Bilingual Education and Learning Achievements in Anglophone and Francophone Sub-Saharan Africa

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ABSTRACT

Background: There is limited evidence on the potential benefits of bilingual medium of instruction (MOI) in sub-Saharan Africa.

Purpose: This study examines the association between bilingual MOI and learning outcomes in Senegal and Zambia, analyzes how the association varies among students from different linguistic backgrounds, and estimates how consistent the relational patterns are between the two countries.

Design and methods: The study employs Hierarchical Linear Modelling (HLM) to analyze PISA for Development 2018 data. The data collection followed a two-stage stratified sampling technique where schools were sampled first, and then students sampled within schools. In Senegal, 162 schools with 5220 students were sampled and 186 schools with 4132 in Zambia.

Results: Results show that bilingual MOI is negatively associated with reading but not mathematics and science in Senegal, but it is not associated with any of these learning achievement measures in Zambia. However, the association may be positive or negative across student linguistic backgrounds in both countries. Moreover, the relational patterns between the countries may be consistent or inconsistent depending on the measure of learning achievements or whether we consider a direct or indirect relation. Implications of the findings were discussed.

Keywords: bilingual education, PISA-D, mother-tongue education, instruction language, language policy

Introduction

Language of instruction is central in the debate on education quality in multilingual countries. Research suggests that children learn to read more easily in a familiar language (e.g., mother-tongue or home language) and the skills they acquire in the process help them learn other languages (Melby-Lervåg & Lervåg, 2011). Similarly, learning outcomes of children who learn in a familiar language are higher than those who do not (Stone et. al., 2019; Kirkpatrick & Liddicoat, 2019). Despite this evidence, in classrooms in sub-Saharan Africa (SSA), European languages (which students usually do not understand) are still solely or dominantly used (Kirkpatrick & Liddicoat, 2019). The argument, sometimes supported by studies, is that learning in local languages will have a negative effect on the acquisition of the official language and the learning of other subjects which are more important for success (Piper et al., 2018). Yet, some studies show that the use of international languages as medium of instruction (MOI) is among the reasons for poor learning achievements in African countries (Alidou & Brock-Utne, 2011; Nikièma, 2011).

Out of the debate, an emerging body of literature seems to suggest that rather than choosing either the official language or a local one, bilingual MOI would be the solution to improve learning outcomes (Milligan et al., 2016; Trudell, 2016; Barrett & Bainton, 2016). However, empirical studies on bilingual MOI are dominantly on developed countries, mainly the United States of America. Linguistic contexts may not be transferred (Laitin et al., 2019), so there is a research gap on the benefits of bilingual MOI with regard to SSA. Additionally, little attention has been paid to how bilingual MOI may affect students from different linguistic backgrounds. Studies supporting monolingual or bilingual MOI assume that MOI would improve learning outcomes for all students, but such a "one-size-fits-all" approach may not be supported by multilingual contexts (Milligan & Tikly, 2016). It is therefore crucial to investigate how bilingual MOI matters for learning achievements across linguistic backgrounds.

Comparative studies on language of instruction in SSA mostly compare countries that are geographically close or use the same official language (Brock-Utne, 2007; Trudell, 2016; Piper & Miksic, 2011). However, although this provides valuable insights into the topic, it does not account for potential differences when comparing French-speaking and English-speaking countries in SSA. Former British and French colonizers approached language-in-education in their former African colonies differently, with many legacies seen in current educational practices. These legacies will likely have differential influences on education quality as already shown in other educational aspects (Dupraz, 2019).

This study takes advantage of Program for International Student Assessment for Development (PISA-D) data which includes two countries from the two biggest international languages in SSA (Senegal and Zambia) and examines how bilingual MOI is associated with students' learning outcomes. Specifically, it asks the following questions: (1) To what extent is bilingual MOI associated with student learning achievements in Senegal and Zambia? (2) How does the association vary among students from different linguistic backgrounds in the two countries? (3) To what extent are the relational patterns consistent between the two countries? Based on the literature, we hypothesized that bilingual MOI will be negatively associated with student learning achievements (H1). We also hypothesized that the association will vary among students from different linguistic backgrounds (H2). Furthermore, we hypothesized that the relational patterns will be inconsistent between Senegal and Zambia (H3). In the current debate on the importance of the "language factor" for education quality in SSA, empirical evidence is crucial to guide national and international stakeholders on appropriate evidence-based language-in-education policies.

Overview of Language-in-education policies and practices in sub-Saharan Africa
African countries usually adopt language-in-education categorized in three models. The first is the total endoglossic strategy, in which national languages are the MOI throughout the education system. The second model is the total exoglossic strategy, in which the official language (European language) is used without considering the mother tongue or local lingua franca that children usually speak before starting school. The third model is a combined endo- and exoglossic strategy, with (a) a subtractive multilingual model where the national language is completely substituted sooner (early-exit) or later (late-exit) by the official language or (b) an additive multilingual model where the official language is added to the national language which remains used throughout the education system. Each language-in-education model has different implications, and the most common ones encountered in Africa are the total exoglossic strategies and combined endo- and exoglossic strategies. French-speaking countries tend to adopt the former while English-speaking ones the latter.

