupils. Semi-Swahili pupils stand in between non-Swahili and Swahili pupils. A potential assumption is that Swahili pupils at lower levels of the Kiswahili distribution may experience reading difficulties, which would explain that they have low reading skills in their own mother tongue. Another possible explanation would be that they are in a situation of subtractive bilingualism with a lack of exposure to Kiswahili, resulting in lower development of the first and the second language (Cummins, 1976, 1979; Verhoeven, 1994). Conversely, for non-Swahili pupils Kiswahili is not their home languages, and

therefore some assumptions can be made. For instance, the literature highlights several factors at stake in the cross-language transfer, such as language exposure, multilingualism or pupil's motivation to learn a language. From a non-Swahili pupil's perspective, learning English is probably more attractive, as English is the language in use in higher education and the common trade language in Kenya. They may therefore focus more on reading in English. Furthermore, third language learners may have specific skills and knowledge that second learners do not have, such as a greater metalinguistic awareness and larger cross-linguistic influences (Dillon, 2009; Jessner, 2008; Ransdell *et al.*, 2006). This food for thought opens new perspectives for future research.

Finally, Chapter 4's findings can further be linked with results from the preceding chapter. Indeed, Chapter 3 showed that non-Swahili pupils achieve significantly lower results in Kiswahili and in English compared to Swahili pupils. Moreover, Chapter 3 showed that compared to Swahili pupils, semi-Swahili pupils have similar scores in Kiswahili, but still they achieve significantly lower scores in English. The higher transfer magnitude for Swahili pupils may contribute to explain why they have significantly higher scores in English. Lastly, Chapter 4 shows that the impact of home language variables is considerably mediated by score levels. Indeed, home language variable coefficients are small on English when the Kiswahili score is accounted for and vice versa. Therefore, one can conclude that it is more the low level of scores in English and in Kiswahili that puts the non-Swahili group at a disadvantage. At higher level of proficiency, the home language does not matter much. Whether Kiswahili is the home language or not, the transfer between Kiswahili and English will be of the same magnitude. To the best, it can actually advantage pupils who speak more languages.

This chapter contributes to the cross-language transfer literature by using a quadratic approach to estimate the relationship between the two languages. It confirms previous findings on the non-linearity of the transfer mechanism. Moreover, Seemingly Unrelated Regression approach is used to account for the mutual influence between Kiswahili and English in the Kenyan context. Finally, this research investigated how one language might impact another for pupils with different home language background and shows that the transfer of literacy knowledge magnitude is not the same for all pupils. Even though speaking the language of instruction at home may facilitate language transfer, in some instances, multilingual pupils may be advantaged despite the fact that they are less exposed to Kiswahili in their home environment. This is especially true for multilingual pupils who successfully developed reading skills in both Kiswahili and English.

Last, robustness check results from Chapter 4 suggested that in schools with more language diversity, the transfer is of similar magnitude between the three home language groups. This may suggest that the language composition at school interferes with reading acquisition and cross-language transfer process. The next chapter, will focus on the language composition in schools and the potential role of peer effects in the language dynamic. This could yield further insight on factors at stake and influencing reading achievement in urban Kenya.

Chapter 5: Peers' language diversity and school achievement

Introduction

School is not just a building or a material input, it is a social environment made up of individuals who interact to improve knowledge and develop skills. It would be naïve to assume that pupils' educational outcomes only rely on pupils' own attributes and on school inputs. Another aspect that deserves attention is the peer influence in the school environment, especially in such a diverse cultural and linguistic environment as in Kenya.

The impact that peers may have on an individual has been explored by many authors and in different contexts. Peer effects have been observed at the neighborhood level in areas such as involvement in criminal activity, drug use, smoking intensity, teenage childbearing, welfare participation, and employment probability (Bertrand *et al.*, 2000; Burns *et al.*, 2010; Case and Katz, 1991; Crane, 1991; Mukong, 2017). As discussed in Chapter 2, peers' influence is part of the Education Production Function (Hanushek, 1979). In many cases, the findings confirm a peer effect on outcomes such as health behavior or school achievement. Several authors found that having high achieving schoolmates' affects students' performance positively (Hanushek *et al.*, 2003; Sacerdote, 2000; Zimmerman, 2003). Among other things, peers' behavior has been identified as impacting students' own behavior. For instance, an increase in the percentage of schoolmates who drink or use drug is associated with an increase in own students' consumption (Duncan *et al.*, 2005; Fletcher, 2012). The effect of peers' ethnic diversity on school achievement has been explored as well, mainly in developed countries, which provided mixed results (Angrist and Lang, 2004; Hoxby, 2000; Hoxby and Weingarth, 2005; Van Ewijk and Sleegers, 2010b). However, the literature on the impact of peers' language composition on school achievement is scanty in the economic field and in the African geographic zone. Only one study in Economics was found that investigated the percentage of indigenous (non-native speakers of Spanish) students in a classroom and how it related to achievement in a developing country (McEwan, 2003). In this paper, a negative association is found between the increase in percentage of indigenous students and students' own score.

In this chapter, the assumption is that peers' language composition in urban schools in Kenya may impact pupils' reading achievement, in addition to the pupils' own home language that was explored in Chapter 3. Chapter 3 showed that pupils who speak Kiswahili at home achieve higher scores and attend schools of better quality than pupils who do not speak Kiswahili at home. To a certain extent, peers' language composition may reflect peers' linguistic quality and may reinforce peer effects on individual test score outcomes. Furthermore, the Kenyan context, and its specificity as a multiethnic and multilingual environment, is likely to affect the language used in the school environment by teachers or by pupils on the playground. Consequently, peers' language

composition at school might increase or decrease a pupil's exposure to English or Kiswahili. As discussed in Chapter 2, the degree of exposure to the oral language can be a determinant in learning basic reading skills in that same language, so that the more pupils are exposed to a spoken language, the faster they are likely to acquire reading skills in that language. More specifically, this chapter is driven by the following questions: Can we identify peer effects in primary schools in urban Kenya? And does being surrounded by a linguistically diverse peer group impact pupils' Kiswahili (or English) scores? A major challenge to addressing these issues is the need to remove endogeneity bias. Indeed, diversity is often confounded with other factors, such as the individual characteristics or the quality of the attended school. Language diversity within schools may reflect parents' choice of school based on their schooling preferences and on who else is attending the school. Because families sending their pupils to a particular school can be expected to be similar in many ways, this chapter uses school fixed effects to purge potential endogeneity bias in peer effects estimates. In this paper, the measure of peers is drawn from the idiosyncratic variation in linguistic diversity between grades within schools.

Chapter 5 makes a unique contribution to the literature on peer effects in African contexts. In particular, it examines the role of peers' linguistic diversity on reading achievement in urban Kenyan classrooms. The innovative aspect of this research is the use of a linguistic fractionalization index in a micro-economic context to measure peer linguistic density. As a result, the contribution to the literature is twofold. Using grade 1 and grade 2 pupils' linguistic composition variation within the same school, Chapter 5 provides evidence that peer effects are mainly activated through peers' quality. The peers' linguistic composition by itself is not a significant determinant of achievement. However, peer effects on Kiswahili scores are mainly operating in high linguistic diversity schools. As language diversity increases in the classroom, peers' scores in Kiswahili decrease, which translate into negative association with pupil's own score in Kiswahili. On English scores, the peer effect is not conditional on the linguistic diversity. The results are robust when additional peer characteristics are controlled for. Further investigation shows that low achievers tend to be more affected by peer effects than high achieving pupils. An alternative model, using the percentage of peers whose home language is Kiswahili, is investigated in this chapter. Results show that the proportion of peers who speak Kiswahili does not matter much, but rather the linguistic diversity.

The rest of this chapter is structured as follows: section 2 reviews the existing literature related to peer effects and the ethno-linguistic fractionalization index. Section 3 describes the empirical framework and provides descriptive statistics. Section 4 presents the main results, and section 5 discusses the conclusions that can be drawn from these results.

Peers look alike and act the same

Being part of a group is not random

One of the main challenges reported in the peer literature arises in the estimation and identification of the peer effect. Indeed, that a group of students is high-achieving might be an effect of belonging to the group, but could also potentially be a reason for belonging to it (Hanushek *et al.*, 2003; Hoxby, 2000). Manski (1993) explicitly provides the three main reasons explaining why individuals belonging to the same group tend to behave similarly: (i) the endogenous interactions from the self-selection of individuals into groups which makes it difficult to isolate the peer effect from the selection effect itself, (ii) exogenous effects (or contextual interactions) driven by the exogeneous characteristics of the group members and (iii) the simultaneous effect of peers on individuals and vice versa. These factors present the challenge in peer analysis of how to isolate the peer effect from other confounding factors (Hanushek *et al.*, 2003; Sacerdote, 2014). In this chapter, the self-selection of pupils into groups is less of a problem given that peers are defined as grade-mates. However, the major challenge in the sample used in this work is the selection bias at the school level. When studying peer effect for students or pupils, a major potential bias is that "families tend to self-select themselves into schools based on their income, job locations, residential preferences and educational preferences" (Hoxby, 2000). Therefore, the formation of groups in an educational environment is typically not random. In the Kenyan context, the self-selection of pupils into schools has been discussed in Chapters 2 and 3. Parents' school choice is largely determined by school characteristics and school quality. Consequently, pupils within a same school share common (observable and unobservable) characteristics. Failing to account for this endogeneity bias would inevitably result in biased peer effects estimates.

In many fields, such as in social science studies, endogeneity bias is usually not taken formally into account, leading to a high risk of overestimating the effect (Van Ewijk and Sleegers, 2010a). As a consequence, peer effects may be artifacts of a specification that is poorly controlled for endogeneity bias (Evans *et al.*, 1992). In the field of economics, authors use different types of identification strategy to address endogeneity, such as quasi-experimental random allocation, within-school variations, or instrumental variables. The endogeneity bias and the identification strategy used for this research will be discussed in more detail in the methodology section.

Peer effects observed in educational contexts

The literature on peer effects in school contexts and amongst youth is quite extensive. Peers' decisions and/or the influence of peer characteristics have been investigated mainly in two areas, education and health. Health outcomes in the school context mostly include health and social

decisions such as drinking or sexual behavior. For instance, Fletcher (2012) reports a significant peer effect on students' alcohol consumption. He shows that an increase in the proportion of classmates who drink, influences undergraduate students' personal alcohol-use decisions and increases their likelihood to drink. The author uses survey data administered to adolescents on their alcohol consumption and compares students from different grades within the same high school. Using a combined instrumental variables/school fixed effect approach to control for endogeneity bias, he reports that a 10% increase in peers' alcohol consumption increases by 5.8 percentage points the student's consumption. Thus, an increase in the proportion of peers who drink is positively related with individual alcohol consumption. Similarly, Duncan *et al.* (2005) find a significant roommate's effect on male students' binge-drinking behavior. Their identification strategy relies on roommate's random assignment and drinking behavior history. The findings are not supported for the female sample or when using drug use and sexual intercourse engagement as alternative outcomes. Similarly, Evans *et al.* (1992) use the (log) percentage of students in the respondent's school who were classified as economically disadvantaged as a proxy for the peer group effect. Their objective is to measure a possible peer effect on the likelihood of being sexually active and/or pregnant at school. The OLS specification findings suggest that being in a school with a 25 percentage points higher proportion of disadvantaged student increases the probability of being pregnant by 1.7 percentage points. However, after using instrumental variables to account for the endogeneity of the peer group, the effect vanishes.

With regard to educational outcomes, many authors argue that peer composition is an important determinant of student achievement (Sacerdote, 2000). A large and growing literature exploring the impact of peers' characteristics on pupils' own achievements suggests that several factors such as peers' SES, peers' gender, or peers' parental education are correlated and influence pupils' own achievements (McEwan, 2003; Van Ewijk and Sleegers, 2010a; Whitmore, 2005). Moreover, several studies show that being surrounded by peers with higher scores increases pupil's performance. Hanushek *et al.* (2003) use a panel data set and school-by-grade fixed effects to isolate the impact of increases in peers' scores on a pupil's own performance. They conclude that peer achievement has a positive effect on achievement growth. A 1 SD increase in peer achievement is associated with a .02 SD increase in own achievement. Moreover, they show that students in lower levels of the distribution are more sensitive to and benefit more than higher-achieving students.

Using a natural experiment randomly assigning college roommates, Sacerdote (2000) finds that higher peer scores increase a student's Grade Point Average (GPA). His estimates suggest that a 1 SD increase in roommate GPA is associated with a .05 SD increase in own GPA. Furthermore, his work suggests that roommates influence decisions to join social organizations as well. Using the same identification strategy, that is, first year random roommates' assignment in college housing, Zimmerman (2003) concludes that there is a small but significant positive peer effect on individual grades. His work shows that peer effects are stronger on verbal scores than on math scores. He finds that a 100-point increment in a roommate's verbal SAT score translates into a .03 increase in the student's GPA. Carrell *et al.* (2009) use the random assignment of the United States

Air Force Academy students to military squadrons to remove potential self-selection bias and measure peer effect on academic performance. They use the proportion of peers belonging to a certain distribution range of scores to estimate different peer coefficients. They find that peers scores impact positively and significantly student scores. Especially, students at the bottom of the distribution are positively and significantly impacted when they are surrounded by peers with higher scores. Nonetheless, group homogeneity may interfere if low performers align themselves with other lower performers, in which case their scores would be negatively impacted (Carrell *et al.*, 2013). Lastly, Duflo *et al.* (2011), using data from a randomized experiment in Kenya in 2005, isolate the peer effect from the random allocation of pupils into peer groups and using school fixed effects. They report that a 1 SD increase in peer achievement increases student's test score by .35 SD. In addition, they show that, in the Kenyan classroom context, this peer effect is also influenced by adjustment of teachers' behavior to the class composition.

Ethnicity and language as peer-effect channels

Ethnicity and language have each been used in the peer literature as a channel through which peer effects operate. Using the fact that people tend to be much more connected to those from the same ethnic community and who speak the same home language, Bertrand *et al.* (2000) use the number of people sharing a similar home language in the area as a proxy for contact availability, i.e network size. The network effect is measured as the interaction of the size and quality of the network, the latter being measured by welfare participation in respective home language groups. Using the same methodology, Burns *et al.* (2010) use age-language cohorts as a measure of network to estimate the impact of social network on employment in South Africa. Similarly, Mukong (2017) uses language composition at the district level to isolate the peer network effect on the decision to smoke amongst youth in South Africa.

Racial and ethnic composition in the school environment has been studied as well. Authors explored variations in peers' racial composition in the school environment and its possible influence on educational outcomes or on social behavior. For instance, Boisjoly *et al.* (2006) used randomly-assigned roommates in first-year college to study whether attitudes and behaviors towards affirmative action change when people from different races share a room. Despite a limited sample size, they observed significant results and found that mixing students from different racial groups tended to make individuals more empathetic to minority students. Students who were assigned black roommates were more inclined to endorse affirmative action and to interact with students from a different racial group. Following a change in the busing system in North Carolina, resulting in a reallocation of students into schools, Billings *et al.* (2013) compared students from the same neighborhood but attending high schools with different percentages of pupils from minorities. They find that a 10-percentage point increase in the proportion of minority students at a school decreases students' test scores by .014 SD. In addition, graduation rates for students who are not part of the minority are negatively impacted when they are in schools with a higher

proportion of minority students. Minority students, however, do not experience a decrease in graduation rate. Using a similar methodology in a desegregation program in Boston, Angrist and Lang (2004) found contradictory results. Their work does not provide any support for the contention that an increase in students from an ethnic minority would negatively impact white students' scores. However, there is some evidence that amongst blacks, and especially for girls, increasing the minority fraction impacts scores negatively. Hanushek *et al.* (2002) investigate the impact of racial composition on school achievement. They used panel data from a school project in Texas with a combination of fixed effects to account for self-selection and other unobserved variables. Their findings show that a higher proportion of black schoolmates negatively impacts a black student's mathematic achievement, especially for high-ability black students. The effect on low achievers and non-black students is much smaller. Similarly, Hoxby (2000) studied the variations in racial composition, comparing different cohorts within schools as identification strategy, to tease out the impact of the cohort composition on individuals' achievement. She finds a stronger peer effect within the same race, especially amongst blacks. A 10-percentage point increase in the proportion of black students in the classroom is associated with a .25 point decrease in black students' reading scores, against a less than .1 decrease for students from other races. Finally, Hoxby and Weingarth (2005) estimate peer-effects models based on a change in policy intending to balance racial composition by reassigning pupils to schools. Their work shows that own-race peers' achievement is a greater determinant of scores, especially for black and Hispanic students. However, they conclude that, after accounting properly for peers' school achievement, peers' race or ethnicity do not matter much or at most have a very slight effect.

Outside the American school context, Gould *et al.* (2009) use a mass migration wave from the Soviet Union to Israel in the 1990s to measure the impact of a change in classroom composition on long-term educational outcomes. The identification strategy relies on migrants' children newly enrolled in schools and uses random variation in the number of immigrants across grades within the same school to measure the impact on native pupils' achievement. They find that an increase of immigrants by 10 percentage points increases the dropout rate by more than .3 percentage points for native pupils. Moreover, it decreases native pupil's matriculation rate by more than 1.5 percentage points.

