Determinants and Consequences of Language-in-Education Policies: Essays in Economics of Education

Garrouste, Christelle
Department of Education, Institute of International Education (IIE), Stockholm University

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DETERMINANTS AND CONSEQUENCES OF LANGUAGE-IN-EDUCATION POLICIES

Essays in Economics of Education

Christelle Garrouste

Institute of International Education
Department of Education
Stockholm University
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Institute of International Education
Department of Education
Stockholm University
SE-10691 Stockholm, Sweden

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To my father

ABSTRACT

This thesis consists of three empirical studies in economics of education on the determinants and consequences of language-in-education (LiE) policies. The "Environmental settings – Inputs – Processes – Immediate outcomes – Long-term outcomes" (EIPOL) evaluation model is applied to LiE policies and programs and serves as the overall framework of this research (see Introductory Chapter). Each study then targets at least one stage of the EIPOL framework to test the validity of the "green" vs. "free-market" linguistic theories. Whereas the two first studies derive models tested empirically in the African context, the third is tested on a sample of countries from the International Adult Literacy Survey (IALS).

The first study, *Rationales to Language-in-Education Policies in Postcolonial Africa: Towards a Holistic Approach*, considers two issues. First, it explores the factors affecting the choice of an LiE policy in 35 African countries. The results show that the countries adopting a unilingual education system put different weights on the influential parameters than countries adopting a bilingual education system and that both groups of countries validate somehow both the "green" and the "free-market" approaches. Second, the article investigates how decision makers can ensure the optimal choice of language(s) of instruction by developing a non-cooperative game theoretic model with network externalities. The model shows that it is never optimal for two countries to become bilingual, or for the majority linguistic group to learn the language of the minority group, unless there is minimum cooperation to ensure an equitable redistribution of payoffs. This finding confirms the "free-market" theory.

The second study, *The Role of Language in Learning Achievement: A Namibian Case Study*, investigates the role played by home language and language proficiency on mathematics scores of 5048 Grade-6 learners in 275 Namibian schools, via the second survey data by the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ). Hierarchical linear modeling is used to partition the total variance in mathematics achievement into its within- and between-school components. Results of the analysis show that although home language plays a limited role in explaining within- and between-school variations in mathematics achievement, language proficiency, when proxied by reading scores, plays a significant role in the heterogeneity of results. Thus, confirming the role of language skills in learning achievement and so validating the "green" theory.

Finally, the third study, *Language Skills and Economic Returns*, investigates the economic returns to language skills, assuming that language competencies constitute key components of human capital. It presents results from eight countries enrolled in the International Adult Literacy Survey (IALS). The study finds commonalities between countries in terms of the valuing of language skills, independent of the type of language policy applied at the national level. In each of the eight countries compared, skills in a second language are estimated to be a major factor constraining wage opportunities. This study validates the "free-market" theory.

Descriptors: Language-in-education policies, decision making analysis, non-cooperative game, language skills, hierarchical linear modeling, human capital theory, rate of return analysis, post-colonial Africa, IALS, SACMEQ

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CONTENTS

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This thesis is the result of a long intellectual and life journey, which started many years ago when I was still a little girl and was listening to my family's stories about former French Indochina and Africa. My need to explore my family's history and, beyond that, to understand the tenants and consequences of that significant piece of World's history that is colonialism, have motivated me to study fervently international economics and international relations at university. I was seeking answers to naive questions, such as, what impact does colonialism still have on former colonies and how can these countries emerge successfully from that past. During an internship at UNESCO in 2001, I came across the very specific field of international and comparative education and realized what powerful tools it could provide me to explore these questions. It became then obvious that the way national education policies were formulated was not only one of the tenants and consequences of colonialism, but also one of the keys for former colonies to move forward from that past.

Consequently, in 2002, I moved to Sweden, Stockholm, and embarked on a long and exciting PhD journey at the Institute of International Education (IIE). The people met there have all greatly stimulated me intellectually by their exceptional world culture, field experience and/or scientific knowledge. The fact that IIE is in the true sense of the word an international and cross-disciplinary working environment fulfilled all my expectations as a young and hungry-for-knowledge researcher. The support from Professor Chinapah, who advised me to apply to IIE, Professor Tuijnman, who was my initial supervisor at IIE, and Professor Daun, who took over my supervision during the later stages of my thesis, has enabled me to explore freely all the corners of this topic. Thanks should also be addressed to Dr. Benson from the Center of Bilingual Studies at Stockholm University and Dr. Limage from UNESCO for their support and enthusiasm for my topic and feedback on early drafts of Study I, and Dr. Taylor for proof reading the introduction of this work.