Senegal follows the exoglossic strategy model, with French as its official language. French is studied and used as a MOI throughout the system. However, more than twenty languages among the local languages of the country have been officially raised to the status of national languages, after these languages have been codified. Many of the national languages are widely used all over the country while some are common regional languages. In the history of the country, debates on the use of local languages in education have been raised and are still ongoing, with many social and political obstacles preventing their wide use so far. Consequently, French, though not spoken much daily by most people in the country, remains solely or predominantly used in the educational system in Senegal.

Zambia follows the endo- and exoglossic strategy model in its language-in-education policy, with English has been its official language. However, many local languages have the status of national languages in the country. These are regional lingua franca and are used alongside English as school subjects, for functional literacy and public education. English is taught as a subject from grade 2 or 3, while national languages are used as MOI from grade 1 to 4 in primary education. There is emphasis on early literacy to be taught in local languages in Zambian policy. This practice is expected to improve children's oral literacy from their early years, and these skills can be transferred to the learning of English language. English is first taught orally and then in written form. As a whole, Zambian languages are much incorporated in the educational system, but many issues are pointed out as to their actual use. Among the issues are teacher preparedness and the lack of appropriate resources to effectively and efficiently incorporate local languages into the educational system of the country.

Language of instruction and students' learning achievements
Research has shown that instruction in languages children understand enhances their learning outcomes (Harris, 2011; Motala, 2013). In the Latin America and Caribbean, Stone et. al. (2019) found lower reading outcomes for children who were not instructed in familiar languages. Similarly, Seymour et al. (2003) showed that with relevant mother-tongue MOI, children can read in their mother tongue by the end of their second grade. In developed countries, in the United States, Peyton (2015) showed the importance of learning in a familiar language but argued that instructional quality and context are more important. Moreover, Chin et al. (2013) examined how using student's native language as MOI for at least in some subjects affects learning outcomes. They found that the practice does not have a significant impact of learning achievements of students who have Spanish as a home language.

In SSA, Hungi (2011) examined SACMEQ countries and found that speaking the language of instruction is a strong predictor of students' achievement in almost all concerned countries. Trudell and Piper (2014) also compared reading achievements for students studying in local language MOI context and those who are not. They found that the former is able to understand what they read, while the latter struggle in understanding what they read. Moreover, Taylor and von Fintel (2016) examined children in South African schools and found that those who were taught in their mother tongue in their early primary school grades showed better English achievements in later grades compared to those taught in English in their early grades. In French-speaking Africa, studies show that the sole or dominant use of French as a MOI is one of the main reasons for the poor learning outcomes (Alidou & Brock-Utne, 2011; Nikièma, 2011). They suggest that teaching is effective when the language used is one that students are familiar with. Oppositely, another body of literature showed that instruction in a language familiar to student does not improve learning achievements and this can be explained by most teachers not being prepared to teach using local languages (Bikongoro 2015; Kombe and Mwanza, 2019; Tambulukani & Bus, 2012).

Piper et al. (2018) examined mother tongue MOI and found that it does affect student learning outcomes. The study even suggests that it decreases student mathematics achievements.

Findings on the benefits of learning in a familiar language are still a subject of debate. Alongside this debate, a relatively new and increasing body of literature seems to support bilingual education as a way to improve learning outcomes (Barrett & Bainton, 2016; Milligan et al., 2016; Trudell, 2016; Wiley & García, 2016). For example, Chin (2015) shows that bilingual MOI may help students who have limited proficiency in the foreign language learn it while keeping up with other subjects, and it also helps these students develop literacy skills in their own language. Moreover, some studies have demonstrated that bilingual MOI gives a cognitive advantage to students because it develops their cognitive skills in terms of competence of learning to learn (Diezmas, 2017; Méndez, 2014). Furthermore, Cummins (2010) argues that bilingual education is "the only option" for equitable education for all children in this century.

Despite these arguments for bilingual MOI, empirical studies are polarized towards developed countries, not necessarily transferable to the context of SSA (Laitin et al., 2019). For example, language minority students in developed countries study in a dominant language which they have high daily exposure to, while students in SSA have low exposure to the foreign language of instruction after classes (Ramachandran, 2017). Few studies have investigated the argument on the effectiveness of bilingual education in SSA, a research gap which needs to be investigated. Additionally, most studies language of instruction do not account for potential differential effectiveness of the practice across student linguistic backgrounds, due to for example some given hidden mechanisms or other instructional factors that may play a role (Tambulukani & Bus, 2012). Furthermore, studies on SSA are usually geographically or linguistically constrained (Piper & Miksic, 2011; Trudell, 2016). There is almost no cross-country systematic quantitative evidence on French and English-speaking SSA; yet, there seems to be evidence to expect different outcomes from the same practices when comparing the two groups (Dupraz, 2019) .