Evidence of an exogeneous peer effect from pupils' ethnicity in the context of developing countries is even more limited (Van Ewijk and Sleegers, 2010b). So far, there appears to be only one study in economics exploring the relationship between peers' ethnicity and achievement. Using a census of eight graders in Chile, McEwan (2003) relies upon using school fixed effects to address the endogeneity issue of peer variables. As previously discussed, a major concern in identifying peer effects is the self-selection of peers into schools. Using within-school variation considerably reduces such a selection bias. McEwan (2003) uses cross-sectional data, including different classrooms within schools. He concludes that peers' mothers' education is the most important peer determinant of achievement. Moreover, he finds that the percentage of indigenous students (non-native speakers of Spanish) in a classroom is negatively correlated with achievement. This effect

is small but significant. According to his estimates, a 1 SD increase in the proportion of indigenous students in the classroom decreases Spanish achievement by 0.03 SD.

Outside the field of economics, even though the existing literature tends to suggest that having a high proportion of ethnic minority students may lead to negative educational outcomes, the ethnic composition effects on test scores appear small in general (Van Ewijk and Sleegers, 2010b). Moreover, research in other fields often shows a lack of a proper methodology to address endogeneity bias, and effects may therefore come from research artifacts (Van Ewijk and Sleegers, 2010b). On the other hand, this literature also includes studies on peers' ethnic composition as a potential vehicle for victimization. Interestingly, some authors suggest that greater diversity may to a certain extend reduce victimization because "students belong to one of many ethnic groups who share a balance of power" (Graham, 2006). In other words, the number of members in each group increases or decreases the power of the group, which determines the likelihood of suffering from or perpetrating victimization (Graham, 2006). Students who are part of a minority group especially tend to be more affected by victimization than students who are part of the dominant group (Agirdag *et al.*, 2011). As a result of victimization, pupils' achievement is negatively affected because of a reduced motivation and an increase in absenteeism and the dropout rate (Buhs, 2006).

Most of these studies tend to associate diversity with negative educational outcomes. In their meta-analysis of peer achievement and ethnicity, Van Ewijk and Sleegers (2010b) offer reasons why student would perform worse as the ethnic diversity increases into four groups: *direct peer interaction, teacher practice, school quality and research artifacts*.[73] The latter group emphasizes on pupils' characteristics in schools with a higher proportion of ethnic minority students. Indeed, pupils attending ethnically diverse schools may have specific attributes that are negatively related to achievement. In which case the negative outcomes would not be driven by ethnic diversity per se but by other attributes that are correlated with ethnic diversity.

Ethno-Linguistic fractionalization

Other than peer effects, economists have explored the impact that ethno-linguistic diversity may have on macro-economic outcomes, such as economic growth, quality of institution, or the provision of public goods. For this, they rely on an ethno-linguistic fractionalization index, often referred to as ELF, which reflects the probability that two randomly selected individuals from a population belong to different ethno-linguistic groups. Alesina *et al.* (1999) found that even after controlling for other socioeconomic determinants, higher diversity is associated with a lower

[73] Direct peer interactions are linked to ethnicity through possible tensions between ethnic groups or because of minority use of a different mother tongue to the majority's language. Secondly, teachers may adjust their teaching style to the pupil's ethnic composition. Similarly, teachers and school quality might be confounded with the proportion of pupils from minorities. Lastly, pupils' characteristics in schools with a higher proportion of ethnic minority students might be negatively related to achievement. For further details on this, please refer to Van Ewijk and Sleegers (2010b).

quality of public goods provision such as roads, libraries, and education in US municipalities. More recently, in a cross-country analysis, comparing about 190 countries, ethnic and linguistic fractionalization were found to be negatively associated with economic growth and the quality of public institutions (Alesina *et al.*, 2003). As in the peer-effects literature, a challenge with the ELF measure is to isolate its effect from other confounding factors. Indeed, ELF may be correlated with other omitted factors, leading to a bias in estimates. For instance, several authors show that, after adding controls, ELF loses significance (Alesina *et al.*, 2003). Furthermore, Alesina *et al.* (2003) highlight the difficulty of estimating the size of the effect owing to the correlation between ELF and other explanatory variables. The literature on ethno-linguistic diversity at the micro level, such as in the school environment, is limited. A study from Miguel (2001) explores the relationship between ethnic diversity and local primary school funding in rural western Kenya. Using local residential ethnic composition as an instrumental variable to account for sorting into schools, he finds that higher school ethnic diversity is associated with lower funding and worse school facilities. Interestingly, Miguel (2001) makes the assumption that in geographical areas of high ethnic diversity, better-quality schools may attract pupils from diverse ethnic groups because parents from the surrounding areas may choose to send their pupils to these particular schools despite the distance. His work confirms this pattern, suggesting that diversity may in some instances be correlated with higher attributes of a school.

This chapter contributes to the number of empirical works examining peer effects on school achievement and the literature on the ethnic composition including ELF index. An extensive literature explores the relationship between peers' characteristics and educational achievement. However, not much has been done in the African context on peers' linguistic composition. This field remain largely underexplored. This chapter investigates the effect of peers' characteristics, including peers' home language diversity, on achievement. One of the main challenges is in the estimation and identification of the peer effect. Especially in the case of Kenya, selection bias at the school level is a major risk, as discussed in previous chapters. Differences can be expected between schools attended by ethnically diverse pupils. Furthermore, school choice and peer composition, including peers' language homogeneity may affect classroom instruction (Hanushek *et al.*, 2003; Taylor and von Fintel, 2016). A rigorous methodology has to be used to overcome potential selection bias issues. This will be discussed in the next section.

Empirical model

Identification strategy: overcoming the endogenous bias

As previously discussed, one of the main challenges in the peer and the ethno-linguistic diversity literature is the risk of endogeneity. Individuals tend to self-segregate into groups, with families choosing their residences or their schools based on observed characteristics of potential peer groups (Evans *et al.*, 1992; Hoxby, 2000). When a "correlation between one individual and the group (or peers) is found, it is very difficult to disentangle the self-selection effect from the actual causal peer effect" (Sacerdote, 2014). Many authors describe potential bias resulting from endogeneity and omitted variables in estimating peer effects, but only a few effectively account for it in their models (Van Ewijk and Sleegers, 2010a). Some authors acknowledge that peer effects identified in their work might suffer self-selection bias. For instance, Case and Katz (1991) admit that their findings may be the result of the way families sort themselves into communities. Therefore, using an OLS approach has some methodological limitations.

The first major challenge is to differentiate selection effects from actual peer effects. As previously discussed, the allocation of individuals into schools is not random and, in the case of Kenya, selection effects at the school level are confirmed by many authors (Miguel, 2001; Zuilkowski *et al.*, 2018). Language might be a criterion of selection. Therefore, the difficulty lies in estimating the effect of diversity and isolating this effect from other confounding factors. To address the self-selection issue and reduce endogeneity bias between linguistic diversity and the outcome variable, the identification strategy hinges upon the existence of between-grades within-school variations in grade-mates' linguistic characteristics. Indeed, parents may choose a specific school for their children based on specific school attributes, including peers' characteristics and other non-observable factors such as motivation or the perceived quality of the school. In such instances, the error term is correlated with school attributes, which is the same for all pupils within a same school. Using school fixed effects considerably reduces potential bias due to unobservables and to endogeneity issues at the school level (Fletcher, 2012; Hanushek *et al.*, 2003; Hoxby, 2000; McEwan, 2003).

The dataset used for this research initially included 2,093 Grade 1 pupils (for more details on the dataset, please refer to Chapter 2). Grade 1 pupils were dropped from the analysis in Chapters 3 and 4 because of the limited variability in the literacy skills acquired in the first year of instruction. Nonetheless, the Grade 1 pupils' sample is of interest in Chapter 5. To disentangle peer effects from other confounding factors, an exogenous variation is needed within schools. By using the variations in language composition between grades (Grade 1 and Grade 2), the proper endogenous interaction linked to the linguistic fractionalization at school can be identified. School fixed effects are used to limit selection bias. The analysis is based on a sample of about 20 pupils randomly selected from Grade 1 and Grade 2 (about 10 from each grade level) within each school. Grade-

mates' language diversity is computed using a Linguistic Fractionalization Index, which is detailed in the next sub-section.

Econometric model

The linear-in-means model defined by Manski (1993) is used with school fixed effects to limit endogeneity bias and peers' unobservables (Fletcher, 2012; Hanushek *et al.*, 2003; Hoxby, 2000; McEwan, 2003). Standardized scores in Kiswahili and English are generated following the methodology given in Chapter 3 but for a larger sample including grade 1 pupils and pupils who speak English at home.[74] Scores are used as dependent variables in the model alternatively. For each pupil, a variable corresponding to grade-mates' scores in Kiswahili and English (minus *i*) within the school is generated. Individual variables, including the pupil's grade, are used as controls as well. The initial model for the effect of peers scores on the score achievement of pupil *i* in grade *j* in school *s* is defined as:

$$Yijs = Xijs\,\beta + Lijs\,\theta + \bar{Y}(-ijs)\delta + S\,\lambda + \varepsilon_{ijs} \qquad (1)$$

where *Yijs* is the score in Kiswahili or in English of individual *i* in grade *j* in school *s*, *X* includes the individual and family characteristics of individual *i*, *L* is the home language dummy variable to control for unobserved language-group-specific characteristics, $\bar{Y}$ *(−ijs)* is the grade-mates' score in Kiswahili or in English (excluding the individual *i*) and *S* the school fixed effects; ε is the error term.

In this chapter, language diversity is measured using a Linguistic Fractionalization Index (LFI). Following Alesina *et al.* (1999), the index is defined as one minus the Herfindahl index. The Herfindahl index gives the probability of selecting randomly two individuals belonging to different linguistic groups in a given grade. This index computes the linguistic group shares at the school-grade level as follow:

$$LFI_{js} = 1 - \sum_{k=1}^{N} {S_{kjs}}^2$$

[74] As a reminder, grade 1 pupils were not part of the sample in Chapters 3 and 4 because the variation in their score is limited as they have only received a year of instruction. English speakers were removed as well to limit possible bias, as detailed in Chapter 2. In this chapter, the variability and level of scores is less of a concern, rather the potential interaction between linguistic diversity and scores is of interest. Therefore, using the grade 1 sample should not affect our results.

Where S_{kjs} is the share of linguistic group *k* (*k* =1...N) in grade *j* in school *s*. In a grade which is fully homogeneous, i.e all pupils are from the same linguistic group, LFI_{js} would equals 0. As heterogeneity increases, LFI_{js} would increase towards 1.

For each pupil, a variable corresponding to the language diversity of grade-mates within the school is generated. The LFI index is calculated for each individual minus *i*. The econometric model for the combined effect of peers' quality and diversity on the score achievement of pupil *i* in grade *j* in school *s* is defined as:

$$Yijs = Xijs\,\beta + Lijs\,\theta + \bar{Y}(-ijs)\delta + LFI(-ijs)\alpha + \bar{Y}(-ijs)\,\mathrm{x}\,LFI(-ijs)\mu + S\,\lambda + \varepsilon_{ijs} \quad (2)$$

where *Yijs* is the score in Kiswahili or in English of individual *i* in grade *j* in school *s*, *X* includes the individual and family characteristics of individual *i*, *L* is the home language dummy variable to control for unobserved language-group-specific characteristics, $\bar{Y}$ *(−ijs)* is the grade-mates' score in Kiswahili or in English (excluding the individual *i*), *LFI(−ijs)*[75] is the grade-mates' linguistic diversity (excluding the individual *i*), $\bar{Y}(-ijs)\,\mathrm{x}\,LFI(-ijs)$ is the interaction term between grade-mates' scores and grade-mates' linguistic diversity and *S* the school fixed effects; ε is the error term.

Three coefficients are of interest: α indicates the extent to which pupils' scores are influenced by their peers' home language diversity, δ reflects the effect of peers' scores on pupils' own scores, which corresponds to peers' quality effect. μ is the peer effect combining peers' quality and peers' linguistic diversity. Parameters of interest for both Kiswahili and English scores are compared. The peer language diversity effect is expected to be much stronger on Kiswahili scores and far less (or even nonexistent) on English scores. Indeed, most pupils learn English at school,[76] whereas Kiswahili is the home language for a majority of the sample. Therefore, language diversity in the classroom may impact the use of Kiswahili within the classroom for two reasons. First, it is the home language for some pupils, and secondly it might be the only common language that pupils from diverse background can use to understand each other. Moreover, pupils who speak a common language are more likely to spend time together and, given the limited number of pupils using English as a home language, a strong peer influence from native English speakers is not expected.

Using a similar approach to model (2), an alternative model is tested. Some authors use the proportion of peers from a certain minority group to search for a possible peer ethnicity impact.

[75] Because in some schools LFI=0, the LFI variable is transformed in the regressions as follows: LFI= (ln(LFI+1)+1).
[76] This is not true for the entire sample as some English speakers are included in the sample.

This alternative is further investigated in this chapter. The (log) proportion of pupils who speak Kiswahili as their home language is used in place of the LFI. Model (3) is defined as:

$$Yijs = Xijs\,\beta + Lijs\,\theta + \bar{Y}(-ijs)\delta + KP(-ijs)\alpha + \bar{Y}(-ijs)\,\mathrm{x}\,KP(-ijs)\mu + S\,\lambda + \varepsilon_{ijs} \quad (3)$$

where *Yijs* is the score in Kiswahili or in English of individual *i* in grade *j* in school *s*, *X* includes the individual and family characteristics of individual *i*, *L* is the home language dummy variable, $\bar{Y}$ *(−ijs)* is the grade-mates' score in Kiswahili or in English (excluding the individual *i*), *KP(−ijs)*[77] is the percentage of grade-mates who are Kiswahili home-speakers (excluding the individual *i*), $\bar{Y}(-ijs)\,\mathrm{x}\,KP(-ijs)$ is the interaction term between grade-mates' score and grade-mates' proportion of Kiswahili speakers and *S* is the school fixed effects; ε is the error term.

Estimation issues

Nonetheless, the use of school fixed effects has some limitations. First, "estimates can only be obtained if there is within-school variation in the peer group characteristics" (McEwan, 2003). Secondly, a fixed effects approach is the removal of all between-school variations which may reduce the variance in peer variables and leave too little actual variation in peer group characteristics to estimate the peer effect (Hanushek *et al.*, 2003). Furthermore, a school fixed effects approach controls for selection effects at the school level. However, it does not control for peers' interactions at school (self-selection into sub-groups) or how interactions outside the school can affect a child's performance (Hanushek *et al.*, 2003). No information on friends and peers' interactions in or out of school is available. Consequently, a potential shortcoming in this study is that it is not possible to identify specifically which peers pupils engage with. It is assumed that pupils in the classroom are peers. At the very least, these are the peers they are surrounded by as they learn. However, in reality this definition might be too restrictive. For instance, language is potentially a factor of self-selection into smaller groups on the playground or in the classroom given that pupils might become closer to other pupils sharing the same home language.

Another potential limitation is that the number of peers in the classroom is not controlled for. Indeed, the effect of diversity in a class of 20 may be different from the effect of diversity in a class of 50. The total number of pupils in the classroom is not available, and therefore cannot be controlled for.[78] In addition, one assumption is that the ten pupils randomly selected per grade in each school are representative of the language composition of the respective grade population. The sample does not provide an exhaustive measure of the grades' language composition and might

[77] Because in some schools the proportion of Kiswahili speakers is 0, the KP variable is transformed in the regressions as follows: KP= (ln(KP+1)+1).

[78] In 2014, the average class size in public primary schools in Kenya was 36 (MOEST, 2014).

differ if it was estimated from a bigger sample of pupils. In such cases, the results could be biased because the pupil would not be exposed to the peer linguistic diversity identified in this work. The sample is stratified by gender and grade, not by linguistic group. However, pupils were randomly selected. This should prevent possible interference between pupils' linguistic characteristics and the probability of being selected for the interviews. Lastly, several authors suggest that the linear-in-means model imposes strict assumptions which may not be appropriate for identifying non-linear peer effects (Hoxby and Weingarth, 2005).

Descriptive Statistics

Linguistic diversity in urban Kenyan schools

Table 24 provides details of the independent variables used in the analysis. This includes home language groups, assessment scores, and peers' characteristics. Five linguistic groups are included in this chapter. As well as the three home language groups defined in previous chapters (Swahili, Semi- and Non-Swahili pupils), two additional language groups are included for pupils who speak English at home. The category 'Semi-English and Swahili pupils' includes pupils who speak both languages at home and English-only pupils are those who use English as their unique home language. As shown in Table 24, Semi-English and Swahili pupils and English-only pupils represent less than 10% of the sample. Pupils who speak only Kiswahili at home are in the majority and represent 61% of the sample. Individual scores in Kiswahili and English are standardized to a mean of zero and a SD of 1.[79] The procedure for standardizing the scores is explained in further detail in Chapter 2.

Peer variables are constructed by averaging grade-mates' variables (own information being excluded from the calculation) within schools. Table 24 summarizes the peer variables used in the results section. The Linguistic Fractionalization Index, which measure peers' diversity within grades of the schools, is of particular interest in this chapter. LFI ranges between 0 and 1, 0 being a fully linguistically homogeneous classroom. On average, the LFI is equal to 0.4, meaning that pupils are in classroom with some diversity but with a dominant linguistic group. This is not surprising given the overall linguistic composition of the sample. Further information on the LFI distribution is provided in Table 25. As expected, peer variables, such as peer scores or the peer wealth index, mostly reflect average individual characteristics, as described in Chapter 2, Table 4. Similarly, individual and school variables have been defined and discussed in Chapter 2, and are therefore not displayed in Table 24.