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Last but not least, I want to dedicate this work to my loving family who has brought me where I am today, especially my beloved Dad, my Mum and my brother Erik, but also Massimo who knows how to stimulate my soul and brain like no other and who is leading me through my next life journey.

Christelle Garrouste

Stockholm, November 2007

INTRODUCTION

> *The dominant monolingual orientation is cultivated in the developed world and consequently two languages are considered a nuisance, three languages uneconomic and many languages absurd. In multilingual countries, many languages are facts of life; any restriction in the choice of language is a nuisance; and one language is not only uneconomic, it is absurd* (Pattanyak, 1984; quoted by Skutnabb-Kangas & Garcia, 1995, p. 221).

1. General Framework of the Thesis

The present thesis builds upon the paradoxical position endorsed by the education sector as a mediator between two opposite linguistic theoretical approaches. On the one hand, the "green" theory of ecological protection claims that endangered languages should be protected by all means respecting linguistic human rights. On the other hand, the "free-market" theory advocates for a homogenization of the market's communication tools to facilitate trade in globalized markets (Kibbee, 2003)[1].

It is in this complex ideological environment that education policies have to define which language(s) should be selected as media of instruction within the classroom. Answering that question is of course not straightforward since the type of language-in-education (LiE) policy adopted by a government reflects its social, cultural and economic ambitions.

The present thesis adopts a holistic approach to the choice of LiE policies by suggesting the consideration of both the rationales and the consequences of an LiE option in the decision making process. Such an approach enables the constructive confrontation of the two theoretical linguistic schools by highlighting their complementarities rather than their oppositions. More concretely, this thesis opts for the "Environmental settings – Inputs – Processes – Immediate outcomes – Long-term outcomes" (EIPOL) grid of evaluation suggested by Bhola (1990). Within this grid, *environmental settings* aim at providing information on the settings to be able to make planning decisions; *inputs* aim at making programming decisions such as alternative project designs and personnel decisions; *process* aims at making decisions related to methodologies and implementation; *immediate*

[1] For more details about the tenants of this debate, see Study III.

outcomes cover learning outcomes and other intermediary outcomes of the program; and *long-term outcomes* cover the long-term effects of the program on the educational and socio-economic domains (ibid.).

The environmental settings are here defined according to Lewis' (1980) classification in terms of diffusion variables, setting variables and mobility variables and a distinction is made between private and social outcomes (or benefits) with respect to the principles of the human capital approach.

As Figure 1 displays, this classification enables the inclusion of all the dimensions necessary for the evaluation of an LiE policy, and constitutes therefore an ideal structure for the design of this thesis' overall conceptual framework. The theoretical assumptions grounding this framework are presented in each of the three studies compiled for this thesis: Study I – Rationales to Language-in-Education Policies in Postcolonial Africa: Towards a Holistic Approach; Study II – The Role of Language in Learning Achievement: A Namibian Case Study; and Study III – Language Skills and Economic Returns.

Each of the three studies targets specific levels of analysis of this framework. For instance, Study I targets explicitly the environmental settings, inputs and process levels. In turn, Study II, by addressing the role of languages in the learning achievement of Namibian grade-6 pupils, targets the private immediate outcomes dimension. Finally, Study III targets the social immediate outcomes and long-term private outcomes of the framework.