Methods

This study uses data from the PISA-D 2018 administered by the Organization for Economic Co-operation and Development. PISA-D 2018 covers eight countries, i.e., Bhutan, Cambodia, Ecuador, Guatemala, Honduras, Paraguay, Senegal, and Zambia. This study uses the samples on the last two countries for its analysis. In each country, PISA-D targeted 15-year-old students in grade 7 and higher and collected information on them, their schools, teachers and principals. The data collection followed a two-stage stratified sampling technique. The first-stage units consisted of schools that have eligible students. Applying Probability Proportional to Size sampling technique, the program sampled schools from a national list of eligible schools. The measure of size was function of the number of eligible students in the school. The units in the second stage of the sampling approach were students within selected schools. PISA-D set a Target Cluster Size (TCS) in each school, typically 42 students, but this value could vary with agreement with given countries. Additionally, when the school had less than the TCS, all students within that schools were selected.

Each country had to sample at least 150 schools which contain eligible students. In Senegal, 162 schools with 5220 students were sampled and 186 schools with 4132 in Zambia. Respondents included in the data are students who completed at least half of the cognitive items in any of the domains covered by the program. Overall, the technical standards in terms of number of schools (≥ 150), school response rate (85%), and student response rate (80%) were met by all participating countries. However, the data used in this

study presented a few missing values, and these were handled using multiple imputation. This method yielded results which were similar to those of the complete case analysis.

PISA-D assessed students' reading, mathematics, and science achievements. We use the three measures as dependent variables in this study. By doing so, we can also explore if the results of the analysis vary across subjects. OECD (2018) provides a framework for the development of each measure. Specifically, reading achievements measure students' skills in understanding, using, engaging and reflecting on texts in written form in order to develop oneself or participate in society. Mathematics achievements measure students' abilities to formulate, use, and interpret mathematics in various contexts relevant to participate in society. Science achievements measure students' abilities to design and assess a scientific inquiry, to interpret data and evidence and explain phenomena scientifically.

Table 1: Definition of variables used in the analysis

Variable	Definition
Reading	Student reading score at PISA-D
Math	Student math score at PISA-D
Science	Student science score at PISA-D
Male	Student gender 1 = male
Age	Student age in years
Family SES	Student family socio-economic index
School attitude	Student attitudes towards schooling index
No books at home	Student has no books at home
Grade repetition	Student has repeated at least one grade in previous years
Home language	Language student speaks at home most of the time
Language of instruction	Language that teacher uses when teaching students in that school
Only official language	Teacher uses only the official language (French/English)
Bilingual MOI	Teacher uses language of instruction and student home language
Public school	School is a government school
Teacher has training	Teacher has completed a pre-service training
Teacher experience	Teacher experience in years
Teacher experience 2	Teacher experience squared
Teaching resources	Index of instructional resources available to teacher
No textbook	Student is not provided with textbooks at school
Class size	Number of students in a classroom
Urban	School is in an urban area

PISA-D questionnaires were drawn from PISA but complemented based on questions from other regional studies and in consultation with participating countries. The school level questionnaire involved 33 questions administered to teachers in each school. It captures the language of instruction that teachers use in classrooms, that is whether the teacher uses only the official language the country (French for Senegal and English for Zambia) or the teacher uses student home language alongside the official one as a MOI. The resulting language of instruction variable used in this study is then a binary one that captures whether the teachers use only the official language of instruction or uses both the official language and student one when teaching. Therefore, bilingual teaching in the approach of this study refers to the utilization of two languages as the MOI and differs from the teaching of a second language as a subject (Wiley and García 2016).

In terms of the student home language and other background information, it was captured though a student questionnaire that contained 49 questions. This student questionnaire

captured various student demographic factors including gender, age, family socio-economic status (SES). Many of these demographic factors were controlled for in the analysis. Table 1 presents the definition of variables used and table 2 the descriptive statistics.

Table 2 Descriptive statistics of variables used in the analysis

Variable	Zambia Mean	Std. Dev.	Senegal Mean	Std. Dev.
Reading	294.835	72.915	306.644	72.524
Math	275.995	75.193	306.216	80.455
Science	324.062	59.706	309.153	54.057
Male	0.478	0.500	0.465	0.499
Age	15.821	0.301	15.855	0.255
Family SES	-1.275	1.337	-1.726	1.346
Attitudes toward school	7.281	2.532	7.452	2.161
No books at home	0.204	0.403	0.265	0.441
Grade repetition	0.358	0.479	0.469	0.499
Student home language				
English	0.192	0.394		
Cinyanja	0.161	0.367		
Chitonga	0.106	0.308		
Icibemba	0.379	0.485		
Kiikaonde	0.017	0.130		
Lunda	0.022	0.146		
Luvale	0.027	0.162		
Silozi	0.066	0.248		
French			0.072	0.259
Pular			0.182	0.386
Serer			0.111	0.314
Diola			0.051	0.220
Wolof			0.515	0.500
Another language	0.031	0.173	0.069	0.254
Language of instruction				
Only official language	0.184	0.388	0.436	0.496
Bilingual MOI	0.816	0.388	0.564	0.496
Public school	0.942	0.234	0.857	0.350
Teacher has training	0.196	0.397	0.340	0.474
Teacher expereince	19.100	27.601	12.876	17.357
Teacher experience 2	1126.422	2922.483	466.976	1770.432
Intruction resources	3.762	0.645	3.521	0.657
No textbooks	0.072	0.259	0.052	0.221
Class size	45.102	10.350	33.889	16.553
Urban school	0.467	0.499	0.618	0.486