[79] The table present weighted data for sub-groups which is the reason why the mean and the SD are slightly different from 0 and 1.

Table 24: Weighted Descriptive statistics

Variables	Mean	SD	N	Min	Max
Language and scores variables					
Swahili pupils	0.61	0.49	3442	0	1
Semi-Swahili	0.12	0.32	3442	0	1
Non-Swahili	0.18	0.38	3442	0	1
Semi-English&Swahili	0.05	0.21	3442	0	1
English only pupils	0.05	0.22	3442	0	1
Kiswahili - total literacy score	-0.03	0.96	3442	-1.66	2.62
English - total literacy score	-0.01	0.97	3442	-1.74	2.52
Peer variables					
Peer linguistic fractionalization index (minus i)	0.40	0.21	3440	0	0.79
Peer Swahili pupils (minus i)	0.61	0.28	3440	0	1
Peer Kiswahili score (classroom minus i)	-0.03	0.60	3440	-1.46	1.95
Peer English score (classroom minus i)	-0.01	0.65	3440	-1.65	2.05
Peer gender (female=1)	0.51	0.07	3440	0	1
Peer age	7.44	0.72	3435	5.57	10.44
Peer enrolled at school since January	0.88	0.15	3440	0.22	1
Peer attended pre-school	0.91	0.16	3425	0	1
Peer repeated G2	0.06	0.10	3420	0	0.75
Peer attendance interrupted (previous year)	0.28	0.21	3350	0	1
Peer wealth index	0.08	0.84	3422	-2.27	2.68
Peer English books at home	0.69	0.22	3438	0	1
Peer Kiswahili books at home	0.61	0.23	3438	0	1

Sources: Midterm evaluation data - PRIMR initiative. Notes: (1) weighted data.

Table 25 provides summary statistics for the main variable of interest, the Linguistic Fractionalization Index. As stated above, the LFI mean is .40[80] and the LFI median is .45. Nonetheless, much more variation can be observed in the LFI distribution across the sample. Indeed, 10% of the sample is made up of pupils whose peers' linguistic diversity is equal to 0, meaning that all peers in the classroom belong to the same linguistic group, in other words, peers are linguistically homogeneous. Only five schools (2.7% of the sample) have a perfect homogeneity, meaning that all pupils in the schools are from the same linguistic group.[81] Conversely, many peer groups are linguistically diverse, with an LFI larger than 0.5. For the full index distribution, please refer to Appendix L.

[80] In his work, Miguel (2001) finds a mean ELF of .48 in rural areas in Kenya.

[81] In these schools, there is no variation in LFI within the school. Nonetheless, given that these schools represent less than 3% of the sample, the full sample is used for the rest of this chapter. A robustness check dropping these schools was performed to ensure that results were qualitatively the same. The set of results can be found in Appendix N.

Table 25: Linguistic Fractionalization Index summary statistics

Percentiles	LFI (minus i)
1%	0
5%	0
10%	0
25%	0.20
50%	0.45
75%	0.59
90%	0.64
95%	0.69
99%	0.74
Obs	3440.00
Mean	0.40
Std. Dev.	0.21

Sources: Authors own calculation

The main empirical strategy hinges upon the existence of within-school LFI variation between grade 1 and grade 2. Indeed, the inclusion of school fixed effects removes between-school variation. The variation in language composition between grades (Grade 1 and Grade 2), is used as an exogeneous variation within schools to facilitate the identification of peer effects. Therefore, within-school variation has to be sufficient to detect peer effects.[82] The within-school standard deviation for LFI is .122, compared to a standard deviation of .211 in the full sample, meaning that around 33% of the variance occurs within schools.

Exogenous linguistic diversity within schools

A second assumption in the identification strategy is that LFI variations between grades should be exogeneous. A clear change in the school policy could impact the linguistic composition but the risk is small, especially as data comes from the same school year for both grades. Another possible reason for LFI variations between grades would be if some language groups repeat a grade more frequently than others. To a certain extent, Chapter 3 showed that non-Swahili and semi-Swahili pupils are more at risk of having to repeat even though the number of repeaters is very small (less than 6% in the sample). To confirm that between-grade variation is not a major threat for this work, Table 26 looks at the differences in linguistic group proportion by grade. Only one linguistic group, the English-only group, has a proportion which differs significantly between grade 1 and 2. However, this is the smallest group and therefore variation in it should not be a major threat to the study. Furthermore, the LFI computes linguistic diversity with all groups combined. A robustness check will be performed excluding this language group to further validate the results.

[82] For more details on this, please refer to the data section in McEwan (2003).

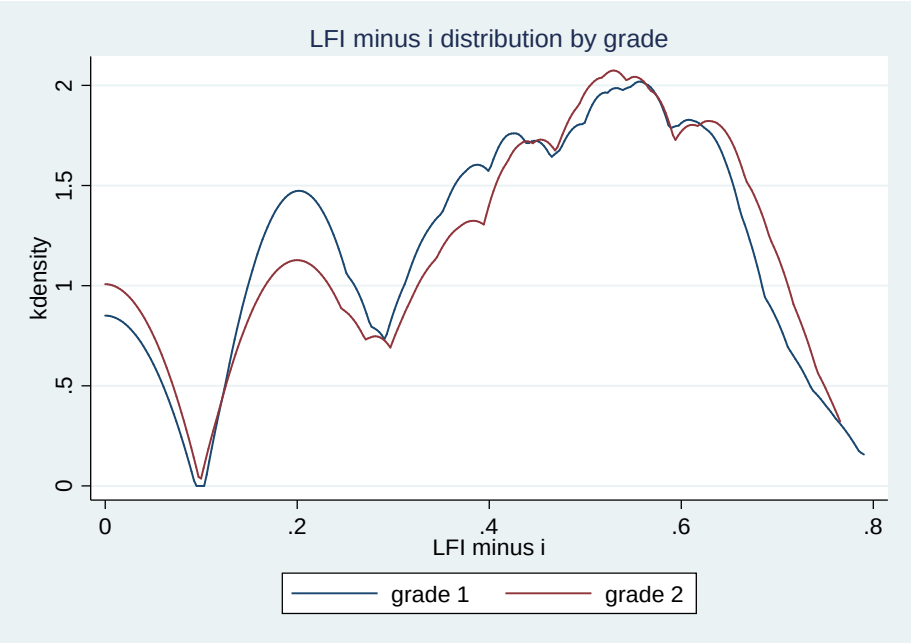
Table 26: Linguistic groups per grade summary statistics

	Grade 2			Grade 1				
Groups	MEAN	SD	N	MEAN	SD	N	Difference	
Swahili pupils	0.615	0.487	1717	0.6	0.49	1725	0.015	
Semi-Swahili pupils	0.116	0.32	1717	0.119	0.324	1725	-0.003	
Non-Swahili pupils	0.188	0.391	1717	0.17	0.376	1725	0.018	
Semi-English&Swahili pupils	0.044	0.204	1717	0.051	0.219	1725	-0.007	
English only pupils	0.038	0.19	1717	0.061	0.239	1725	-0.023	**

*Note: level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01*

To ensure that the assumption of exogeneity is consistent, the LFI distribution across the grades is verified to make sure it is equally distributed between grades. Figure 8 shows the LFI distribution by grade. The two patterns are similar and the difference in mean (not displayed) does not show any statistically significant difference.

Figure 8: LFI distribution by grade



Sources: Own calculations based on Midterm evaluation data - PRIMR initiative.

Table 27 presents the summary statistics of peer variables for schools with low and high linguistic fractionalization separately. Schools with low linguistic fractionalization include schools with an LFI less than the median (.45) and schools with a high linguistic fractionalization include schools which are much more diverse (LFI higher than .45). The statistics are reported with information on the statistical significance (t-test) of the observed differences between the two groups.

Table 27: Peer characteristics in schools with low and high linguistic fractionalization

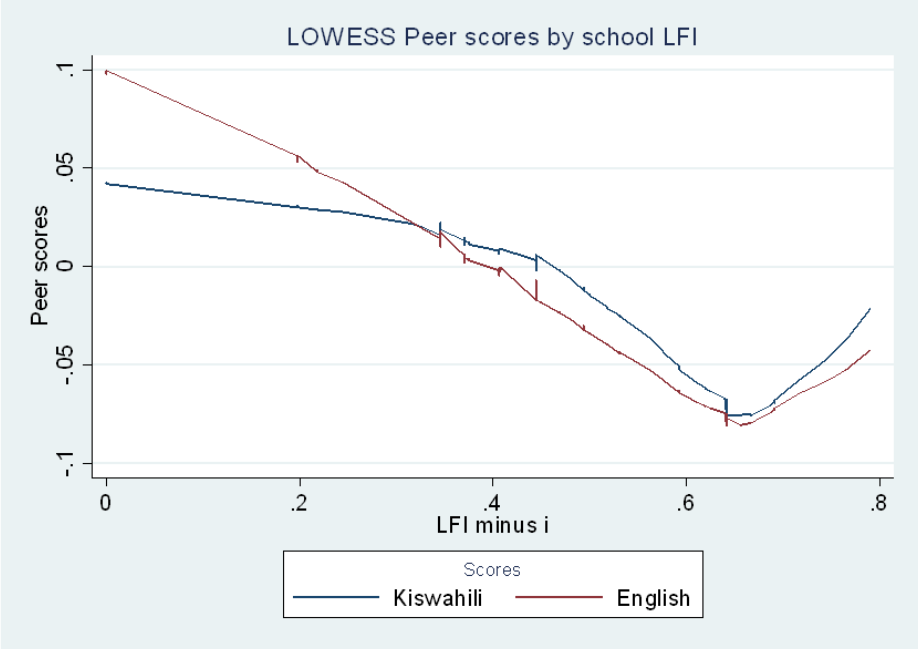
	Low LFI (LFI<.45)			High LFI (LFI>.45)				
Peer variables (classroom minus i)	Mean	SD	N	Mean	SD	N	Difference	
Peer linguistic fractionalization index (individual level)	0.243	0.179	1714	0.535	0.135	1726	0.292	***
% of Swahili pupils peer	0.786	0.234	1714	0.462	0.219	1726	-0.324	***
Peer Kiswahili score	0.043	0.591	1714	-0.093	0.592	1726	-0.135	**
Peer English score	0.108	0.634	1714	-0.105	0.643	1726	-0.213	***
Peer gender (female=1)	0.506	0.083	1714	0.506	0.067	1726	-0.001	
Peer age	7.316	0.664	1710	7.542	0.746	1725	0.226	***
Peer enrolled at school since January	0.872	0.146	1714	0.88	0.147	1726	0.008	
Peer attended pre-school	0.89	0.173	1707	0.93	0.139	1718	0.039	*
Peer repeated G2	0.056	0.09	1705	0.069	0.103	1715	0.013	
Peer attendance interrupted (previous year)	0.274	0.229	1664	0.275	0.196	1686	0.002	
Peer wealth index	0.043	0.735	1710	0.108	0.917	1712	0.065	
Peer English books at home	0.687	0.222	1713	0.684	0.208	1725	-0.003	
Peer Kiswahili books at home	0.587	0.239	1712	0.631	0.226	1726	0.044	

*Note: (1) schools with low linguistic fractionalization include schools with a LFI less than the median (.45) and schools with high linguistic fractionalization include schools with a LFI higher than the median and (2) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01.*

Unsurprisingly, the peer linguistic fractionalization at the individual level is higher in schools with higher linguistic diversity. This is true for the proportion of Swahili pupils as well. The proportion of Swahili pupils is significantly higher in low diversity schools. Moreover, results show that peer scores in Kiswahili and in English are significantly lower in schools with higher linguistic diversity. In other words, higher linguistic fractionalization at schools is associated with lower peer test score quality. Regarding other peer characteristics, age and pre-school attendance are the only two variables which significantly differ between schools with low and with high linguistic fractionalization. Indeed, in schools with high linguistic diversity, peers are significantly older and attended pre-school in a significantly higher proportion.

Figure 9 investigates further the distribution of Kiswahili and English peer scores by a school's linguistic diversity. Overall, both distributions highlight a potential discriminating effect for attending schools with a more diverse linguistic composition. The higher the LFI is, the lower the peer scores are (except at the extreme top of the distribution). This holds true for scores in both Kiswahili and English.

Figure 9: Kiswahili and English scores in schools with low and high linguistic fractionalization



Sources: Own calculations based on Midterm evaluation data - PRIMR initiative.

Last, differences between high and low achieving pupils are investigated further in

Table 28. LFI, peer scores and peer scores' standard deviation summary statistics are presented separately for pupils achieving above and below average (respectively to their grade).

Table 28: Peer scores and LFI summary statistics for low and high achieving pupils

	Kiswahili scores							English scores						
	High achiever (above average)			Low achiever (below average)				High achiever (above average)			Low achiever (below average)			
	Mean	SD	N	Mean	SD	N	Difference	Mean	SD	N	Mean	SD	N	Difference
LFI (minus i)	0.393	0.213	1721	0.414	0.214	1719	-0.02 *	0.382	0.22	1764	0.426	0.205	1676	-0.04 ***
Peer Kiswahili scores (minus i)	0.171	0.595	1721	-0.217	0.531	1719	0.388 ***	0.174	0.568	1764	-0.237	0.55	1676	0.411 ***
Standard Deviation Peer Kiswahili scores	0.776	0.199	1721	0.758	0.204	1719	0.019 *	0.777	0.197	1764	0.756	0.206	1676	0.022 *
Peer English scores (minus i)	0.188	0.602	1721	-0.19	0.635	1719	0.377 ***	0.256	0.568	1764	-0.274	0.613	1676	0.529 ***
Standard Deviation Peer English scores	0.735	0.208	1721	0.751	0.203	1719	-0.02	0.742	0.206	1764	0.745	0.204	1676	-0

*Notes: (1) pupil scoring above average is defined as a pupil scoring above the grade average score in Kiswahili, (2) pupil scoring below average is defined as a pupil scoring below the grade average score in Kiswahili and (3) level of significance for the differences: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01.*

As shown in Table 28, peer scores are significantly higher in Kiswahili and in English and the LFI is smaller for pupils scoring above average (high achievers) in comparison to pupils scoring below average (low achievers). This suggests that low achieving pupils are surrounded by peers who are more linguistically diverse and have lower scores. There is also a significant difference in peer scores' standard deviation in Kiswahili which is significantly higher for high achievers. This doesn't hold true for English scores' standard deviation.

Nonetheless, and as discussed in the literature section, several confounding factors at the school level, and especially in the self-selection of pupils into schools, may explain why higher linguistic fractionalization is associated with lower peer scores. For instance, if higher-quality schools tend to attract pupils from a less diversified linguistic background, pupils in these schools will achieve higher scores because they attend better-quality schools and not because of the lower linguistic diversity. As peers are not exogenously assigned to schools, the use of school fixed effects is crucial to this study's approach. Controlling for school fixed effects is required as the language composition at school or other specific attributes, including peers characteristics, may be taken into account in parents' decisions to send their child to one school or the other (Hanushek *et al.*, 2003). Within the same school, a considerable amount of bias is removed and, by using the variations in language composition between grades, the proper endogenous interaction linked to the linguistic fractionalization at school can be identified. Lastly, the inclusion of grade-mates' characteristics can help to reduce further the contextual interaction affecting scores, such as differences due to the socio-economic composition of the group (Manski, 1993). This will be investigated in the next section.

Results and Discussion

First, the focus is on the effect of peers' scores and how it relates to pupils' own score. Differences between schools with high versus low linguistic diversity are further investigated. Table 29 presents two sets of four regressions. Column 1 to 6 use the Kiswahili score as the outcome variable and column 7 to 12 use the English score as the outcome variable. Individual control variables are included in all specifications. In each set, the first two regressions (Columns 1-2 and 7-8) estimate the peers' scores coefficient for the full sample by ordinary least squares and school fixed effects respectively. These regressions are then replicated for schools with low (Columns 3-4 and 9-10) and high (Columns 5-6 and 11-12) linguistic diversity separately.