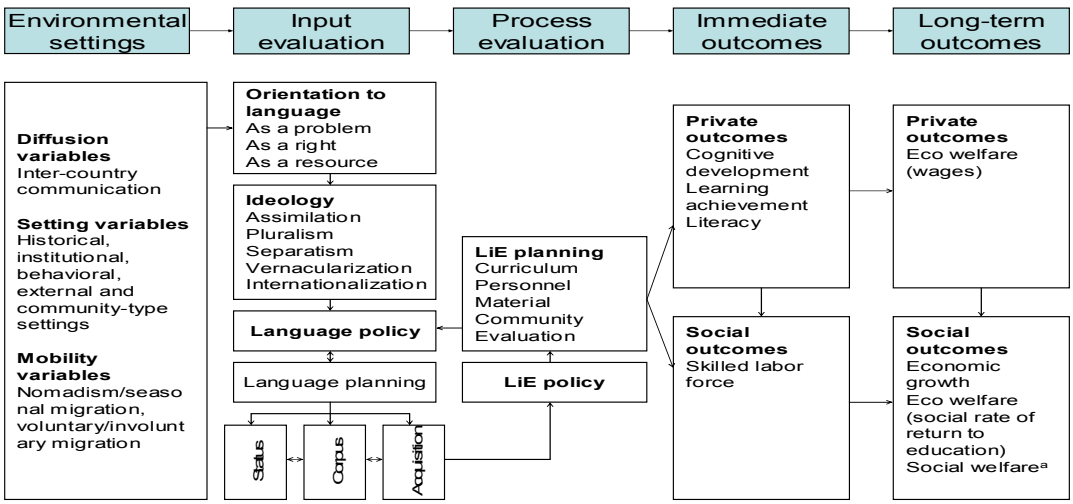

Figure 1 General Framework of the Thesis

Note: a. Social welfare designates civic involvement, democratic empowerment, social cohesion, etc.

2. Aims and Objectives of the Research

The overall objective of this thesis is to investigate the determinants and consequences of LiE policies in the frame of the theoretical debate opposing the "green" and the "free-market" theories, to identify which level of evaluation each theory serves best. It is assumed that neither of the two approaches is sufficient to explain all the levels of evaluation identified in Figure 1. Rather, it is believed that either approach can be validated as optimal from a decision-making point of view according to which level of analysis is identified as the priority by the decision maker.

This potential complementary nature of the two theories is tested by each study within this thesis. More specifically, each study aims at answering the following questions:

Study I:

A. How much do environmental settings affect the nature of LiE policies in postcolonial Africa?

A conceptual and theoretical framework is developed based on sociolinguistics literature and tested empirically on 35 African countries with ordered logistic regression (see Tables A and B in Annexes). The main hypothesis is that in some countries, internal factors (e.g., behavioral, community-type and institutional settings) might have a larger impact on the number of languages retained as media of instruction than external factors (e.g., financial and economic dependency, colonial history and openness to external ideologies). If so, the "green" theory is expected to be validated. In the opposite case of a comparatively stronger position of external factors the "free-market" is expected to be validated.

B. What is the optimal decision for a LiE policy-maker?

A non-cooperative game with network externalities is developed to inform this issue. The assumption is that the most optimal LiE policy ranks the language of the majority group first as the medium of instruction. This implies that the "free-market" theory should be validated unless a cooperative approach is adopted by the players of the game.

Study II:

A. How much do pupils' linguistic characteristics affect mathematics achievement compared to some other individual and structural parameters?

A hierarchical linear model (HLM) is developed and tested on Grade-6 Namibian learners, controlling for within- and between-school variations. In this model, the assumption is that mathematics achievement is facilitated by language proficiency, which is itself facilitated by mother-tongue instruction. The "green" theory is therefore expected to be validated by this model. The data used are all issued from the Namibian SACMEQ II survey but the modeling process results mainly from non-quantitative observations gathered upon two short field visits to Namibia in December 2003 and April-May 2004[2].

Study III:

A. Does proficiency in the official language(s) play a significant role on wages?
B. Are language skills more rewarded in countries applying an official bilingual policy than in countries applying another type of language policy?

An empirical human capital model is developed to elucidate both questions controlling for gender and immigration status. The assumptions are, first, that language skills are expected to have a positive impact on wage opportunities and, second, that the reward of language skills are higher in countries implementing a bilingual LiE policy. These assumptions are tested using the International Adult Literacy Survey (IALS) for eight countries. In this last study, the "green" theory is expected to be validated if wage opportunities are positively affected by language skills in non-international or dominant languages, and if the second assumption is true. Otherwise, the "free-market" theory will be validated.

3. Main Findings

Study I's first model shows that of the 35 countries considered, the countries adopting a unilingual education system weigh differently the environmental parameters than countries adopting a bilingual education system. For instance, multilingual policies appear positively influenced by both external settings and community-type settings, and negatively influenced by institutional settings and degree of openess.

These results neither validate or invalidate the hypothesis in favor of the "green" vs. "free-market" theory, which demonstrates that both theoretical approaches may be of equal validity when addressing Bhola's (1990) three first levels of evaluation (i.e. environmental settings, inputs and process).