The analysis employed hierarchical linear modeling (HLM). Students going to the same school are likely to share similarities relative others attending another school. This can be due to, for example, the backgrounds they come from or the processes they are exposed to. As such, their learning outcomes will depend not only on their individual differences, but also the differences in schools they attend. An analysis that does not account for both differences at the same time is likely to produce biased estimates (Hofmann, 1997). HLM accounts for these differences by clustering students within schools, to separate the variability in outcomes due to the school they attend and the variability due to their background differences (Woltam et al, 2012).

The analysis of the study was done following a step-wise approach. In the first step, a null model, model 1, was estimated. After the null model, in the second step, a model 2 was estimated by including student background predictors. Next, the third step consisted of estimating model 3 which includes school level predictors. Model 3 allowed to estimate the direct effect of our variable of interest, language of instruction, on the outcome variables and thereby answer our first research question. In order to answer our second research question, we estimated a model 4 by including a cross-level interaction term between language of instruction and student home language. The final model is specified in equation 1:

$$y_{ij} = \beta_{0j} + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \beta_3 x_{3ij} + \beta_4 x_{4ij} + \beta_5 x_{5ij} + \beta_6 x_{6ij} + \beta_7 x_{7ij} + \gamma_{01} w_{1j} + \gamma_{02} w_{2j} + \gamma_{03} w_{3j} + \gamma_{04} w_{4j} + \gamma_{05} w_{5j} + \gamma_{06} w_{6j} + \gamma_{07} w_{7j} + \gamma_{08} w_8 + \gamma_{09} w_{8j} * x_{7ij} + u_{ij} + \varepsilon_{ij} \quad (1)$$

$$u_{ij} \sim N(0, u_u^2)$$
$$e_{ij} \sim N(0, \sigma_e^2)$$

Where:
y_{ij} is the learning achievements of student i in school j
β_0 is the overall mean across schools;
$x_{1ij} \sim x_{7ij}$ are student level covariates
$w_{1j} \sim w_{8j}$ are school level covariates (including language of instruction variable)
u_j is the effect of school j on learning achievements
ε_{ij} is the student level residual term

Throughout the explorative approach of the analysis, the fit of subsequent models relative to preceding ones was checked by using the deviance statistics. For such an approach, estimations were done using maximum likelihood, which provided the log likelihood that is needed to compute the deviance statistics (- 2 X log likelihood). Higher deviance statistics estimates for a more complex model indicate a poor fit of the model, suggesting dropping "newly" added variables and exploring other ones (Anderson 2012). Furthermore, some studies suggest centering part of or all the variables around the grand mean or the group mean (e.g., Enders & Tofighi, 2007). However, some other studies indicate that the practice has statistical implications and may result in estimating a model different than the one intended (Hofmann & Gavin, 1998; Ita et al., 1995; Paccagnella, 2006). Consequently, variables were not centered before the analysis. Estimations were carried out using Stata 16.1.

Findings & Discussion
The first research question of the analysis compares the use of only the official language as a MOI (French for Senegal and English for Zambia) and bilingual MOI. To improve readability, results presented are models 3 and 4 and only the main variables of interest. Table 3 presents the results on Senegal. Model 3 indicates the direct association between language of instruction and student learning achievements. It indicates that bilingual MOI is negatively associated with student reading achievements. Specifically, students being taught using bilingual MOI score about 13 grade points lower than their peers who are taught using only French, statistically significant at 1% level. In terms of mathematics and science achievements, results show that bilingual MOI is negatively associated with their learning achievements but not statistically significant for both outcomes. In other words, our results indicate that there is no statistical evidence to support an association between bilingual MOI and mathematics and science achievements in Senegal.