Table 29: OLS and FE regressions of English and Kiswahili scores on peers' score by low and high linguistic diversity schools

	Kiswahili scores outcome						English scores outcome					
			Low LFI (LFI<.45)		High LFI (LFI>.45)				Low LFI (LFI<.45)		High LFI (LFI>.45)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Peer Kiswahili scores (minus i)	0.534***	-0.501***	0.501***	-0.252	0.506***	-0.827***						
	0.037	0.162	0.052	0.205	0.061	0.22						
Peer English scores (minus i)							0.575***	-0.522***	0.516***	-0.576**	0.589***	-0.484**
							0.033	0.165	0.059	0.23	0.048	0.231
Non-Swahili pupils	-0.120**	-0.1	-0.181**	-0.102	-0.132*	-0.118	-0.160***	-0.132**	-0.247***	-0.101	-0.157***	-0.151**
	0.05	0.062	0.076	0.1	0.069	0.077	0.046	0.06	0.091	0.117	0.059	0.073
Semi-Swahili pupils	-0.121**	-0.120*	0.208*	0.169	-0.217***	-0.172**	-0.154***	-0.133**	0.104	0.131	-0.217***	-0.193***
	0.056	0.064	0.104	0.108	0.065	0.07	0.054	0.061	0.11	0.109	0.063	0.065
English only pupils	-0.06	-0.13	-0.082	-0.117	-0.074	-0.155	0.01	-0.003	0.008	0.002	0.019	-0.01
	0.077	0.088	0.108	0.127	0.113	0.115	0.078	0.082	0.108	0.113	0.116	0.113
Semi-English&Swahili pupils	-0.026	-0.08	-0.045	-0.045	-0.054	-0.126	0.008	0.024	0.015	0.088	0.008	-0.009
	0.076	0.077	0.12	0.128	0.097	0.089	0.078	0.081	0.155	0.146	0.096	0.096
Female	0.107***	0.101***	0.074	0.065	0.134**	0.127***	0.126***	0.121***	0.160***	0.134***	0.105*	0.109*
	0.036	0.035	0.052	0.052	0.052	0.047	0.038	0.038	0.053	0.044	0.059	0.057
Age	0.232**	0.216**	0.194	0.154	0.302***	0.280**	0.141	0.154	0.271	0.201	0.144	0.181
	0.089	0.092	0.235	0.227	0.104	0.106	0.096	0.11	0.203	0.206	0.117	0.134
Age squared	-0.014**	-0.013**	-0.013	-0.011	-0.017***	-0.016**	-0.010*	-0.01	-0.019	-0.015	-0.009	-0.011
	0.005	0.005	0.015	0.014	0.006	0.006	0.006	0.007	0.013	0.013	0.007	0.008
At school since January	0.116***	0.110**	0.111*	0.118	0.142**	0.113*	0.117***	0.124**	0.125*	0.160**	0.116*	0.102
	0.043	0.048	0.066	0.072	0.059	0.066	0.045	0.048	0.071	0.07	0.062	0.069
Attended pre-school	0.031	0.01	0.022	-0.016	0.022	0.075	0.028	0.059	-0.026	-0.023	0.087	0.169
	0.059	0.071	0.083	0.085	0.095	0.117	0.057	0.068	0.087	0.073	0.092	0.114
Repeater	-0.094	-0.097	-0.084	-0.08	-0.144	-0.113	-0.1	-0.077	-0.103	-0.091	-0.123	-0.065
	0.074	0.075	0.096	0.122	0.097	0.096	0.067	0.068	0.117	0.106	0.089	0.092
Attendance interrupted	-0.095**	-0.087	-0.092*	-0.133**	-0.095	-0.047	-0.126***	-0.098**	-0.116**	-0.106*	-0.133**	-0.09
	0.04	0.054	0.051	0.054	0.063	0.082	0.039	0.048	0.053	0.06	0.058	0.068
Wealth index	0.008	-0.009	0.003	-0.001	0.008	-0.019	0.025*	0.01	0.046**	0.039*	0.009	-0.014
	0.013	0.016	0.019	0.019	0.02	0.024	0.014	0.018	0.02	0.022	0.021	0.025
Kiswahili books at home	0.037	0.062	0.073	0.096	-0.001	0.032	0.023	0.049	0.033	0.051	0.014	0.043
	0.04	0.04	0.064	0.066	0.055	0.051	0.038	0.037	0.065	0.056	0.053	0.05
English books at home	0.172***	0.152***	0.212***	0.221***	0.156***	0.097*	0.151***	0.122***	0.160**	0.156**	0.154***	0.108*
	0.04	0.041	0.067	0.068	0.052	0.054	0.041	0.043	0.068	0.06	0.057	0.062
Grade	0.219***	0.797***	0.265***	0.690***	0.210***	0.945***	0.215***	0.809***	0.243***	0.853***	0.199***	0.770***
	0.039	0.122	0.059	0.181	0.053	0.128	0.037	0.105	0.063	0.158	0.048	0.143
No. of Obs.	3294	3294	1634	1634	1660	1660	3294	3294	1634	1634	1660	1660
R-Squared	0.29	0.37	0.28	0.35	0.29	0.4	0.35	0.43	0.32	0.41	0.36	0.44
School control variables	Y	NA	Y	NA	Y	NA	Y	NA	Y	NA	Y	NA
School FE	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show OLS and FE results of the Kiswahili score on peers' scores, (3) Columns 3 to 6 show the same regressions for with low vs. high diversity schools respectively, (4) Columns 7 and 8 show OLS and FE results of the English score on peers' scores, (5) Columns 9 to 12 show the same regressions for with low vs. high diversity schools respectively and (6) Standard errors are indicated below the coefficients.*

As shown, peers' scores coefficients are large and significant across most specifications. The only exception is on Kiswahili scores in low diversity schools. These results suggest that peer scores, which reflect peers' quality within the classroom, are strongly associated with pupils' own score. This is particularly true for English scores. On Kiswahili scores, this association between peer scores and pupils' own score is mediated by the linguistic diversity within the classroom. Indeed, peers' quality is a strong determinant of pupils' own score in high diversity schools only.

Peer effects on Kiswahili scores are mediated by linguistic diversity

To investigate further whether peer effects are operating through school diversity, LFI is added as control in the main regression, along with an interaction term between peers' scores and LFI. Table 30 presents these regression results. Column 1 to 3 use the Kiswahili score as the outcome variable and column 4 to 6 use the English score as the outcome variable. The first regression (Column 1) estimates linguistic diversity, peer scores and interaction term coefficients by ordinary least squares. The second regression (Column 2) estimates linguistic diversity, peer scores and interaction term coefficients using school fixed effects. In the third regression (Column 3), additional peer characteristics are included as control variables as a robustness check. The same regressions are run using English as the outcome variable and are presented in columns 4 to 6 respectively.

In Table 30, LFI coefficient estimates are positive on Kiswahili scores, suggesting that linguistic diversity is positively associated with Kiswahili achievement at school. The estimated LFI coefficient in the OLS model (Column 1) suggests that increasing the peers' linguistic diversity from complete linguistic homogeneity to complete heterogeneity is associated with a significant .182 SD increase in the Kiswahili score. Similarly, the peer scores coefficient is positive and significant in the OLS specification, suggesting that attending linguistically-diverse classrooms and having higher-achieving peers both have a positive impact on pupils' own Kiswahili scores. However, after controlling for school fixed effects (Column 2), both coefficients reduce sharply and lose significance, but the interaction term becomes significant and is negative. This suggests that a peer effect is influencing Kiswahili scores. As the linguistic diversity increases, the peers' scores in Kiswahili become negatively associated with pupil's own score in Kiswahili.

Because the socio-economic composition of peers may affect their scores, the inclusion of grade-mates' characteristics can help to reduce possible contextual interaction further. This aspect is investigated in Table 30, Column 3. As shown, the inclusion of other peer characteristics, such as peers' gender, peers' age or peers' socio-economic status, does not greatly affect previous findings. Coefficients change slightly but their sign and significance remain unchanged. Interestingly, the Kiswahili score is mediated by other peer exogenous variables. Indeed, after the inclusion of school fixed effects, several peer variables are significantly associated with the Kiswahili score, such as the peers' gender or the peers' wealth.

Table 30: OLS and FE regressions of English and Kiswahili scores on LFI, peers' score and additional peers' variables

	Kiswahili scores outcome			English scores outcome		
	(1)	(2)	(3)	(4)	(5)	(6)
LFI (minus i)	0.182*	0.017	0.115	0.001	0.067	0.119
	0.1	0.284	0.254	0.11	0.253	0.24
Peer Kiswahili scores (minus i)	0.723***	0.427	0.214			
	0.204	0.495	0.493			
LFI x Peer Kiswahili scores (minus i)	-0.148	-0.730*	-0.687*			
	0.158	0.421	0.399			
Peer English scores (minus i)				0.492**	-0.658	-1.057*
				0.192	0.622	0.599
LFI x Peer English scores (minus i)				0.063	0.103	0.325
				0.141	0.473	0.463
Peer female (minus i)			1.147*			0.468
			0.68			0.676
Peer age (minus i)			-0.166			-0.073
			0.119			0.116
Peer wealth index (minus i)			-0.185**			-0.104
			0.087			0.09
Peer at school since January (minus i)			0.239			0.449*
			0.275			0.24
Peer attended pre-school (minus i)			-0.709*			-0.33
			0.4			0.427
Peer repeater (minus i)			-0.299			-0.126
			0.583			0.552
Peer attendance interrupted (minus i)			-0.096			-0.02
			0.254			0.229
Peer English books at home (minus i)			0.236			0.072
			0.364			0.301
Peer Kiswahili books at home (minus i)			0.293			0.454
			0.376			0.285
Non-Swahili pupils	-0.130**	-0.099	-0.097	-0.161***	-0.130**	-0.123**
	0.05	0.062	0.062	0.047	0.061	0.059
Semi-Swahili pupils	-0.134**	-0.116*	-0.116*	-0.155***	-0.131**	-0.129**
	0.057	0.066	0.066	0.055	0.062	0.062
English only pupils	-0.063	-0.139	-0.116	0.01	0.002	0.019
	0.076	0.09	0.082	0.078	0.084	0.081
Semi-English&Swahili pupils	-0.037	-0.087	-0.051	0.007	0.026	0.045
	0.076	0.079	0.077	0.079	0.083	0.08
No. of Obs.	3294	3294	3294	3294	3294	3294
R-Squared	0.29	0.37	0.38	0.35	0.43	0.43
Individual control variables (includ	Y	Y	Y	Y	Y	Y
School control variables	Y	NA	NA	Y	NA	NA
School FE	N	Y	Y	N	Y	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show OLS and FE results of the Kiswahili score on LFI, peers' scores, and their interaction, (3) Column 3 shows FE results of the Kiswahili score on LFI, peers' scores, interaction, and additional peer variables, (4) Columns 4 and 5 show OLS and FE results of the English score on LFI, peers' scores, and their interaction, (5) Column 6 shows FE results of the English score on LFI, peers' scores, interaction, and additional peer variables and (6) Standard errors are indicated below the coefficients.*

On English scores, peer effects are not conditional on diversity

In the second set of columns in Table 30, the relationship between the linguistic diversity and English scores is examined. As expected, the peer linguistic diversity does not affect English scores much. Results show that the peer linguistic diversity coefficient is close to zero and is not significant across specifications. After controlling for school fixed effects (Column 5), the peer scores effect disappears and the interaction term does not appear as a significant determinant. This confirms the initial assumption that peer linguistic diversity is not a determinant of English scores.

After controlling for additional peer characteristics (Column 6), both the LFI and the interaction term remain non-significant on English scores. However, the peers' scores coefficient becomes significant, suggesting that on English scores peer effects are not conditional on linguistic diversity. Other peer exogenous variables do not seem to mediate English scores either. Indeed, after the inclusion of school fixed effects, having peers attending school since the beginning of the year is the only variable associated with English scores, and this variable specifically translates higher exposure to the school environment. Other peer characteristics are not found to be as significantly related to English scores in the sample. This result supports the initial assumption that peer effects are mostly driven by Kiswahili interactions.

The magnitude of the coefficient differences between specifications with and without school fixed effects is quite large, suggesting that sorting between schools produces important bias in peer-group linguistic diversity estimates. It validates the methodological decision to use school fixed effects to reduce the bias induced by pupils' self-selection into schools. Furthermore, to ensure that these estimates are consistent and not biased by other possible factors interfering with the home language, the same set of regressions was run without including the individual language group dummy variables as independent variables. The results can be found in Appendix M and show that the estimates are consistent even when the language groups are not accounted for.

To conclude this sub-section, results suggest that the linguistic composition has no negative effect on reading scores per se. Rather, what matters is the quality of peers. Findings show that peers effects on Kiswahili scores are mediated by linguistic diversity, which is not the case for English scores. As the peers' linguistic diversity increases, the quality of peers decreases in Kiswahili which negatively affects pupils' own score. In the next sub-section, an additional control is performed using peers scores' standard deviation to confirm the importance of peers' quality.

Peers' quality is determinant

To evidence further the importance of peers' quality, Table 31 estimates peer scores' coefficients and peers scores' standard deviation coefficients. The first two regressions (Columns 1 and 2) show OLS and school fixed effect results of the Kiswahili score on peer scores, peer scores'

standard deviation and their interaction. Columns 3 and 4 show OLS and school fixed effect results of the English score on peer scores, peer scores' standard deviation and their interaction.

Table 31: OLS and FE regressions of English and Kiswahili scores on peers score standard deviation

	Kiswahili scores outcome		English scores outcome	
	(1)	(2)	(3)	(4)
Peer Kiswahili scores (minus i)	1.099***	0.635**		
	0.085	0.284		
Kiswahili scores Standard Deviation	-0.031	0.148		
	0.073	0.258		
Peer Kiswahili scores x SD	-0.802***	-1.608***		
	0.124	0.359		
Peer English scores (minus i)			1.057***	0.473**
			0.063	0.227
English scores Standard Deviation			-0.093	-0.006
			0.072	0.201
Peer English scores x SD			-0.753***	-1.554***
			0.106	0.287
Non-Swahili pupils	-0.129***	-0.108*	-0.173***	-0.139**
	0.049	0.056	0.045	0.054
Semi-Swahili pupils	-0.111**	-0.098	-0.149***	-0.099*
	0.055	0.061	0.052	0.056
English only pupils	-0.048	-0.118	-0.002	-0.003
	0.076	0.088	0.076	0.079
Semi-English&Swahili pupils	-0.018	-0.082	0.014	0.047
	0.075	0.075	0.078	0.077
No. of Obs.	3294	3294	3294	3294
R-Squared	0.3	0.39	0.36	0.45
Individual control variables (includin	Y	Y	Y	Y
School control variables	Y	NA	Y	NA
School FE	N	Y	N	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show OLS and FE results of the Kiswahili score on peers' score and peers' score standard deviation, (3) Columns 3 and 4 show OLS and FE results of the English score on peers' score and peers' score standard deviation.*

As shown in Table 31, peer scores and the interaction term are both strongly associated with Kiswahili and English pupils' own scores. Peer scores' coefficients are positive and significant across all specifications, suggesting that peers' higher achievement positively affects scores. This holds true when school fixed effects are included. On the other hand, the interaction term between peer scores and peer scores' standard deviation has a strong negative effect. This suggests that as the peer scores' heterogeneity increases, the effect of peer scores on pupils' own score becomes negative. Overall, these results confirm our previous finding that peer effects are mainly driven by peers' quality rather than peer's linguistic diversity.

To ensure that previous estimates are consistent, two other specifications are tested as robustness check. The same set of regressions is run on a reduced sample excluding pupils who speak English only. In the descriptive section, significant difference was found in the proportion of pupils from this language group (English only) between grade 1 and grade 2. Therefore, the coefficients consistency after excluding English pupils from the sample is verified. Secondly, because peer effects may affect pupils differently depending on whether pupils are low or high achievers, regressions are run separately for pupils scoring below or above zero. These issues are investigated in the next sub-sections

Results are robust on a reduced sample excluding pupils who speak English only

Table 32 presents two sets of four regressions for a sample limited only to English speakers. Column 1 to 6 use the Kiswahili score as the outcome variable and column 7 to 12 use the English score as the outcome variable. Individual control variables are included in all specifications. In each set, the first two regressions (Columns 1-2 and 7-8) estimate the peers' scores coefficient for the full sample by ordinary least squares and school fixed effects respectively. The following two regressions present school fixed effects estimates for low (Columns 3 and 9) and high (Columns 4 and 10) linguistic diversity schools separately. In each set, the fifth column (Column 5 and 11) estimates linguistic diversity, peer scores and interaction term coefficients using school fixed effects. Lastly, the sixth column presents estimates for the peers scores and peers' standards deviations scores.

Results support previous findings and coefficients are consistent with those found in the full sample. However, the inclusion of LFI and the interaction term between LFI and peer scores is not found as significant in the reduced sample. On English scores, peer effects are mainly driven by peers' quality rather than linguistic diversity. On both scores, peer scores and peers' standard deviation scores are affecting pupils' own score much more than diversity does.

Table 32:OLS and FE regressions of English and Kiswahili scores on peer scores and LFI – reduced sample

	Kiswahili scores outcome						English scores outcome					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LFI (minus i)					0.088						0.154	
					0.267						0.252	
Peer Kiswahili scores (minus i)	0.538***	-0.499***	-0.252	-0.823***	0.224	0.625**						
	0.039	0.169	0.214	0.226	0.515	0.29						
LFI x Peer Kiswahili scores (minus i)					-0.684							
					0.417							
Kiswahili scores Standard Deviation						0.133						
						0.268						
Peer Kiswahili scores x SD						-1.572***						
						0.36						
Peer English scores (minus i)							0.579***	-0.512***	-0.599**	-0.449*	-1.327**	0.497**
							0.034	0.168	0.242	0.229	0.636	0.236
LFI x Peer English scores (minus i)											0.53	
											0.485	
English scores Standard Deviation												-0.025
												0.209
Peer English scores x SD												-1.557***
												0.294
No. of Obs.	3130	3130	1549	1581	3130	3130	3130	3130	1549	1581	3130	3130
R-Squared	0.29	0.37	0.34	0.4	0.38	0.39	0.34	0.43	0.4	0.44	0.43	0.45
Individual control variables (including grade)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Peer control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	N/A	N/A	N/A
School FE	N/A	Y	Y	Y	Y	Y	N/A	Y	Y	Y	Y	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show OLS and FE results of the Kiswahili score on peers' scores, (3) Columns 3 and 4 show OLS and FE results of the Kiswahili score on peers' score in low vs. high diversity schools respectively (4) Column 5 shows FE results of the Kiswahili score on LFI, peers' scores, interaction, and additional peer variables, (5) Column 6 shows FE results of the Kiswahili score on peers' score and peers' score standard deviation, (6) Columns 7 to 12 show corresponding results when English score is the outcome variable, and (7) pupils who speak English only are excluded from the sample.*

Pupils scoring below average are more affected by peer effects

As discussed in the literature section, peer effects may affect pupils differently depending on their location in the scores' distribution. To further explore possible differences between high and low achieving pupils, the same set of regressions is run for pupils scoring above average and below average separately. Table 33 shows regressions run with Kiswahili score as the outcome. Table 34 shows regressions run with English score as the outcome. In each Table, Columns 1 to 6 present regressions run for pupils scoring above average in the respective language and grade. Columns 7 to 12 present regressions run for pupils scoring below average in the respective language and grade.