[2] See acknowledgements in Study II.

Study I's second model confirms the hypothesis in favor of the "free-market" theory by demonstrating that it is never optimal for two countries to become bilingual in one another's language, or for the majority linguistic group to learn the language of the minority group, unless there is minimum cooperation to ensure an equitable redistribution of payoffs.

In turn, Study II suggests that although home language plays a limited role in explaining within- and between-school variations in Namibian pupils' mathematics achievment, language proficiency (proxied by reading scores) plays a significant role at both levels of analysis, thus supporting the significant role of language in learning achievement. This study confirms the hypothesis in favor of the "green" theory.

Finally, Study III reveals commonalities between the eight countries of the sample in terms of language skills valuying, independent of the type of language policy, confirming the hypothesis that the higher the second language skills the higher the wage opportunities. However, this positive effect of language skills on earnings is only observed for skills in an international or dominant language, which confirms the "free-market" theory at the expense of the "green" theory.

4. Definitions and Delimitations of the Research

Among the terms recurrently used in this study and grounding its *raison d'être* are 'language-in-education policy', 'bilingual education policy', 'bilingual skills', 'value' of bilingual skills, and 'literacy'. Although the theoretical background of each concept is depicted in the following studies, a short definition of each term is presented to avoid any lexical confusion and to delimitate the scope of the study.

The term 'language-in-education (LiE) policy' is, throughout this dissertation, used to refer to the third element of language planning, named by Cooper (1989) as 'acquisition planning'. According to language policy theories, 'language planning' corresponds to the activity – most visibly undertaken by governments because of the massive changes it involves in a society – that aims at changing the linguistic behavior of a speech community. On the other hand, 'language policy' refers to the "body of ideas, laws, regulations, rules and practices intended to achieve the planned language change in the society, group or system" underlying the actual language planning process (Kaplan &

Baldauf, 1997, p. xi)[3]. Language planning consists of three elements: status planning, corpus planning and acquisition planning. The two first derive from Kloss' (1969) addition to Haugen's (1966) *Model of language planning,* and the third was later introduced by Cooper (1989). Kloss (1969) defined corpus planning as concerned with the internal structure of the language, and status planning as the efforts undertaken to change the use and function of a language within a given society. Cooper (1989) later added acquisition planning to cover the efforts to spread and promote the learning of a language. Because most of these efforts are monitored by the education system, 'acquisition planning' is also called 'language-in-education policy' (see Study I for a detailed classification of language policies and LiE policies).

Note that countries are classified in this work in terms of their 'official' LiE policy with no effort made to verify whether the policy is actually implemented or not. This delimitation constitutes a limitation, which could have been overcome with a rigorous qualitative investigation in absence of time or budget constraints. This limitation should be taken into consideration in the interpretation of the results.

Further, the definition of bilingual education retained for this dissertation (in Study I and Study III) is the one offered by Fishman (1979), in which, "[i]n very general terms, bilingual education implies some use of two (or more) languages of instruction in connection with teaching other than language per se" (p. 12). Consequently, bilingual education policies are the programs using two or more languages of instruction. A bilingual person is, in turn, defined as one whose linguistic ability in two languages is similar to that of a native speaker (Malmkjær, 1991).

Moreover, the concept of value as applied to language competences refers to the theory of utility-value according to which the value of a good depends on the utility that consumers estimate the good will provide them. Thus, the utility-value theory defines the link between the usage value and the exchange value, which is the market price. In the case of education, the value reflects the objective preferences of the actors for that activity above other activities, and the price is no more than the translation of these preferences in monetary terms in the context of scarcity at a given place and time (Grin, 1999, p. 33).

[3] "'Language policy' may be realized at a number of levels, from very formal language planning documents and pronouncements to informal statement of intend (i.e. the discourse of language, politics and society) which may not at first glance seem like language policies at all. Indeed, …, policy statements tend to fall into two types – symbolic and substantive, where the first articulates good feelings toward change (or perhaps ends up being so nebulous that it is difficult to understand what language specific concepts may be involved), and the latter articulates specific steps to be taken" (Kaplan & Baldauf, 1997, p. xi).