Table 3: Association between bilingual MOI and student learning outcomes (Senegal)

Variables	Reading achievements		Math achievements		Science achievements	
	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4
Pular	-0.693	-26.080	-16.390	-29.299*	-2.672	-17.696
	(9.413)	(19.573)	(14.092)	(16.304)	(6.935)	(11.360)
Serer	-4.295	-31.294	14.272	-17.140	-5.456	-32.052**
	(9.036)	(19.816)	(13.127)	(18.005)	(6.110)	(12.681)
Diola	-21.461**	-42.765**	-8.618	-35.162*	-19.169*	-40.703***
	(10.906)	(19.846)	(14.947)	(18.563)	(10.348)	(14.633)
Another Lang.	8.528	-2.312	5.838	-9.841	4.391	-11.133
	(9.388)	(19.191)	(13.596)	(23.364)	(7.228)	(12.257)
Wolof	13.633	-3.735	8.961	-11.078	5.159	-13.285
	(8.336)	(19.180)	(13.001)	(16.221)	(5.135)	(10.707)
Bilingual MOI	-13.734***	-42.385**	-5.689	-32.074	-6.015	-31.191**
	(4.076)	(19.711)	(6.743)	(23.606)	(4.507)	(12.824)
FrenchXPular		38.714*		18.554		22.055*
		(20.454)		(26.533)		(13.399)
FrenchXSerer		37.346*		42.967*		36.826**
		(22.089)		(24.974)		(14.829)
FrenhXDiola		37.412*		56.766**		41.944***
		(21.281)		(25.381)		(13.689)
FrenchXAnother Language		16.492		24.223		23.584
		(22.172)		(27.812)		(14.875)
FrenchXWolof		25.927		29.305		27.070**
		(20.363)		(22.586)		(12.018)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: the base language of instruction is "French only"
    Another Lang.: another local language

The association between language of instruction and student learning achievements may vary depending on student linguistic background. Our second research question tests this potential by accounting for an interaction term and results presented in model 4 still in table 3. In terms of reading achievements, results indicate a significant interaction term for students with Pular, Serer, and Diola home language backgrounds, statistically significant at 10% level. The direction of the interaction term is plotted in the upper left panel of figure 1 and it indicates downward slopes for all the three languages. This means that the negative effect of using bilingual MOI is worse for students from these three linguistic backgrounds. Similarly, a statistically significant interaction is found for students of Serer and Diola language backgrounds in terms of mathematics achievements, at 10% and 5%, respectively. The direction of the interaction presented in the upper right panel of figure 1 indicates upward slopes. This indicates that even though bilingual MOI is not related to student mathematics achievements from an overall perspective, it is for students from Serer and Diola linguistic backgrounds. In terms of science achievements, the interaction is significant

for students from Pular, Serer, Diola, and Wolof. The lower left panel of figure 1 indicates that bilingual MOI improves the science achievements of students from Serer and Diola background but decreases the science achievements of those from Pular and Wolof backgrounds.
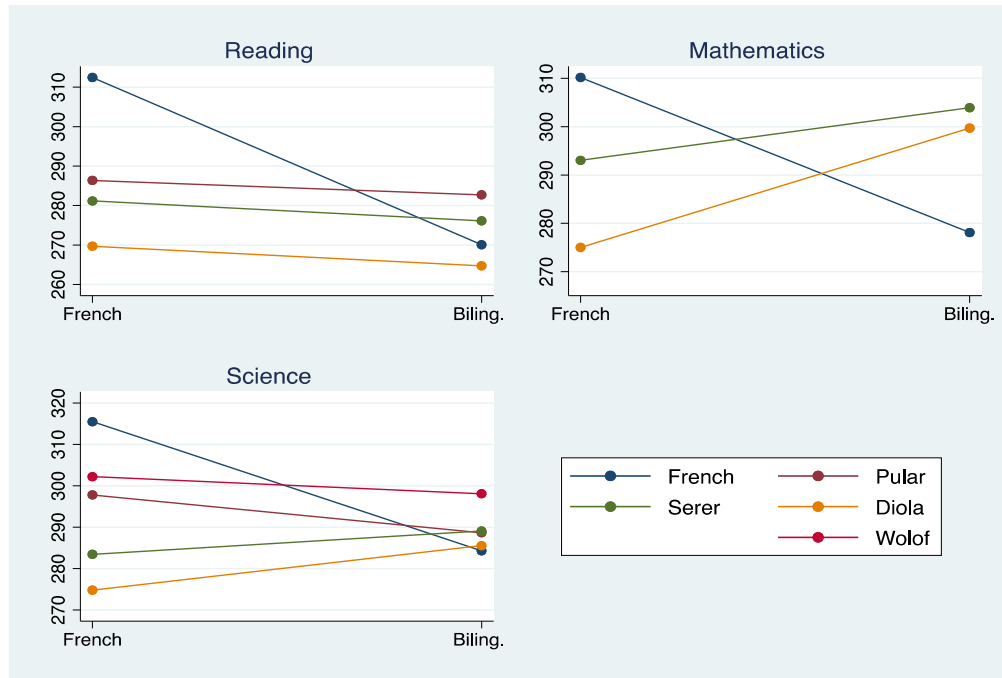

Figure 1: The effect of language of instruction across student home language in Senegal
Note: "Biling." refers to "bilingual MOI"

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Table 4: Association between bilingual MOI and student learning outcomes (Zambia)