As shown in Table 33 and Table 34, after controlling for school fixed effects, peers' score is not a significant determinant of higher achieving pupils' scores anymore (Column 2). This holds true for both Kiswahili and English scores. Moreover, all other factors being held constant, for pupils scoring above average LFI appears to be positively associated with pupils' own scores (Column 5). The LFI interaction term is not significant for pupils scoring above average. Overall, these results suggest that pupils scoring above average are less affected by peer effects.

In the second set of columns (Columns 7 to 12 in Table 33 and in Table 34) showing pupils scoring below average, the pattern is different. For pupils scoring below average in Kiswahili, peer effects are mainly driven by peer scores in Kiswahili. Kiswahili peer scores' coefficients are significant in most regressions and the LFI interaction term is negative and strongly significant (Column 11 in Table 33). This suggests that the linguistic diversity is mediating peers' score quality in Kiswahili, which in turn negatively affects low achieving pupils. On English scores, peer effects on pupils scoring below average are not activated through peers' linguistic diversity (Column 11 in Table 34). Interestingly, while previous findings showed that peer score effects are stronger in high diversity schools, for pupils scoring below average in English the effect seems to be stronger in low diversity schools. This result suggests that low achievers in low diversity schools are more affected by their peer scores in English.

To summarize results from the robustness check, peer effects differ between low and high achiever pupils. Low achieving pupils are more affected by peer effects, particularly in Kiswahili. This confirms that findings from the full sample are mainly driven by pupils scoring below average. A high diversity at school associated with low achieving peers strongly affects low achieving pupils in Kiswahili.

Table 33:OLS and FE regressions of Kiswahili scores on peer scores and LFI for pupils scoring above and below average

	Kiswahili scores outcome											
	Pupils scoring above average						Pupils scoring below average					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LFI (minus i)					0.422**						0.019	
					0.162						0.205	
Peer Kiswahili scores (minus i)	0.172***	-0.131	0.004	-0.312***	0.024	0.491***	0.180***	-0.224**	-0.151	-0.300*	0.58	0.344*
	0.033	0.081	0.104	0.101	0.32	0.161	0.039	0.105	0.117	0.171	0.44	0.175
LFI x Peer Kiswahili scores (minus i)					-0.167						-0.673*	
					0.239						0.352	
Kiswahili scores Standard Deviation						0.705***						-0.687***
						0.112						0.149
Peer Kiswahili scores x SD						-0.816***						-0.639***
						0.23						0.218
No. of Obs.	1672	1672	868	804	1672	1672	1622	1622	766	856	1622	1622
R-Squared	0.31	0.39	0.39	0.4	0.4	0.41	0.28	0.38	0.43	0.36	0.39	0.39
Individual control variables (including grade)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Peer control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	N/A	N/A	N/A
School FE	N/A	Y	Y	Y	Y	Y	N/A	Y	Y	Y	Y	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) pupil scoring above average is defined as a pupil scoring above the grade average score in Kiswahili, (3) pupil scoring below average is defined as a pupil scoring below the grade average score in Kiswahili, (4) Columns 1 and 2 show OLS and FE results of the Kiswahili score on peers' scores for pupils scoring above average in Kiswahili, (5) Columns 3 and 4 show OLS and FE results of the Kiswahili score on peers' score in low vs. high diversity schools respectively for pupils scoring above average in Kiswahili, (6) Column 5 shows FE results of the Kiswahili score on LFI, peers' scores, interaction, and additional peer variables for pupils scoring above average in Kiswahili, (7) Column 6 shows FE results of the Kiswahili score on peers' score and peers' score standard deviation for pupils scoring above average in Kiswahili, (8) Columns 7 to 12 show corresponding results for pupils scoring below average in Kiswahili, and (9) Standard errors are indicated below the coefficients.*

Table 34: OLS and FE regressions of English scores on peer scores and LFI for pupils scoring above and below average

	English scores outcome											
	Pupils scoring above average						Pupils scoring below average					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LFI (minus i)					0.416**						-0.037	
					0.189						0.248	
Peer English scores (minus i)	0.207***	-0.194	-0.114	-0.317	-0.318	0.529***	0.246***	-0.217**	-0.235*	-0.193	-0.236	0.306*
	0.032	0.119	0.118	0.194	0.415	0.186	0.034	0.108	0.133	0.15	0.423	0.183
LFI x Peer English scores (minus i)					0.063						-0.024	
					0.316						0.341	
English scores Standard Deviation						0.760***						-0.777***
						0.133						0.158
Peer English scores x SD						-0.917***						-0.618***
						0.23						0.21
No. of Obs.	1717	1717	927	790	1717	1717	1577	1577	707	870	1577	1577
R-Squared	0.24	0.32	0.34	0.33	0.34	0.35	0.3	0.4	0.48	0.36	0.4	0.42
Individual control variables (including grade)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Peer control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	N/A	N/A	N/A
School FE	N/A	Y	Y	Y	Y	Y	N/A	Y	Y	Y	Y	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) pupil scoring above average is defined as a pupil scoring above the grade average score in English, (3) pupil scoring below average is defined as a pupil scoring below the grade average score in English, (4) Columns 1 and 2 show OLS and FE results of the English score on peers' scores for pupils scoring above average in English, (5) Columns 3 and 4 show OLS and FE results of the English score on peers' score in low vs. high diversity schools respectively for pupils scoring above average in English (6) Column 5 shows FE results of the English score on LFI, peers' scores, interaction, and additional peer variables for pupils scoring above average in English, (7) Column 6 shows FE results of the English score on peers' score and peers' score standard deviation for pupils scoring above average in English, (8) Columns 7 to 12 show corresponding results for pupils scoring below average in English (9) Standard errors are indicated below the coefficients.*

So far, the linguistic diversity was investigated as a possible factor impacting peer interactions under the assumption that a more homogeneous linguistic group will have additional interactions which may reinforce peer effects. Some authors adopted a different approach, looking at the proportion of peers from a certain minority group. For instance, McEwan (2003) uses the percentage of indigenous students in the classroom to search for a possible peer ethnicity impact. In the next sub-section, an alternative model is tested, using the (log) percentage of peers who speak Kiswahili at home in place of the LFI.

Linguistic diversity matters more than the proportion of pupils who speak Kiswahili

Findings from the previous section showed that peer effects (on Kiswahili scores) are channeled by linguistic diversity in the classroom combined with peer quality. Another potential peer-effects channel would be the proportion of peers in the classroom who speak Kiswahili at home. One might expect that the higher the proportion of Kiswahili speaker, the higher the probability of having interaction between pupils in their home language, i.e. Kiswahili. In this sub-section, the percentage of peers who speak Kiswahili at home is used in place of the LFI. Table 35 replicates the regressions presented in Table 30, but using the (log) percentage of peers who speak Kiswahili at home instead of the LFI. Columns 1 to 4 use the Kiswahili score as the outcome variable and columns 5 to 8 use the English score as the outcome variable.

Interestingly, coefficient estimates suggest that the proportion of peers who speak Kiswahili at home is not significantly associated with a pupil's own achievement. This holds true for both Kiswahili and English scores, and across the OLS and school fixed effects models. Regarding peer scores, coefficients are positive and significant in the OLS specifications, but after controlling for school fixed effects, both coefficients lose significance. Turning to the interaction between the proportion of peers who speak Kiswahili at home and peer scores, the coefficient is positive on peer scores when Kiswahili is the outcome. This is not surprising, given that the percentage of peers who speak Kiswahili at home is inversely related to LFI. Nonetheless, this coefficient is not significant. On English scores, the interaction term is not significant either. These results suggest that the proportion of peers in the classroom who speak Kiswahili at home is not a major peer-effects channel.

Table 35: OLS and FE regressions of English and Kiswahili scores on percentage of Swahili pupils

	Kiswahili scores outcome		English scores outcome	
	(1)	(2)	(3)	(4)
% of Swahili pupils peer (log)	-0.1	0.271	0.039	0.109
	0.108	0.373	0.105	0.371
Peer Kiswahili scores (minus i)	0.507***	-0.921		
	0.187	0.718		
% of Swahili peer x Peer Kiswahili scores (minus i)	0.02	0.276		
	0.124	0.44		
Peer English scores (minus i)			0.652***	-0.254
			0.175	0.755
% of Swahili peer x Peer English scores (minus i)			-0.055	-0.185
			0.119	0.478
Non-Swahili pupils	-0.131**	-0.107*	-0.155***	-0.135**
	0.053	0.064	0.048	0.065
Semi-Swahili pupils	-0.133**	-0.130*	-0.149***	-0.136**
	0.058	0.067	0.056	0.064
English only pupils	-0.065	-0.141	0.013	-0.008
	0.077	0.088	0.078	0.083
Semi-English&Swahili pupils	-0.035	-0.091	0.013	0.023
	0.075	0.082	0.079	0.084
Female	0.108***	0.100***	0.126***	0.120***
	0.036	0.036	0.038	0.039
Age	0.233**	0.206**	0.142	0.156
	0.089	0.094	0.096	0.111
Age squared	-0.014***	-0.013**	-0.010*	-0.011
	0.005	0.006	0.006	0.007
At school since January	0.116***	0.110**	0.118***	0.124**
	0.043	0.048	0.045	0.048
Attended pre-school	0.026	0.013	0.029	0.059
	0.059	0.072	0.057	0.069
Repeater	-0.097	-0.097	-0.099	-0.077
	0.074	0.076	0.067	0.069
Attendance interrupted	-0.095**	-0.086	-0.126***	-0.099**
	0.04	0.053	0.038	0.048
Wealth index	0.009	-0.009	0.025*	0.01
	0.013	0.015	0.014	0.018
Kiswahili books at home	0.173***	0.153***	0.151***	0.121***
	0.039	0.041	0.041	0.044
English books at home	0.036	0.059	0.024	0.05
	0.04	0.04	0.038	0.037
Grade	0.220***	0.802***	0.215***	0.807***
	0.039	0.125	0.037	0.106
No. of Obs.	3294	3294	3294	3294
R-Squared	0.29	0.37	0.35	0.43
School control variables	Y	NA	Y	NA
School FE	N	Y	N	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show OLS and FE results of the Kiswahili score on the percentage of peers belonging to the Swahili language group, peers' score and their interaction, (3) Columns 3 and 4 show OLS and FE results of the English score on the percentage of peers belonging to the Swahili language group, peers' score and their interaction and (6) Standard errors are indicated below the coefficients.*

In this section, several models were tested. Results showed that a failure to control adequately for pupils' self-selection into schools would lead to considerable bias in estimates. For instance, findings suggest that unobservable factors at the school level lead to an upward bias of the LFI and the peer scores coefficients in the OLS models. It confirms the importance of using school fixed effects to remove bias and to isolate peer effects from other confounding factors. Results from this work show that peers' quality is a much stronger determinant of pupils' own scores, than peers' linguistic diversity. Nonetheless, the relationship between peer scores and a pupil's own Kiswahili score appears as mediated by linguistic diversity. As the linguistic diversity increases, peer scores in Kiswahili decrease, which negatively impacts pupils' own score in Kiswahili. On English scores, peer influence does not seem to be driven by linguistic diversity. These results support the initial assumption that peer effects are mostly driven by Kiswahili interactions. Moreover, findings are robust when additional peer characteristics are accounted for. Investigation of peer effects on low versus high achieving pupils further shows that low achievers are more affected by peer effects than high achieving pupils. Lastly, the proportion of peers in the classroom who speak Kiswahili at home was used as another likely peer-effects channel. Findings show that peer effects rely more on the linguistic diversity than the proportion of peers who speak Kiswahili.

Conclusion

In this chapter, the emphasis is on the relationship between the linguistic diversity of a pupil's peers at school and a pupil's achievement. An extensive literature shows that peers from the neighborhood or peers in the school environment may influence an individual's behavior. Amongst other things, health and educational outcomes have been shown to be sensitive to the peer composition and to peers' characteristics. Nonetheless, many authors do not address the self-selection of pupils into schools, which may induce an upward bias in their estimates (Evans *et al.*, 1992). Papers using a specific methodology to address endogeneity bias usually find small or non-existent effect (Hoxby, 2000; Hoxby and Weingarth, 2005; McEwan, 2003; Sacerdote, 2014). The ethnicity of a pupil's peers has mostly been studied in US schools, on populations including immigrants and minorities such as black or Hispanic pupils. These studies tend to show that students perform worse when the ethnic minority share increases at a school (Hanushek *et al.*, 2002; McEwan, 2003).

In a multilingual environment such as in Kenya, another dimension to consider is the possible impact of the linguistic diversity of peers. Peers come from diverse ethnic groups and have different home language backgrounds. Therefore, having peers from linguistically diverse background and different home language may affect peer scores and peers' quality. Moreover, the linguistic composition of the classroom may impact the language used at school by teachers (Taylor and von Fintel, 2016). Similarly, the language in use between peers may change according to the linguistic composition of the peers. The language used for regular communication in class

or on the playground between pupils could change if all pupils (or most) share the same home language, in comparison to a classroom where pupils speak different languages at home. Therefore, investigating peer effects on school achievement, and how these might be mediated by peer linguistic diversity at school, is of interest. This research provides further evidence of the effects of peer linguistic diversity on reading achievement at school in the urban Kenyan context. The endogeneity of peer variables is addressed, with school fixed effects controlling for unobserved characteristics at the school level. Using a linguistic fractionalization index, the linguistic diversity in grades 1 and 2 is compared within each school to isolate potential peer effects.

Interesting conclusions can be drawn from this work. In the first place, Kiswahili scores are much more sensitive to peer effects than English scores are. Indeed, results show that the coefficients of interest, the peer linguistic diversity coefficient and the interaction, are close to zero or not significant when English score is the outcome. This suggest that peers' linguistic diversity do not interfere much with English achievement. Secondly, findings suggest that peers' linguistic diversity does not affect Kiswahili achievement directly, but it mediated the association between peers' scores and pupil's own Kiswahili score. After controlling for school fixed effects, as the language diversity increases in the classroom, peers' scores in Kiswahili becomes worse and negatively affect pupil's own score. These findings are consistent with previous findings showing a negative association between ethnicity and educational outcomes. Last but not least, this chapter shows that peer effects mainly affect low achieving pupils. This chapter's results can be further linked to the work done in previous chapters. In particular, non-Swahili and semi-Swahili pupils were found in Chapter 3 to be lower achievers in comparison to Swahili pupils. The same pupils also attend schools with a higher diversity. This additional burden on their score helps to explain the difference in scores between Swahili pupils and other minority language groups.

Chapter 6: Summary and Conclusion

Empirical findings summary and Policy Implications

This research feeds into the current policy debate about the language of instruction in Kenya and more widely in Africa. The language of instruction policy has been questioned many times in the past in African multilingual environments. Pupils often receive instruction in a language different from the language they speak at home, which may be detrimental to reading acquisition. Despite the concerns raised, not much has been done in the field of research to investigate potential repercussions on pupils' reading skills. This research offers a better understanding of the dynamic between the language(s) spoken at home and in the school environment on reading outcomes in the urban Kenyan context. Three main questions were examined. The first relates to the importance of mother-tongue instruction for reading achievement. The second relates to the nature of the reading skills knowledge transferring between Kiswahili and English. The third and final one relates to the linguistic composition of peers at school and the impact this has on achievement.

The data used in this research were collected in Kenya in October 2012 on USAID's behalf for the Primary Math and Reading (PRIMR) midterm impact evaluation. The sample included data on grade 1 and grade 2 pupils from different home-language backgrounds within each school. Pupils' learning outcomes were assessed using the Early Grade Reading Assessment (EGRA), which was administered in Kiswahili and in English to the same pupils, thereby offering a unique opportunity to compare differences in learning outcomes on both languages and for pupils with different home-language backgrounds. Standardized literacy scores in the two languages of interest, Kiswahili and English, were computed from four decoding and reading subtasks.