The value of language can be given a market or non-market, private or social equivalent. The private market value of competences in second languages is defined by wage differentials, which fall to the share of individuals in possession of these competences. This study is especially interested in *net* differentials that is, the wage gaps between individuals that are unequal in terms of their level of possession of linguistic competences, but similar in terms of age or professional experience. The estimation methods are presented in Study III. Further, the private non-market value targets the satisfaction directly felt by the practice of activities enabled by certain language proficiency. The social market value is the sum of private market values, moderated by positive or negative externalities. Finally, the social non-market value is the aggregation of private non-market values collected at the individual level. However, despite the obvious worth of non-market and social market values, the complexity of the collection of comparative data on such values compelled this study to limit its analysis solely to market values of second language competences.

Furthermore, the definition of literacy used in this study is the one adopted by the IALS, according to which literacy is a mode of adult behavior (see Study III for the rationale behind this definition). Overall, literacy consists in "[u]sing printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential" (Statistics Canada, 2002, p. 15).

Beyond the above lexical specifications, it is important to mention that the general complexity embedded in language issues requires from any research on these matters a certain interdisciplinary research method. In the present case, although the research questions adhere to the fundamental positivist economic paradigm, references to sociolinguistic, political, educational and linguistic concepts are judged necessary to capture the manifold dimensions of the topic. Following Grin's (1999, p. 3) argument, the method adopted here is therefore applied interdisciplinarity (or "interdisciplinarity by articulation" as defined by Coenen-Huther, 1989) rather than methodological interdisciplinarity (as defined by Wallerstein, 1989; 2004, as part of his world-systems analysis[4]).

[4] Against the dissection of social phenomena in separate independent academic disciplines, such as politics, economics, sociology, and culture studies, the world-systems analysis claims the need for a holistic historical social science. Originally, the ambition of this perspective was to broaden the loci of analysis in the following way: "World-systems analysis was an attempt to combine coherently concern with the unit of analysis, concern with social temporalities, and concern with the barriers that had been erected between different social science disciplines" (Wallerstein, 2004, p. 16). This implies the analysis of materials from

Finally, due to the relatively recent development of the consideration of languages in economic terms, and hence, the consequent scarcity of empirical demonstrations of its impact on education, it should be underlined that this study defines itself more as a tentative and explorative study than as a demonstration of definite or well established findings.

5. Significance of the Studies

In view of the above delimitations and limitations, the significance of this work lies mainly in its effort to address LiE policy issues within a holistic and interdisciplinary frame of analysis at an international comparative level. In so doing, this study hopes to improve political decision-making and implementation practices at several levels. First of all, understanding the construct rationales to LiE policies, their outcome in term of learning achievement, and the status of languages for the international labor market, can provide necessary information to help policy makers and international donor agencies evaluate LiE policies in a more holistic, and hence efficient, perspective.

Such contribution falls well into the demands for interdisciplinarity raised by several sociologists, linguists and sociolinguists, who recommended integrating linguistic analysis as part of the peoples' and nation states' economic, political and cultural development (Goke-Patriola, 1993; and Mackey, 1992). They hoped this would avoid the emergence of an educational hegemony built on the exclusive cultural, political and economic positions of the schools (Apple, 1990; Williams, 1976), which had already led to the rise of elitist systems, such as described by Bourdieu (1991) in occidental countries, and witnessed by Goke-Patriola (1993) in postcolonial countries.

Secondly, all the studies of this thesis belong to the broad category of quantitative multilevel analysis. Studies I and III are classic inter-country analyses and Study II is an inter-pupil and inter-school analysis. As underlined by Bray & Thomas (1995), the importance of multilevel analysis for certain types of inquiry is an increasingly recognized

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multiple disciplines, for example history, economics, political science or sociology, within a single analytical frame. Therefore, Wallerstein specifies that "The resulting world-systems analysis was not multidisciplinary, since the analysts were not recognizing the intellectual legitimacy of these disciplines. They were being unidisciplinary" (p. 19). Hence, this unidisciplinarity can be understood as resulting much more from a methodological 'interdisciplinary' quest than from 'multidisciplinarity'.

fact[5]. However, they claim that too many studies lack an international dimension or a multilevel dimension within a national framework. A decade later, this weakness persists and the present study hopes to overcome these traditionally observed weakness by attempting to combine different units and levels of analysis in each study. For instance, by comparing the results of the environmental factors analysis among 35 countries, Study I adds an international-level to the initial country-level analysis. In turn, Study II investigates both pupil and school levels within the Namibian framework and Study III lifts up the traditional human capital return analysis to an international dimension.