Variables	Reading achievements		Math achievements		Science achievements	
	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4
Cinyanja	-7.425	-20.788***	-8.852	-18.503***	-2.114	-9.506*
	(4.561)	(7.106)	(5.719)	(6.579)	(3.280)	(5.332)
Chitonga	-22.183***	-40.582***	-17.204**	-36.414***	-19.303***	-32.241***
	(6.787)	(10.566)	(6.919)	(11.946)	(4.640)	(8.930)
Icibemba	-14.115***	-23.206***	-9.137**	-11.036	-8.391**	-8.018
	(3.717)	(6.106)	(4.052)	(7.844)	(3.618)	(5.768)
Kiikaonde	-22.072***	-36.420**	-30.012***	-62.343***	-20.233***	-31.618**
	(8.470)	(15.945)	(9.781)	(15.654)	(7.376)	(15.391)
Lunda	-13.545**	-12.500	-28.496**	-26.151	-5.975	-13.238
	(6.552)	(15.483)	(11.490)	(17.126)	(6.087)	(14.801)
Luvale	-32.993***	-50.808***	-16.803***	-26.004**	-12.402***	-13.680*
	(8.460)	(11.991)	(6.420)	(11.279)	(4.446)	(8.062)
Silozi	-21.577***	-26.117***	-29.460***	-35.274***	-17.787***	-18.619**
	(7.092)	(8.742)	(7.222)	(8.622)	(5.111)	(7.899)
Another Lang.	-19.010**	-30.176***	-12.620	-29.951***	-12.822*	-21.321**
	(7.886)	(8.987)	(10.126)	(11.215)	(6.662)	(9.950)
Bilingual MOI	-7.951	-19.346***	-2.757	-12.256	-5.640	-9.813
	(5.110)	(7.293)	(5.656)	(7.564)	(4.241)	(7.232)
EnglishXCinyanja		15.865*		11.375		8.578
		(8.217)		(8.668)		(6.226)
EnglishXChitonga		21.446*		22.063*		14.722
		(11.790)		(12.768)		(9.536)
EnglishXIcibemba		11.234		2.214		-0.581
		(7.220)		(9.063)		(6.844)
EnglishXKiikaonde		18.178		41.633*		14.701
		(22.084)		(21.710)		(22.606)
EnglishXLunda		1.261		-1.758		8.340
		(18.159)		(24.413)		(16.525)
EnglishXLuvale		24.365		10.963		1.158
		(16.503)		(14.545)		(10.380)
EnglishXSilozi		4.681		6.618		0.866
		(9.750)		(8.831)		(9.549)
EnglishXAnother language		13.229		20.440		9.886
		(11.337)		(14.610)		(11.158)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: the base language of instruction is "English only"

     Another Lang.: another local language

The results for Zambia are presented in table 4. The direct association presented in model 3 indicates that bilingual MOI is negatively associated with reading, mathematics, and science achievements. However, the negative association is not statistically significant. In other words, there is not statistical evidence to support that bilingual MOI is associated with students' learning achievements in Zambia. An interaction term explores whether these findings vary across students from different linguistic backgrounds, and results are presented in model 4 in table 4. In terms of reading achievements, the interaction is statistically significant for students from Cinyanja and Chitonga backgrounds, at 10% for both languages. The left panel of figure 2 indicates a decreasing slope for students speaking Cinyanja and slightly increasing one for students speaking Chitonga. This means that

bilingual MOI reduces the reading achievements of the former but increases them for the latter. In terms of mathematics achievements, the interaction term is statistically significant for students from Chitonga and Kiikaonde language backgrounds. The right panel on figure 2 indicates upward slopes for students from both linguistic backgrounds. This suggests that bilingual MOI improves the mathematics achievements of students from Chitonga and Kiikaonde language backgrounds.
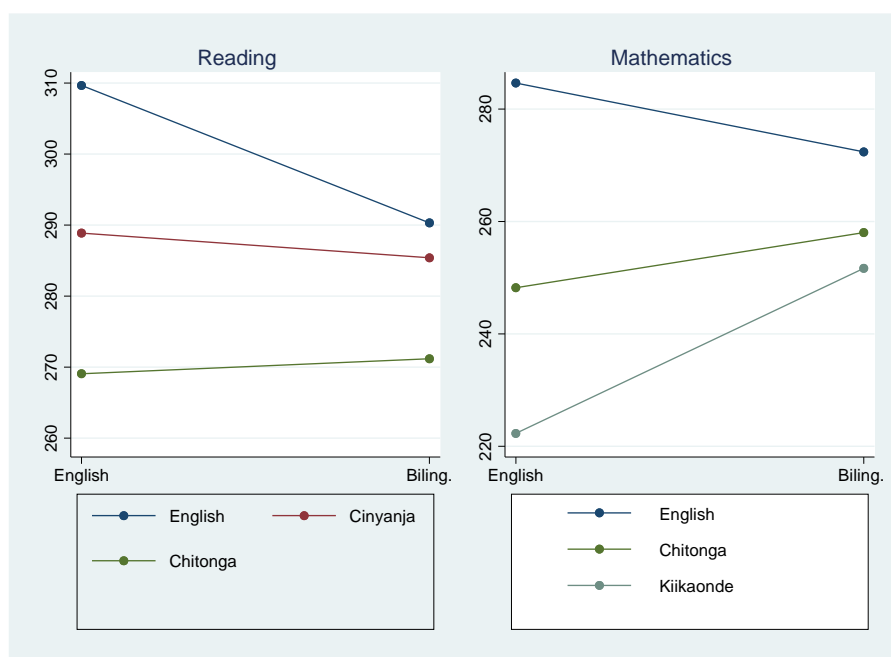