The first essay searched for potential test score inequalities among pupils as a result of their home language differing from the language of instruction, Kiswahili. Receiving instruction or assessing pupils in another language than their home language could be discriminatory. Using school fixed effects to reduce self-selection bias at the school level, results from assessments, run over a population of pupils who speak Kiswahili at home against those who do not, were compared. The determinants of literacy outcomes and the estimates of the effect of language on educational attainment are modeled using the education production function. Discriminatory evidence was found, with pupils who speak Kiswahili at home having a significant advantage in literacy acquisition. On the total Kiswahili literacy score, Kiswahili speakers score .206 standard deviations higher than pupils who do not speak Kiswahili at home. Pupils who speak several languages at home, including Kiswahili, are not disadvantaged on Kiswahili scores in comparison to pupils who speak Kiswahili only. More importantly, findings show a greater effect on English scores. Even though English is only taught at school, pupils who do not speak Kiswahili at home (or only partially), experience more difficulties in English than pupils who speak Kiswahili at

home. Pupils whose home language differs from Kiswahili score .247 of a standard deviation lower on the English total literacy score than pupils who speak Kiswahili at home. Results presented in Chapter 3 are consistent with the evidence found in other African contexts, that is, that pupils who do not speak the language of instruction at home achieve lower results. This has clear implications for policymakers, who should encourage home language instruction as a policy instrument to improve reading skills acquisition. The language diversity in Kenya is a major challenge for language of instruction policies. Pupils have different home language backgrounds and therefore it is practically impossible to teach all pupils in their home language. Eventually, this work opens new perspectives for language groups for which pupils might be at risk. It calls for government efforts to implement policies targeting pupils from linguistic minorities to provide them with additional support to prevent them from lagging behind. An additional challenge in Kenya is the predominant use of English in the school environment. In most cases, English is not a language spoken at home, and therefore oral comprehension in that language can be limited. Unfortunately, listening comprehension in English was not tested in the sample used for this research. Nonetheless, the low level of reading comprehension in English compared to Kiswahili, even though pupils read more words in English than in Kiswahili, suggests a low level of oral comprehension in English. This has important policy implications, especially as a sufficient level of listening comprehension in English, to allow reading skills acquisition and reading with comprehension, is needed before shifting to instruction in that language. Reinforcing the oral aspect before transitioning to English is crucial. Similarly, for non-Kiswahili speakers, additional oral comprehension practice in Kiswahili may help to bridge the gap between Kiswahili and non-Kiswahili speakers. More practically, explicit and intensive vocabulary training in Kiswahili and English should be part of the curriculum to ensure that multilingual pupils have the minimum oral language skills required for successful reading with comprehension. In addition, in light of the critically low level of reading skills in Kiswahili and English, all home language groups confounded, pupils should be equipped with stronger decoding skills. Teaching should be emphasized on phonological awareness, alphabet letters, phonics, and reading comprehension strategies in replacement of traditional instruction focusing on whole-word reading. Both decoding skills and vocabulary play a significant role in reading comprehension. Chapter 3 did not look at the possible influence of Kiswahili and English on each other in the Kenyan context and how it may contribute to language acquisition. To address this lack, Chapter 4 investigates a possible knowledge *transfer* between reading skills in Kiswahili and in English.

The purpose of Chapter 4 was to understand the relationship between Kiswahili and English better and the nature of the knowledge transferring between languages in the Kenyan context. The literature shows that cross-language transfer has been observed in many contexts. It is a multi-dimensional phenomenon and the rate of transfer is mediated by many factors. Seemingly unrelated quadratic regressions were used to account for the non-linearity of the relationship and for the mutual language influence. According to available evidence, reading skills in one language (Kiswahili or English) are associated with reading skills in the other. Moreover, the cross-language transfer is observed to be a non-linear process. Results further showed that the transfer is stronger

when tied to the English proficiency level, with increasing marginal effects across the distribution. This confirms previous findings that the transfer magnitude increases with a higher level of the second language proficiency. Unexpectedly, reading in English contributes more to reading in Kiswahili than does reading in Kiswahili to reading in English. This has been observed before, in another African context, in South Africa, and may suggest that pupils receive more reading instruction in English than in Kiswahili. Nonetheless, findings from this chapter suggest that when both languages develop simultaneously, gains are higher. The interdependence between languages evidenced in this work, and in previous research, calls for more attention to be paid to cross-language transfer and to emphasizing simultaneous learning in both languages. The policy implications suggest that the government could opt for a bilingual education, with both languages kept as language of instruction in later grades, in order to encourage simultaneous learning in both languages. Practically, findings suggest that the instructional approach should focus on the links between the two languages rather than being considered as two different topics. Teachers should emphasize on similarity and differences between English and Kiswahili. Evidence of cross-linguistic transfer should be used as a leverage to promote reading comprehension skills bidirectionally. Moreover, instructional approach should capitalize more on the shallower orthography of Kiswahili to promote transfer from Kiswahili to English. Lastly, potential differences between pupils' home language groups were further investigated. Specifically, pupils who speak Kiswahili at home were compared to pupils who do not, to see whether home language may impact the transfer mechanism. Interestingly, results suggest that having a home language other than Kiswahili is not detrimental to language transfer between English and Kiswahili, as long as a certain proficiency level is reached in the two languages. In fact, the magnitude of the cross-language transfer is superior for non-Kiswahili speakers in the higher level of the score distribution. For policy direction, this suggests that strengthening basic reading skills for non-Kiswahili speakers in both languages may attenuate the gap between home language groups, especially regarding English outcomes.

In Chapter 5, the peer language diversity at school and its potential impact on reading outcomes was investigated. Research on peers' language composition at school is largely absent from literature in the field of economics. Previous research on ethnicity seems to show that higher ethnic diversity is negatively associated with educational outcomes. The language composition in the classroom is likely to affect a pupil's exposure to Kiswahili through communication with peers or the language used by teachers, which is another factor impacting pupils' reading outcomes. Moreover, Chapter 3 found that pupils whose home language is different from Kiswahili score lower than Swahili pupils. Therefore, a higher linguistic diversity amongst peers may translate into lower peer scores which can in turn affect pupils' own score. Chapter 5 looked at this in more depth. A linguistic fractionalization index was used to measure language diversity in grade 1 and grade 2 classrooms within the same school. In the peer effects literature, a major difficulty is the self-selection of pupils into peer groups. In this work, the measure of peers is drawn from the idiosyncratic variation in language composition between grades, and school fixed effects are used to purge potential endogeneity bias in peer-effects estimates. Results showed that language

diversity within classrooms is not a significant determinant of achievement. However, the interaction between peers' Kiswahili scores and language diversity is negatively associated with pupil's own score in Kiswahili. This negative effect mainly affects low achieving pupils. When developing instructional interventions, government and planners should bear in mind this important result. Including more mixing between strong and low achiever pupils in programs design or intervention may soften the negative effect on Kiswahili scores and improve scores overall. Furthermore, results support that the peer linguistic composition effect on English scores is close to zero. This suggests that English scores are not tied to the peer linguistic composition. These results are robust when additional peers' characteristics are further controlled for. The chapter introduces for the first-time peer language diversity as a potential mechanism of the peer influence on reading outcomes. Further investigation was done using the percentage of peers whose home language is Kiswahili as a possible peer-effect vector. Results showed that peer effects are not activated through the proportion of peers who speak Kiswahili. The finding that there is no impact of language diversity on English scores within schools may be important for the government and heads of schools. It shows that the language spoken by pupils within schools does not cause much variation in English scores, i.e. variation comes from other school factors. Therefore, other means should be used at the school level to improve both the quality of the instruction and reading scores in English.

Limitations of the study

There are several data limitations to acknowledge in this study. Notably, data used in the analysis come mostly from seven-year-old pupils, with the possible reliability issues that this raises. As discussed in Chapter 2, the independent variables come from the pupil questionnaire answered by pupils themselves. One might question whether seven-year-old pupils can report reliable information in terms of items in their house or previous attendance. Moreover, some questions are retrospective, which may increase the reporting error. Another potential issue relates to the calibration of the subtasks used to compute the total literacy scores. This question arises from the observation of the score distribution of subtasks. In social and economic sciences, scores are expected to be normally distributed. In cases where the results do not follow a normal distribution, they can show floor or ceiling effects which might derive from the construction of the tests. This is the case for several subtasks used in this work, especially for grade 1 pupils' scores. Unfortunately, it was not possible to control for this and standardized scores were used to overcome this limitation. Moreover, Chapter 3 and Chapter 4 used grade 2 data only, which follow a much more normal distribution.

Regarding the assumptions formulated in this work, some limitations need to be pointed out. For instance, the assumption was made that Kiswahili is in use at school in the sample. However, this might be an incorrect assumption. Previous research, including classroom observations in Kenya, showed that in many schools the instruction in early grades is given in English, despite the national

policy requesting the use of Kiswahili. In such cases, the interpretation of some results may have to be revised, especially in the discussion of the language transfer mechanism in Chapter 4. Under the assumption that pupils are taught in English, the transfer would then mainly rely on decoding and reading skills in English that pupils transfer to Kiswahili without formal instruction. It may explain reading difficulty in Kiswahili. Secondly, Swahili pupils' advantage over the other language groups would then be explained by other indirect effects. For instance, if teachers use Kiswahili in the classroom to give guidance or to explain complex information in English. Nonetheless, results from this research remain valid in many ways. In all chapters, scores achieved in both languages, Kiswahili and English, were analyzed. Whether instruction is in Kiswahili or not, both scores were negatively impacted for non-Swahili speakers, showing that pupils from language minorities experience additional difficulties to those who speak the majority language.

Lastly, Chapter 5 may suffer from some limitations in terms of sample size. The linguistic fractionalization index is constructed on the basis of an average of ten pupils randomly selected per classroom (for grade 1 and grade 2). This sample may not be representative of the language diversity in the entire classroom. With a bigger sample of pupils selected within the same classroom, further exploration of peer effects would have been possible. Working on peer effects within classrooms rather than between grades within schools would add an additional level of control. Nonetheless, and as previously discussed, this should not be a major concern for the present work.

Suggestions for future research work

Many projects are currently being implemented on the African continent that focus on educational quality through the improvement of teacher training, teaching materials, school environment, and school facilities in order to ensure that schooling effectively translates into the acquisition of basic learning skills'. Little attention has been paid to the possible impact of the pupil's home language on reading outcomes and evidence is scarce in this field. This research has showed that the home language, when different from the language of instruction, is of importance. It is recommended that research and development programs investigate this topic further. More research is needed to test potential pathways by which language affects learning achievement when the home language is different from the language in use at school. At a minimum, more attention should be paid to develop tailored approaches for pupils who do not speak the language of instruction as their home language.

In addition, some results from Chapter 4 need further examination to either support or discount the explanations given in this work regarding the transfer mechanism. A potential area for future research is to achieve a better understanding of why the relationship follows a negative quadratic curve when scores are tied to the Kiswahili level of proficiency. Possible explanations were provided in Chapter 4 on the decreasing marginal effects across the Kiswahili scores' distribution.

However, evidence is needed to confirm these assumptions. Similarly, further research is needed to confirm whether multilingualism facilitates cross-language transfer in the Kenyan context. Findings tend to support this at the top of the English scores' distribution. However, this rests on a limited sample of higher-achieving non-Swahili pupils, and further evidence is needed to establish this finding properly.

Appendix

Appendix A: Proportion of Swahili pupils per school

Proportion of Swahili pupils (%)	No. of Schools	%	Cumul.
0.0	2	1.13	1.13
5.3	2	1.13	2.26
10.0	3	1.69	3.95
10.5	3	1.69	5.65
15.0	1	0.56	6.21
20.0	6	3.39	9.6
21.1	2	1.13	10.73
25.0	3	1.69	12.43
26.3	2	1.13	13.56
27.8	1	0.56	14.12
30.0	2	1.13	15.25
35.0	4	2.26	17.51
36.8	2	1.13	18.64
38.1	1	0.56	19.21
40.0	5	2.82	22.03
42.1	1	0.56	22.6
44.4	1	0.56	23.16
45.0	2	1.13	24.29
46.2	1	0.56	24.86
50.0	8	4.52	29.38
52.6	3	1.69	31.07
55.0	8	4.52	35.59
57.9	2	1.13	36.72
60.0	9	5.08	41.81
61.1	1	0.56	42.37
62.5	1	0.56	42.94
63.2	2	1.13	44.07
65.0	8	4.52	48.59
68.4	1	0.56	49.15
70.0	14	7.91	57.06
72.2	2	1.13	58.19
72.7	1	0.56	58.76
73.7	2	1.13	59.89
75.0	7	3.95	63.84
78.9	1	0.56	64.41
80.0	11	6.21	70.62
83.3	2	1.13	71.75
84.2	3	1.69	73.45
85.0	14	7.91	81.36
88.2	1	0.56	81.92
89.5	6	3.39	85.31
90.0	10	5.65	90.96
94.4	1	0.56	91.53
94.7	1	0.56	92.09
95.0	8	4.52	96.61
100.0	6	3.39	100
Total	177	100	

Appendix B: Sample representativity

For comparison purposes, the tables below show descriptive statistics from the DHS and UWEZO survey in Kenya in 2014 and 2012 respectively. DHS data shows that the three regions of interest, namely Nairobi, Rift Valley and Central are among the richest region in Kenya. Regarding Grade 1 and Grade 2 pupils' gender and age, data from the UWEZO survey mirror what was found in the sample used for the data analysis.

- DHS survey - Kenya 2014: Summary of wealth index per region

Region	Mean	SD	N
Coast	4.185	1.029	2097
North	3.396	1.453	722
Eastern	3.706	1.191	2096
Central	4.388	0.887	1489
Rift Valley	3.984	1.192	3625
Western	3.160	1.415	1001
Nyanza	3.484	1.387	1644
Nairobi	4.528	0.704	1240

Sources: Own calculations based on DHS survey data 2014 restricted to urban areas.
Note: The wealth index is rated from 1 to 5 with 5 being the richest.

- UWEZO survey – Kenya 2012: Summary statistics for Grade 1 and Grade 2 pupils

	Full sample			Grade 1 pupils			Grade 2 pupils		
Variables	Mean	SD	N	Mean	SD	N	Mean	SD	N
Age	7.515	1.778	36972	7.007	1.732	18681	8.008	1.68	18291
Gender (female=1)	0.483	0.5	36972	0.482	0.5	18681	0.484	0.5	18291

Sources: Own calculations based on UWEZO survey data 2012 restricted to Grade 1 and Grade 2 pupils.

Appendix C: Descriptive statistics - reading scores (z-scores)

	Total			Non-Swahili group			Semi-Swahili group			Swahili group			Non-Swahili vs. Semi-Swahili Difference	Swahili vs. Semi-Swahili Difference	Swahili vs. Non-Swahili Difference
	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR	MEAN	N	VAR			
Kiswahili - letter sound z-score	-0.034	1573	0.874	-0.459	305	0.782	-0.074	184	0.66	0.104	1084	0.869	-0.385 ***	0.178 **	0.563 ***
Kiswahili - invented word z-score	-0.076	1573	0.921	-0.338	305	0.938	-0.183	184	0.787	0.024	1084	0.909	-0.154	0.208 **	0.362 ***
Kiswahili - oral reading z-score	-0.082	1573	0.947	-0.349	305	1.002	-0.261	184	0.814	0.035	1084	0.915	-0.088	0.296 ***	0.384 ***
Kiswahili - reading comp. z-score	-0.061	1573	0.971	-0.348	305	1.072	-0.318	184	0.892	0.076	1084	0.9	-0.03	0.393 ***	0.424 ***
Kiswahili - listening comp. z-score	-0.002	1573	1.045	-0.272	305	1.044	-0.029	184	1.012	0.087	1084	1.023	-0.243 *	0.115	0.358 ***
English - letter sound z-score	-0.021	1573	0.875	-0.286	305	0.751	-0.161	184	0.68	0.088	1084	0.915	-0.126	0.248 ***	0.374 ***
English - invented word z-score	-0.062	1573	0.955	-0.416	305	1.005	-0.249	184	0.934	0.083	1084	0.879	-0.167	0.332 ***	0.498 ***
English - oral reading z-score	-0.057	1573	1.006	-0.467	305	1.151	-0.312	184	1.007	0.118	1084	0.868	-0.155	0.43 ***	0.585 ***
English - reading comp. z-score	-0.055	1573	0.977	-0.489	305	0.714	-0.285	184	0.909	0.123	1084	0.973	-0.204 *	0.408 ***	0.612 ***

*level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01*

Appendix D: Factor analysis

- Correlation between subtasks

Kiswahili - Variable	letter sound score	invented word score	oral reading score	reading comp. score
letter sound score	1			
invented word score	0.492	1		
oral reading score	0.4496	0.8709	1	
reading comp. score	0.4108	0.7219	0.8065	1

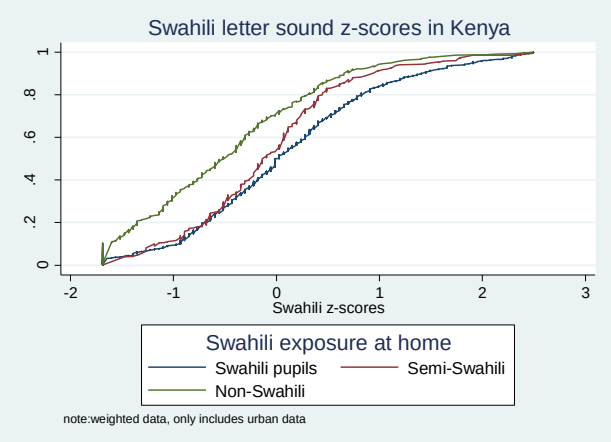
English - Variable	letter sound score	invented word score	oral reading score	reading comp. score
letter sound score	1			
invented word score	0.4495	1		
oral reading score	0.3247	0.8203	1	
reading comp. score	0.299	0.5383	0.6455	1

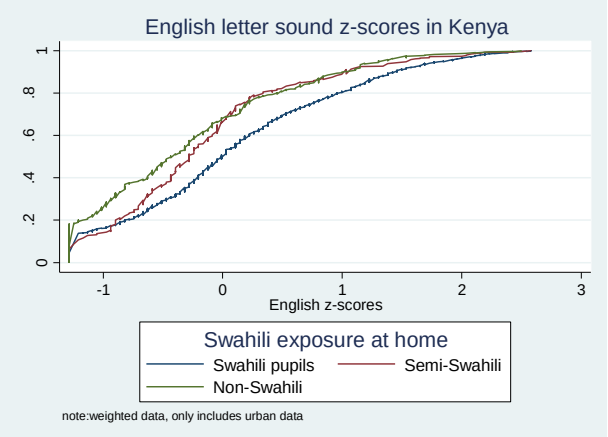
- Kaiser-Meyer-Olkin measure of sampling adequacy

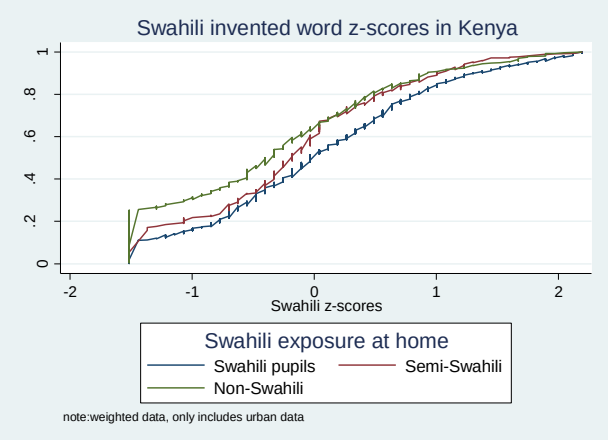
Kiswahili - Variables	kmo
letter sound score	0.9158
invented word score	0.7435
oral reading score	0.6841
reading comp. score	0.8272
Overall	0.7601

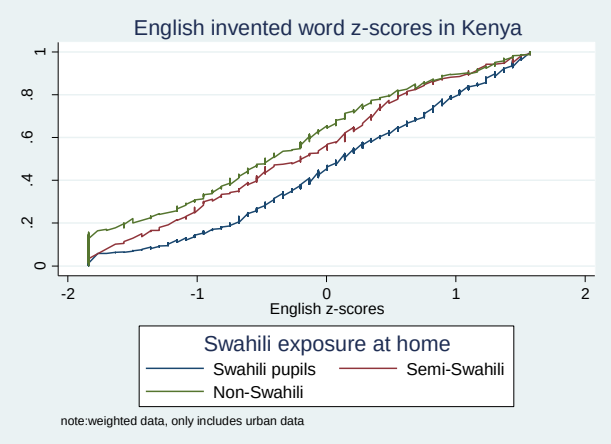
English - Variables	kmo
letter sound score	0.7293
invented word score	0.6427
oral reading score	0.6187
reading comp. score	0.7967
Overall	0.672

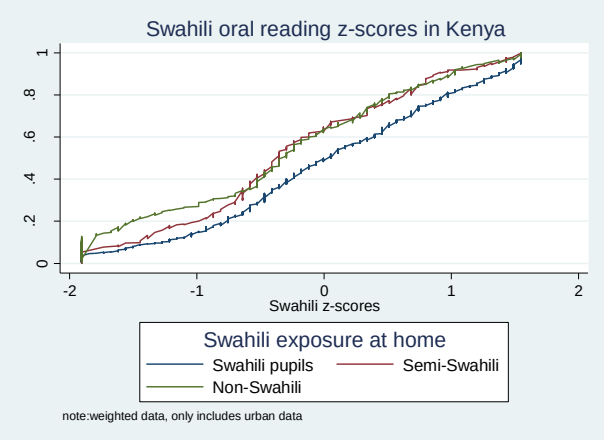
Appendix E: Home language group z-scores in Kiswahili and English per literacy subtasks

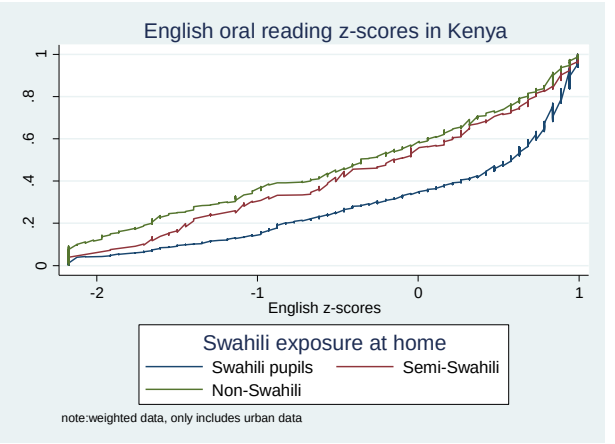












Appendix F: Full set of regressions results per subtasks in Kiswahili

	Kiswahili scores per subtasks											
	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Listening comp.	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Listening comp.
Non-Swahili	-0.385***	-0.159**	-0.133*	-0.155*	-0.225***	-0.200**	-0.303***	-0.160**	-0.116	-0.172	-0.206**	-0.08
	0.064	0.074	0.078	0.087	0.074	0.09	0.075	0.081	0.102	0.117	0.09	0.117
Semi-Swahili	-0.146*	-0.097	-0.144	-0.240**	-0.181**	-0.036	-0.122	-0.089	-0.189	-0.228*	-0.185	0.101
	0.078	0.087	0.093	0.096	0.09	0.113	0.084	0.104	0.127	0.123	0.115	0.142
Female	0.190***	0.067	0.064	0.025	0.091*	-0.065	0.187***	0.07	0.061	0.023	0.09	-0.08
	0.047	0.053	0.057	0.054	0.053	0.055	0.052	0.059	0.068	0.057	0.059	0.055
Age	0.138	0.174	0.342**	0.630***	0.385**	0.551***	0.218	0.288	0.411**	0.663***	0.471**	0.451*
	0.167	0.201	0.164	0.167	0.159	0.21	0.224	0.216	0.194	0.2	0.199	0.258
Age squared	-0.007	-0.009	-0.018**	-0.035***	-0.021**	-0.033***	-0.013	-0.016	-0.022**	-0.037***	-0.026**	-0.028*
	0.009	0.011	0.009	0.009	0.009	0.012	0.013	0.012	0.011	0.011	0.011	0.015
At school since January	-0.001	0.1	0.124	0.067	0.091	-0.051	-0.076	0.065	0.08	0.048	0.044	-0.012
	0.063	0.078	0.077	0.08	0.072	0.093	0.061	0.09	0.087	0.093	0.081	0.108
Attended pre-school	0.053	-0.014	-0.041	-0.041	-0.018	-0.015	0.074	0.001	0.058	-0.005	0.034	-0.025
	0.077	0.095	0.103	0.096	0.09	0.141	0.108	0.15	0.124	0.156	0.139	0.169
Repeater	0.105	-0.158	-0.164	-0.237*	-0.151	-0.159	0.045	-0.1	-0.134	-0.193	-0.123	0.059
	0.107	0.144	0.131	0.129	0.122	0.153	0.076	0.165	0.148	0.142	0.127	0.195
Pupil has skipped G1	0.128	-0.016	0.051	0.071	0.061	-0.173	0.479**	0.085	0.107	0.045	0.181	-0.201
	0.116	0.111	0.123	0.102	0.116	0.108	0.185	0.135	0.15	0.139	0.14	0.159
Attendance interrupted	-0.03	-0.156**	-0.212***	-0.153**	-0.170**	0.024	-0.015	-0.08	-0.135	-0.136	-0.113	0.013
	0.056	0.066	0.071	0.07	0.066	0.08	0.07	0.083	0.092	0.095	0.087	0.089
Wealth index	0.041**	0.019	0.014	0.03	0.028	0.048**	0.043**	-0.001	-0.008	0.009	0.009	0.026
	0.019	0.022	0.021	0.022	0.022	0.024	0.019	0.024	0.022	0.027	0.023	0.029
Kiswahili assessment 1st	-0.210***	-0.110*	-0.077	-0.117**	-0.141***	-0.103	-0.216***	-0.106*	-0.084	-0.103	-0.139**	-0.149*
	0.054	0.056	0.054	0.056	0.053	0.072	0.06	0.059	0.055	0.063	0.056	0.083
Kiswahili books at home	0.011	-0.065	-0.073	0.033	-0.032	0.022	-0.016	-0.071	-0.07	0.018	-0.043	-0.018
	0.06	0.062	0.067	0.067	0.063	0.075	0.067	0.075	0.076	0.078	0.073	0.091
English books at home	-0.015	0.204***	0.138**	0.195***	0.164**	0.08	-0.073	0.112	0.064	0.1	0.07	-0.014
	0.063	0.068	0.068	0.068	0.064	0.081	0.062	0.077	0.072	0.074	0.067	0.104
PRIMR Treatment school	0.844***	0.195**	0.247***	0.168**	0.378***	0.047						
	0.079	0.076	0.073	0.073	0.075	0.085						
Nonformal school	0.177**	0.487***	0.616***	0.391***	0.509***	-0.014						
	0.07	0.075	0.077	0.078	0.076	0.103						
Multigrade class	0.209**	-0.169	-0.143	-0.077	-0.076	-0.064						
	0.095	0.195	0.15	0.166	0.164	0.135						
Kiswahili as language of instruction	-0.018	-0.032	-0.1	-0.107	-0.079	-0.123						
	0.069	0.076	0.074	0.078	0.076	0.092						
Teacher was absent the previous day	-0.06	0.071	0.024	-0.086	-0.009	-0.047						
	0.065	0.074	0.073	0.075	0.075	0.095						
Teacher was late the previous day	-0.011	-0.165*	-0.240***	-0.316***	-0.227***	-0.191*						
	0.086	0.089	0.085	0.08	0.085	0.109						
Water available at school	0.045	-0.037	0.013	0.007	0.004	0.129						
	0.069	0.071	0.074	0.07	0.07	0.086						
School with electricity	0.047	0.265***	0.272***	0.277***	0.265***	0.215**						
	0.062	0.068	0.069	0.07	0.067	0.084						
Feeding program at school	0.243***	0.077	0.052	0.038	0.106*	0.096						
	0.067	0.064	0.067	0.068	0.064	0.083						
Girlwashroom at school	-0.001	-0.114	-0.035	-0.057	-0.064	-0.128						
	0.082	0.104	0.098	0.116	0.101	0.131						
Library at school	0.038	-0.007	0.022	-0.014	0.009	-0.001						
	0.072	0.071	0.069	0.072	0.07	0.087						
No. of Obs.	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519
R-Squared	0.27	0.12	0.16	0.15	0.18	0.07	0.5	0.32	0.34	0.31	0.37	0.3
Individual control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A	N/A
School fixed effects	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y

*Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 - 6 show results from the OLS model including school level factors and column 7 - 12 are the school fixed effect model regressions (3) Standards errors are indicated below the coefficients, (4) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative.*

Appendix G: Full set of regressions results per subtasks in English

	English scores per subtasks									
	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score	Letter sound	Invented word	Reading a story	Reading comp.	Total literacy score
Non-Swahili	-0.229***	-0.262***	-0.264***	-0.312***	-0.330***	-0.111*	-0.237**	-0.214**	-0.215**	-0.247***
	0.063	0.08	0.078	0.072	0.071	0.067	0.099	0.091	0.092	0.09
Semi-Swahili	-0.183**	-0.201**	-0.206**	-0.209**	-0.247***	-0.164	-0.2	-0.117	-0.183**	-0.203*
	0.081	0.092	0.089	0.081	0.078	0.101	0.123	0.117	0.087	0.103
Female	0.200***	0.082	0.081	0.043	0.115**	0.178***	0.081	0.083	0.048	0.112*
	0.048	0.062	0.059	0.05	0.054	0.052	0.076	0.074	0.057	0.067
Age	-0.087	0.038	-0.073	0.096	-0.003	0.038	0.291	0.119	0.086	0.177
	0.17	0.177	0.184	0.171	0.153	0.205	0.184	0.201	0.208	0.175
Age squared	0.005	-0.003	0.003	-0.006	-0.001	-0.004	-0.017*	-0.008	-0.005	-0.011
	0.009	0.01	0.01	0.01	0.009	0.012	0.01	0.012	0.012	0.01
At school since January	0.023	0.130*	0.048	0.094	0.096	-0.066	0.085	0.007	0.028	0.025
	0.071	0.078	0.072	0.077	0.069	0.079	0.087	0.087	0.091	0.078
Attended pre-school	-0.039	-0.005	-0.095	-0.005	-0.045	-0.071	0.061	0.005	0.094	0.035
	0.089	0.099	0.099	0.098	0.093	0.113	0.168	0.138	0.086	0.138
Repeater	-0.017	-0.146	-0.259*	-0.253*	-0.222*	-0.069	-0.09	-0.143	-0.148	-0.141
	0.106	0.127	0.137	0.148	0.131	0.098	0.141	0.133	0.138	0.129
Pupil has skipped G1	-0.089	0.089	0.052	0.085	0.055	0.282**	0.104	0.074	0.029	0.135
	0.134	0.122	0.114	0.091	0.117	0.116	0.156	0.137	0.11	0.125
Attendance interrupted	-0.139**	-0.183***	-0.268***	-0.358***	-0.298***	-0.061	-0.08	-0.164*	-0.166**	-0.149*
	0.056	0.066	0.064	0.062	0.061	0.073	0.081	0.085	0.077	0.082
Wealth index	0.004	0.017	0.056***	0.070***	0.047**	0.016	-0.01	0.018	0.049	0.022
	0.021	0.021	0.021	0.023	0.02	0.024	0.027	0.024	0.031	0.027
English assessment 1st	-0.226***	-0.069	0.039	-0.024	-0.069	-0.228***	-0.078	0.032	-0.078	-0.091
	0.057	0.068	0.066	0.071	0.06	0.062	0.074	0.077	0.081	0.068
English books at home	-0.082	0.160**	0.175**	0.04	0.110*	-0.143***	0.086	0.121	0	0.039
	0.061	0.071	0.071	0.071	0.063	0.051	0.08	0.083	0.08	0.068
Kiswahili books at home	0.069	-0.109	-0.09	0.007	-0.052	0.034	-0.112	-0.123*	-0.023	-0.081
	0.058	0.069	0.062	0.06	0.059	0.065	0.077	0.063	0.069	0.061
PRIMR Treatment school	0.942***	0.266***	0.166**	-0.039	0.353***					
	0.074	0.073	0.069	0.067	0.07					
Nonformal school	0.107	0.458***	0.510***	0.317***	0.458***					
	0.066	0.066	0.066	0.082	0.063					
Multigrade class	-0.036	-0.144	-0.213	-0.021	-0.139					
	0.143	0.225	0.204	0.165	0.188					
Kiswahili as language of instruc	-0.11	-0.167**	-0.298***	-0.371***	-0.299***					
	0.067	0.068	0.064	0.072	0.06					
Teacher was absent the previo	-0.052	0.081	-0.062	-0.193**	-0.064					
	0.059	0.062	0.064	0.081	0.061					
Teacher was late the previous d	-0.053	-0.304***	-0.398***	-0.343***	-0.361***					
	0.092	0.091	0.082	0.078	0.084					
Water available at school	0.013	-0.047	-0.084	0.094	-0.014					
	0.067	0.071	0.068	0.066	0.066					
School with electricity	-0.026	0.231***	0.308***	0.207***	0.245***					
	0.066	0.069	0.073	0.071	0.069					
Feeding program at school	0.190***	0.057	0.11	0.08	0.125**					
	0.068	0.066	0.067	0.065	0.061					
Girlwashroom at school	-0.12	-0.024	0.063	0.002	-0.013					
	0.088	0.107	0.107	0.096	0.104					
Library at school	-0.071	-0.009	-0.099	-0.126*	-0.092					
	0.072	0.069	0.07	0.07	0.065					
No. of Obs.	1519	1519	1519	1519	1519	1519	1519	1519	1519	1519
R-Squared	0.27	0.15	0.24	0.23	0.25	0.48	0.31	0.4	0.42	0.42
Individual control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School fixed effects	N	N	N	N	N	N	N	N	N	N

*Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 - 5 show results from the OLS model including school level factors and column 6 - 10 are the school fixed effect model regressions (3) Standards errors are indicated below the coefficients, (4) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative.*

Appendix H: regressions with District fixed effects

For comparison purposes, the table below shows the regressions results with district fixed effect in comparison to school fixed effects for both language scores. The coefficients are slightly different but there is no major change in sign or significance for the non-Swahili variable. The semi-Swahili variable appears as significant in the district fixed effects model.

	Kiswahili total literacy score		English total literacy score	
Non-Swahili	-0.206**	-0.183**	-0.247***	-0.263***
	0.09	0.067	0.09	0.076
Semi-Swahili	-0.185	-0.185*	-0.203*	-0.246*
	0.115	0.088	0.103	0.113
No. of Obs.	1519	1519	1519	1519
R-Squared	0.37	0.19	0.42	0.26
Individual controls	Y	Y	Y	Y
School fixed effects	Y	N	Y	N
District fixed effects	N	Y	N	Y

*Notes: (1) level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) For clarity, variables of interest only are displayed (3) Robust Standards errors are indicated below the coefficients, (4) Data are from the G2 pupils Midterm evaluation data - PRIMR initiative.*

Appendix I: Justification for not using the 3SLS approach

In Chapter 4, the model uses the Kiswahili score as explanatory variable when English is the outcome and vice et versa. One might be concerned by the endogeneity resulting from the simultaneity issue (Y causing X and X causing Y). However, as a reminder, Chapter 4 is not searching for causality but rather for associations between scores.

Nonetheless, to validate the stability of our results further investigation was done to search for variables which could possibly be instrumented. However, because school fixed effects are used only individual variables can be used as instrumental variable. From all the individual variables available in the dataset, no instrumental variable could be identified given that all variables are correlated with both scores in a similar way. It is worth mentioning that both scores are highly correlated (r = .85).