Figure 2: The effect of language of instruction across student home language in Zambia
Note: "Biling." refers to "bilingual MOI"

The third research question of this study examines whether the relational patterns on bilingual MOI and student learning achievements are consistent between Senegal and Zambia. The consistency of the results is considered from the perspective of a direct association as presented in models 3 in tables 3 and 4, and from the perspective of an indirect association as presented in models 4 in the same tables. The presentation of the consistency is also done while considering each measure of learning achievements used in the analysis.

From the perspective of a direct association, it can be said that the relational patterns between language of instruction and learning achievements between Senegal and Zambia are inconsistent for reading achievements. Bilingual MOI in negatively associated with reading achievements in Senegal but not in Zambia. However, the relational patterns of the direct association between bilingual MOI and learning achievements between the two countries are consistent for both mathematics and science achievements. In both countries, no statistically significant association was found between these two measures of learning achievements and bilingual MOI. From the perspective of the indirect association, the relational patterns between language of instruction and learning achievements across students from different language backgrounds are consistent for reading and mathematics achievements but not for science achievements. The results show that in the two countries, the association between bilingual MOI and learning achievements in reading and mathematics vary depending on the linguistic background of the student. However, there is variation of the association between bilingual MOI and science achievements across student home language in Senegal, but not in Zambia.

Discussion

The objective of this study was to examine the association between bilingual MOI and student learning outcomes in Senegal and Zambia, analyze how the association varies among students from different linguistic backgrounds, and estimate how consistent the relational patterns are between the two countries. The analysis was used three measures of learning achievements, i.e., reading, mathematics, and science. While previous studies suggest that bilingual MOI is expected to increase learning achievements, few of such studies were carried out on SSA, and those that were do not account for a potential variation across student linguistic backgrounds. Moreover, language-in-education policies are different between French-speaking and English-speaking SSA, but few studies examined a potential differential effectiveness of practices between the two groups.

Findings revealed that bilingual MOI is negatively related with reading achievements in Senegal but it is not associated with mathematics and science achievements. No statistically significant association was found between bilingual MOI and the three measures of learning achievements in Zambia. Therefore, our first hypothesis that bilingual MOI will be negatively associated with student learning achievements is confirmed only for Senegal, in terms of reading achievements. These findings are consistent with Chivhanga & Chimhenga (2013). A plausible explanation for the finding may be that in Senegal, teachers who are using student home language in addition to French to teach do not use the former much enough to offset the negative relation between using the official language and reading achievements. Senegal is one of the typical French-speaking countries in SSA which tend to use exoglossic language-in-education policies, to some extent as a legacy from its former colonizer. Subsequently, in classrooms, teachers solely or dominantly use French as a MOI, and they are sometimes supported by many parents who are against the use of local languages as a MOI. This low use of the local languages in classrooms is often referred to as teacher resistance to use local languages (Piper et al. 2018). From this perspective, this study adds to the literature which demonstrates that teachers may be reluctant to use local languages in classrooms, which reinforces the view that they are important mediators of language policy practices at the classroom level (Henderson 2017).

Oppositely, in Zambia, there is a focus on early literacy in national languages, with the expectation that acquired literacy skills can be used to learn the official language more smoothly (Taylor and von Fintel, 2016). As such, it is not surprising that no direct negative association is found between bilingual MOI and reading achievements in Zambia. Children must be much used to teachers using their language when learning, which smoothens the learning process. Nevertheless, our first hypothesis is not confirmed for mathematics and science, consistent with García-Centeno et al. (2020). A plausible explanation is that using local language to explain mathematical and scientific concepts consistently is complex for teachers. Most teachers in SSA are likely not have an adequate training to implement bilingual education, if they have it at all. Studies have highlighted that it is almost impossible to implement bilingual education efficiently in contexts where teacher lack capabilities in this type of teaching (Mwanza 2020; Chin 2015). Moreover, studies have pointed out the lack of appropriate mathematics or science instructional and learning materials in local languages in SSA (Chivhanga & Chimhenga, 2013). This also makes it almost impossible for the addition of local languages in teaching to show learning gains, unless teachers are skilled enough to accurately translate content into the various languages each classroom usually accommodates.

Findings show that the association between bilingual MOI and learning achievements varies across student linguistic background in all three measures of learning achievements for Senegal and only two measures (reading and mathematics) for Zambia.

This confirms our second hypothesis that the association between language of education and learning achievements will vary among students from different linguistic backgrounds. These findings suggest that bilingual MOI may create learning inequities among students, opposite to Cummins (2010) who supported that bilingual MOI is the only way to provide equitable education for all children. An explanation of the finding may be that both Senegal and Zambia may lack teaching and learning materials in local languages, but some languages are more disadvantaged relative to others. In other words, disproportional availability of teaching and learning materials across local languages may be an important factor to understand how bilingual MOI may benefit student learning achievements in SSA. Chin (2015) highlighted the the lack in these materials in some student languages may make bilingual teaching challenging. However, the results show that bilingual MOI benefits students from given linguistic backgrounds, but this may suggest a need to also address other relevant teaching and learning factors (Brock-Utne & Mercer 2014; Cheung & Slavin 2012; Chin 2015).

Findings also revealed that the direct association between language of instruction and learning achievements is inconsistent between Senegal and Zambia for reading achievements but not for mathematics and science achievements. Therefore, our third hypothesis that the relational patterns will be inconsistent between Senegal and Zambia is confirmed for reading achievements but not for the other two measures of learning achievements. This difference across learning achievements measures may be explained by the different language-in-education policies between the two countries. While Senegal dominantly uses French from the early to the later stages of education and in all subjects, Zambia uses local languages in initial education, with a focus on early literacy to be done in languages students are familiar with. Students in Zambia and may use skills in their languages to learn English or at least reduce the obstacles they may have in learning it. However, Piper et al. (2018) showed that transferring these skills to learn other subjects is not obvious, which may explain the non-significant direct effect for mathematics and science in Zambia. In Senegal, children have no previous literacy background to rely on to learn French. Therefore, a combined endo- and exoglossic strategy seems to benefit students more, at least in literacy.

Contrary to our expectations, the relational patterns between language of instruction and learning achievements across student of different language backgrounds in Senegal and Zambia are consistent for reading and mathematics achievements. Such findings may suggest that though the language-in-education practices are different between the two countries, their linguistics contexts remain similar. The two countries have many languages, with some of them having the official status of national languages. A national language in both countries is usually a regional lingua franca that many children are likely to speak and use daily. Incorporating local languages in the educational systems of two countries with such a similar linguistic context is likely to produce similar results. However, the inconsistency in the indirect effect for science achievements may be due to specific factors related to science education that would be interesting to investigate in future studies.

Conclusion

Research on the potential benefits of bilingual MOI in SSA is limited. This study examined the association between bilingual MOI and student learning achievements in Senegal and Zambia, how the association varies among students of different linguistic backgrounds, and how consistent the relational patterns are between the two countries. Our results suggest that bilingual MOI in itself is not able to improve student learning achievements, but may even worsen them in learning domains like reading. However, there may be learning achievement

benefits of bilingual MOI for certain linguistic backgrounds, but learning inequalities for some other ones. Furthermore, the relational patterns between the country may be consistent or inconsistent depending on the measure of learning achievements or whether we consider a direct or indirect relation.

These results, though encouraging for at least the languages that showed learning achievements benefits, seems not to address the concerns on whether local languages should be used alongside the foreign one in educational systems. With bilingual education, children may be able to get some reading skills in the language they are familiar with, but in other subjects, they are likely not to benefit from it. This study reiterates that language of instruction is one feature of education quality. Student learning outcomes may be improved through bilingual MOI, but other features that determine learning outcomes also need to be addressed. These features of learning quality include, among others, adequate teacher professional development, relevant teaching a learning material, and curriculum reforms. Though they are expensive, they are not impossible to provide.

Furthermore, for SSA, what also needs to be highlighted is that the use of a foreign language in itself is not a problem, but the way local languages are devalued and disregarded in formal educational systems in most countries in the region. Global players have brought international languages to be given pride of in educational and social contexts, and they are perceived as signs of economic prosperity and global citizenship. Many are even convinced that 'African languages are not useful for learning and communication in the twenty-first century' (Trudel 2016, 289). However, there is a need to turn such practices and convictions around. In order to promote more inclusion and diversity, which are important factors of social and economic development, language-in-education policies in SSA need to be forward-looking and follow some guiding principles, such as no linguistic discrimination and measures to protect and guarantee education access, the respect for multilingual capacity and for the various individual languages, and the establishment of language capacity programs in various languages (Spolsky, 2011). For example, books in local languages can be developed and produced for language capacity development or awareness-raising programs, and involvement of more stakeholders in language decisions may be promising towards the change in the way African languages are approached in education and society.

This study has some limitations that need to be noted. First, the variables used to operationalize language of instruction did not allow a categorization of the concept of bilingual MOI, which leaves a limitation as to potential differences in effect depending on categories of bilingual MOI (e.g., transitional bilingual education and dual language bilingual education). Further research is therefore needed to determine whether different types of bilingual MOI can improve student learning outcomes or not. Second, the study used cross-sectional data and does not show causality but correlations. Further studies reproducing our findings over time may help show causality. And third, classrooms in SSA usually accommodates many languages because students are from many different linguistic backgrounds. Subsequently, the classroom environment becomes a multilingual one, which can also have spillover effects on students. Such issues could not be addressed by this study and they are potential paths for future research.

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