In an attempt to estimate the model using the 3SLS approach, results from Chapter 3 were further exploited to test hypothetical instrumental variables. Indeed, in Chapter 3, after including school fixed effects, age and age squared were found as significant on Kiswahili scores. On English scores, female and attendance interrupted were both significant variables. Tentatively, these variables were used to instrument scores in both regressions respectively. Results of the linear model are presented in the Table H.1 along with the two-least squares procedure. As shown, coefficients are decreased after instrumentation but their sign and significance remain constant. Even though these instruments appear to be weak, they tend to support findings discussed in Chapter 4. Last, because explanatory variables are the same for both scores, this led to identification problems when the 3SLS procedure was tested.

Table H.1: Linear school fixed effects regressions and instrumented variables

	English score outcome		Kiswahili score outcome	
	(1)	(2)	(3)	(4)
English total score			0.850***	0.776***
			0.025	0.155
Kiswahili total score	0.784***	0.539**		
	0.029	0.227		
Non-Swahili pupils	-0.090*	-0.092	0.005	-0.037
	0.049	0.06	0.045	0.049
Semi-Swahili pupils	-0.064*	-0.015	-0.019	-0.047
	0.037	0.053	0.047	0.045
Female	0.047	0.078**		
	0.043	0.035		
Age			0.324***	0.118
			0.114	0.106
Age squared			-0.017***	-0.007
			0.006	0.006
At school since January	-0.009	0.056	0.022	0.01
	0.043	0.044	0.042	0.039
Attended pre-school	0.002	0.054	-0.002	-0.011
	0.06	0.057	0.053	0.052
Repeater	-0.043	-0.132	0.002	-0.032
	0.081	0.089	0.073	0.072
Pupil has skipped G1	0.008	0.013	0.076	-0.025
	0.094	0.071	0.105	0.064
Attendance interrupted	-0.062	-0.062		
	0.042	0.038		
Wealth index	0.017	0.014	-0.007	-0.008
	0.019	0.011	0.017	0.011
Kiswahili books at home	-0.039	-0.065*	0.028	0.034
	0.029	0.034	0.035	0.033
English books at home	-0.015	0.048	0.035	0.008
	0.033	0.039	0.032	0.035
No. of Obs.	1519	1519	1519	1519
R-Squared	0.81	0.73	0.8	0.72
School FE	Y	Y	Y	Y
Score variable instrumented	N	Y	N	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) column 1 shows linear regression of English scores on Kiswahili scores and column 2 gives the same linear regression with the Kiswahili scores instrumented, (3) column 3 shows linear regression of Kiswahili scores on English scores and column 4 gives the same linear regression with the English scores instrumented, (4) Standard errors are indicated below the coefficients.*

Appendix J: SUR of English and Kiswahili scores - reduced robustness check sample

	English score outcome	Kiswahili score outcome
	(1)	(2)
Non-Swahili pupils	-0.021	0.02
	0.048	0.049
Semi-Swahili pupils	-0.058	0.048
	0.05	0.051
Kiswahili total literacy	0.981***	
	0.029	
Kiswahili total literacy x Non-Swahili	-0.03	
	0.038	
Kiswahili total literacy x Semi-Swahili	0.011	
	0.042	
English total literacy		0.986***
		0.029
English total literacy x Non-Swahili		0.042
		0.038
English total literacy x Semi-Swahili		-0.013
		0.041
No. of Obs.	475	475
R-Squared	0.83	0.83
School FE	Y	Y
Other control variables	Y	Y
Squared terms included	Y	Y
Correlation matrix of residuals:	-0.8390***	

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 shows SUR results with English as the outcome variable and column 2 gives SUR results with Kiswahili as the outcome, (3) The sample is limited to schools including a maximum of 50% of Swahili pupils, (4) Standard errors are indicated below the coefficients and (5) the correlation matrix of residual between the two equations is given at the bottom of the table.*

Appendix K : English and Kiswahili subtasks summary statistics per quartile

	English Letter sound	Kiswahili Letter sound	English Invented word	Kiswahili Invented word	English Oral reading	Kiswahili Oral reading	English Reading compreh.	Kiswahili Reading compreh.
Quartile 1	164	179	278	283	278	278	283	279
Quartile 2	86	85	27	22	29	28	24	27
Quartile 3	40	35	2	2	0	1	0	1
Quartile 4	17	8	0	0	0	0	0	0
	307	307	307	307	307	307	307	307

Amongst the 307 pupils belonging to the first quartile in the two languages (19.52% of the sample), more than 30% of them are in the first quartile for each Kiswahili and English literacy subtask.

Appendix L: Linguistic Fractionalization Index distribution

ELF (minus i)	Freq.	Percent	Cum.
0.00	444	12.91	12.91
0.20	581	16.89	29.8
0.22	66	1.92	31.72
0.24	10	0.29	32.01
0.32	2	0.06	32.06
0.35	246	7.15	39.22
0.37	317	9.22	48.43
0.38	35	1.02	49.45
0.41	18	0.52	49.97
0.41	12	0.35	50.32
0.44	152	4.42	54.74
0.45	21	0.61	55.35
0.47	40	1.16	56.51
0.48	4	0.12	56.63
0.49	440	12.79	69.42
0.50	17	0.49	69.91
0.52	71	2.06	71.98
0.53	34	0.99	72.97
0.56	2	0.06	73.02
0.57	174	5.06	78.08
0.58	2	0.06	78.14
0.59	195	5.67	83.81
0.59	42	1.22	85.03
0.61	5	0.15	85.17
0.62	109	3.17	88.34
0.62	4	0.12	88.46
0.63	20	0.58	89.04
0.64	5	0.15	89.19
0.64	128	3.72	92.91
0.66	20	0.58	93.49
0.67	73	2.12	95.61
0.69	4	0.12	95.73
0.69	67	1.95	97.67
0.72	42	1.22	98.9
0.72	4	0.12	99.01
0.74	13	0.38	99.39
0.75	2	0.06	99.45
0.77	16	0.47	99.91
0.79	3	0.09	100
Total	3,440	100	

Sources: Own calculations based on Midterm evaluation data - PRIMR initiative.

Appendix M: LFI Regressions without home language dummy variables

	Kiswahili scores outcome		English scores outcome	
	(1)	(2)	(3)	(4)
LFI (minus i)	0.114	0.081	-0.072	0.094
	0.098	0.284	0.106	0.253
Peer Kiswahili scores (minus i)	0.748***	0.418		
	0.202	0.494		
LFI x Peer Kiswahili scores (minus i)	-0.16	-0.722*		
	0.157	0.417		
Peer English scores (minus i)			0.519***	-0.665
			0.194	0.624
LFI x Peer English scores (minus i)			0.056	0.106
			0.143	0.474
Female	0.105***	0.096***	0.125***	0.120***
	0.036	0.035	0.039	0.039
Age	0.243***	0.215**	0.152	0.172
	0.089	0.093	0.096	0.109
Age squared	-0.015***	-0.013**	-0.011*	-0.012*
	0.005	0.006	0.006	0.007
At school since January	0.117***	0.111**	0.121***	0.127***
	0.043	0.047	0.046	0.048
Attended pre-school	0.022	0.018	0.028	0.063
	0.059	0.072	0.058	0.07
Repeater	-0.105	-0.101	-0.108	-0.075
	0.074	0.075	0.067	0.068
Attendance interrupted	-0.098**	-0.084	-0.123***	-0.098**
	0.04	0.053	0.039	0.049
Wealth index	0.009	-0.011	0.028**	0.01
	0.013	0.016	0.014	0.019
Kiswahili books at home	0.175***	0.152***	0.151***	0.122***
	0.04	0.042	0.042	0.044
English books at home	0.036	0.06	0.026	0.053
	0.041	0.04	0.038	0.037
Grade	0.221***	0.819***	0.208***	0.812***
	0.039	0.126	0.037	0.106
No. of Obs.	3294	3294	3294	3294
R-Squared	0.28	0.37	0.34	0.42
School control variables	Y	NA	Y	NA
School FE	N	Y	N	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Column 1 and 2 show OLS and FE results of Kiswahili score on LFI, (3) Column 3 and 4 show OLS and FE results of English score on LFI, (4) Standard errors are indicated below the coefficients.*

Appendix N: LFI regressions in a sub-sample excluding schools with no diversity

	Kiswahili scores outcome						English scores outcome					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LFI (minus i)					0.162						0.138	
					0.273						0.23	
Peer Kiswahili scores (minus i)	0.535***	-0.605***	-0.420**	-0.827***	0.057	0.519*						
	0.038	0.149	0.207	0.22	0.521	0.278						
LFI x Peer Kiswahili scores (minus i)					-0.703							
					0.43							
Kiswahili scores Standard Deviation						-0.03						
						0.242						
Peer Kiswahili scores x SD						-1.577***						
						0.367						
Peer English scores (minus i)							0.584***	-0.487***	-0.506**	-0.484**	-0.613	0.500**
							0.032	0.166	0.241	0.231	0.5	0.224
LFI x Peer English scores (minus i)											0.004	
											0.395	
English scores Standard Deviation												-0.073
												0.194
Peer English scores x SD												-1.568***
												0.285
No. of Obs.	3206	3206	1546	1660	3206	3206	3206	3206	1546	1660	3206	3206
R-Squared	0.29	0.38	0.38	0.4	0.4	0.4	0.35	0.43	0.42	0.44	0.44	0.45
Individual control variables (including grade)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Peer control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
School control variables	Y	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	N/A	N/A	N/A
School FE	N/A	Y	Y	Y	Y	Y	N/A	Y	Y	Y	Y	Y

*Notes: (1) Level of significance: * p-value<0.1, ** p-value<0.05 and *** p-value<0.01, (2) Columns 1 and 2 show OLS and FE results of the Kiswahili score on peers' scores, (3) Columns 3 and 4 show OLS and FE results of the Kiswahili score on peers' score in low vs. high diversity schools respectively (4) Column 5 shows FE results of the Kiswahili score on LFI, peers' scores, interaction, and additional peer variables, (5) Column 6 shows FE results of the Kiswahili score on peers' score and peers' score standard deviation, (6) Columns 7 to 12 show corresponding results when English score is the outcome variable, and (7) pupils who belongs to school with a perfect linguistic homogeneity are excluded from the sample.*

Appendix O: LFI Regressions by subtask

	Kiswahili subtask scores outcome								English subtask scores outcome							
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)	(4b)	(5a)	(6a)	(7a)	(8a)	(5b)	(6b)	(7b)	(8b)
LFI (minus i)	0.109	0.169	0.104	0.240**	0.237	-0.054	-0.016	-0.044	0.109	0.186	0.05	-0.342*	0.274	0.068	-0.048	0.004
	0.135	0.112	0.108	0.121	0.216	0.282	0.259	0.368	0.14	0.113	0.111	0.176	0.207	0.254	0.275	0.277
Peer Kiswahili scores (minus i)	0.505*	0.752***	0.757***	0.458*	0.076	0.459	0.72	0.127								
	0.266	0.221	0.202	0.251	0.479	0.512	0.475	0.526								
LFI x Peer Kiswahili scores (minu	-0.034	-0.193	-0.229	-0.023	-0.309	-0.714	-0.917**	-0.492								
	0.201	0.172	0.16	0.186	0.36	0.433	0.406	0.433								
Peer English scores (minus i)									0.463*	0.211	0.192	0.832***	-0.612	-0.425	-0.463	-0.722
									0.26	0.266	0.235	0.245	0.39	0.638	0.613	0.55
LFI x Peer English scores (minus i)									-0.103	0.188	0.241	-0.208	0.3	-0.127	-0.032	0.304
									0.198	0.196	0.171	0.181	0.299	0.499	0.456	0.403
Non-Swahili pupils	-0.191***	-0.077*	-0.083	-0.126**	-0.130**	-0.077	-0.058	-0.093	-0.102**	-0.133***	-0.124**	-0.164***	-0.069	-0.132**	-0.103*	-0.113*
	0.053	0.045	0.053	0.059	0.06	0.05	0.07	0.071	0.047	0.051	0.048	0.05	0.053	0.063	0.059	0.062
Semi-Swahili pupils	-0.049	-0.098	-0.106*	-0.199***	-0.078	-0.088	-0.094	-0.140*	-0.02	-0.160**	-0.168***	-0.124**	-0.047	-0.143*	-0.098	-0.124**
	0.059	0.06	0.06	0.06	0.066	0.068	0.072	0.073	0.059	0.067	0.058	0.053	0.058	0.077	0.068	0.059
English only pupils	-0.036	-0.064	-0.05	-0.064	-0.057	-0.135	-0.111	-0.163	-0.045	-0.067	0.054	0.079	-0.011	-0.112	-0.001	0.144
	0.076	0.078	0.079	0.081	0.083	0.089	0.087	0.099	0.08	0.08	0.08	0.088	0.075	0.087	0.083	0.101
Semi-English&Swahili pupils	0.028	-0.005	-0.062	-0.071	0.01	-0.06	-0.121	-0.107	-0.01	-0.053	-0.022	0.117	0.003	-0.053	-0.017	0.162*
	0.086	0.082	0.077	0.088	0.091	0.086	0.087	0.102	0.083	0.083	0.077	0.082	0.089	0.089	0.085	0.094
Female	0.155***	0.112***	0.106***	0.015	0.162***	0.102***	0.092**	0.002	0.145***	0.109**	0.123***	0.049	0.145***	0.099**	0.115***	0.052
	0.033	0.037	0.037	0.041	0.032	0.037	0.037	0.044	0.033	0.042	0.038	0.039	0.033	0.044	0.039	0.04
Age	-0.015	0.107	0.278***	0.402***	0	0.08	0.235**	0.363***	-0.019	0.155	0.087	0.213**	0.004	0.175	0.082	0.227*
	0.102	0.11	0.099	0.093	0.123	0.105	0.107	0.101	0.1	0.109	0.108	0.098	0.128	0.113	0.114	0.12
Age squared	0	-0.006	-0.016***	-0.024***	-0.001	-0.005	-0.014**	-0.021***	0	-0.01	-0.007	-0.013**	-0.002	-0.012*	-0.006	-0.014*
	0.006	0.007	0.006	0.005	0.007	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.008	0.007	0.007	0.008
At school since January	0.088**	0.098**	0.129***	0.076	0.019	0.104**	0.140***	0.094*	0.122***	0.152***	0.062	0.059	0.063	0.162***	0.098**	0.066
	0.039	0.047	0.047	0.049	0.038	0.05	0.052	0.057	0.044	0.049	0.046	0.054	0.049	0.053	0.049	0.063
Attended pre-school	0.049	0.052	-0.007	-0.009	0.083	0.018	0.007	-0.039	-0.041	0.047	-0.015	0.08	-0.016	0.033	0.01	0.153
	0.059	0.063	0.063	0.062	0.073	0.075	0.074	0.075	0.071	0.066	0.059	0.067	0.088	0.088	0.07	0.096
Repeater	0.029	-0.092	-0.092	-0.143*	-0.026	-0.082	-0.084	-0.135	0.013	-0.067	-0.093	-0.157**	-0.032	-0.042	-0.053	-0.121*
	0.071	0.085	0.078	0.082	0.056	0.093	0.078	0.09	0.064	0.08	0.075	0.073	0.054	0.087	0.08	0.063
Attendance interrupted	-0.072**	-0.089**	-0.108**	-0.072*	-0.039	-0.07	-0.084	-0.096*	-0.092**	-0.054	-0.089**	-0.187***	-0.053	-0.043	-0.098**	-0.126***
	0.036	0.042	0.044	0.042	0.044	0.054	0.057	0.052	0.038	0.041	0.038	0.04	0.047	0.049	0.044	0.045
Wealth index	0.013	-0.001	0.008	0.008	0.017	-0.018	-0.012	-0.013	-0.006	0.007	0.031**	0.043***	0.008	-0.011	0.005	0.033
	0.012	0.013	0.013	0.015	0.013	0.015	0.014	0.02	0.014	0.014	0.013	0.016	0.016	0.017	0.016	0.022
Kiswahili books at home	0.035	0.221***	0.154***	0.167***	0.03	0.200***	0.142***	0.134***	0.01	0.175***	0.179***	0.088*	-0.012	0.146***	0.158***	0.063
	0.041	0.042	0.042	0.044	0.04	0.048	0.043	0.049	0.041	0.045	0.044	0.046	0.042	0.05	0.048	0.045
English books at home	0.069*	0.009	0.02	0.035	0.074*	0.033	0.048	0.058	0.062	0.007	-0.008	0.033	0.058	0.044	0.027	0.043
	0.041	0.041	0.043	0.043	0.04	0.041	0.042	0.046	0.04	0.044	0.04	0.041	0.043	0.045	0.037	0.041
Grade	-0.183***	0.155***	0.326***	0.367***	0.259**	0.707***	0.854***	0.892***	-0.206***	0.116***	0.391***	0.278***	0.091	0.684***	0.942***	0.751***
	0.042	0.043	0.043	0.046	0.104	0.116	0.128	0.117	0.043	0.044	0.041	0.04	0.094	0.103	0.097	0.093
No. of Obs.	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294
R-Squared	0.28	0.2	0.26	0.25	0.42	0.28	0.34	0.33	0.28	0.21	0.35	0.31	0.4	0.3	0.43	0.41
School control variables	Y	Y	Y	Y	NA	NA	NA	NA	Y	Y	Y	Y	NA	NA	NA	NA
School FE	N	N	N	N	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y

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