Finally, the results of this research have the capacity to challenge the attitudes at the microeconomic (individuals and firms) and macroeconomic (public) levels towards language skills. For instance, among the hypotheses[6] tested in this work, the validation of the hypothesis that "the higher the level of bilingual skills, the higher the wages" tested in Study III has the potential to support private and public efforts to develop competencies in languages, either through bilingual education policies or other vocational education and training options, if the environmental settings necessary for their construction and implementation are gathered. On the other hand, if this hypothesis had been invalidated by this study it could have led to the questioning of the worth of bilingual education policies and promoted unilingual education policies[7] or even no LiE policy at all. The significance of this study lies therefore also in its capacity to address the interests of the stakeholders involved in this debate, namely decision-makers, entrepreneurs, teaching staff and students.

6. Limitations of the Studies and Recommendations for Further Research

Among the three studies of this thesis, two make use of international educational achievement or literacy studies: the second survey from the Southern African Consortium on Monitoring and Evaluation of Education Quality (SACMEQ II survey) is used in Study

[5] See, for instance, Burstein (1980; 1988); Cronbach (1976); Goldstein (1987); Raudenbush & Willms (1991).
[6] In this dissertation, the terms hypothesis and assumption are used as synonyms.
[7] Policies of promotion of the official language, also called 'unilingualism', consist in promoting a single language at all levels of the society, i.e. political, legislative, social, economic, educational, etc. They can promote the dominant language, in which case it is the national language when it has acquired the status of official language, or a colonial language of international diffusion. Although these policies only recognize one language, minority languages can still beneficiate from certain linguistic rights (Leclerc, 2006).

II; and the International Adult Literacy Survey (IALS) in Study III. It is important to underscore the limitations of such datasets. As explained by Beaton, Postlethwaite, Ross, Spearritt & Wolf (1999), such international studies have the advantage of compelling participating countries to subject their curricula to close scrutiny. They can alert ministries to differences between their curricula and that of other countries, in terms of emphasis given to different subject areas for instance. However, the weakness of these studies is the misinterpretation that may result from such comparisons. Differences among countries do not necessarily imply any deficiency of curricula, rather the adoption of a particular curriculum may be justified by the state of development of a country's education system.

Furthermore, the nature of the variables derived from such surveys does not allow for in-depth analyses of the tenants of within- and between-countries variations. Hence, any result should be supplemented by further field study analyses before deriving any policy recommendations. Besides, as an outsider to the data collection process, the researcher analyzing these data is subject to 'ecological fallacy' [i.e. conclusions drawn from the erroneous assumption that a relationship established at one level of aggregation (e.g., among countries) holds at any other level of analysis (e.g., among students within countries)]. For the same reason, sampling error bias and endogeneity issues are also common fallacies encountered by empirical works based on such datasets. Rather than resolving them, the present research has put emphasis in attempting to account for these issues.

Beyond the general weaknesses embedded in large international survey data, it is worth emphasizing the limitations suffered by the empirical applications of all three studies due to lack of data on language background and language skills at an international level. This lack of data has resulted in the use of challenging proxies which weaken the impact of the findings. For instance, Study I bases its empirical test solely on data arbitrarily recoded (see Tables A and B in the Annex section of this thesis for a detailed overview of the information grounding the computation of the data used in Study I)[8]; Study II makes use of a seriously questionable dummy variable to define pupils' home language status; and, in absence of informative data, all the studies make the challenging assumption that the official LiE policies of the sampled countries are actually implemented in all schools. Similarly, the lack of longitudinal studies at the international level addressing the issues

[8] These two tables were removed from the version of Study I submitted to the Economics of Education Review (reproduced in this thesis with authorization from Elsevier) to comply with the format imposed by the journal. They are annexed to this thesis for transparency and clarification reasons.

raised in this thesis limited the interpretation scope of the results tremendously. These data pitfalls need to be addressed by further international survey designers and researchers.

Finally, this research did not include any analysis of the social returns to language skills nor of the impact of language skills on economic development. These two dimensions would of course need to be accounted for to complete the holistic evaluation framework presented in this introduction. Such analyses are therefore strongly recommended for further research.

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STUDY I

Rationales to Language-in-Education Policies in Postcolonial Africa: Towards a Holistic Approach*

Christelle Garrouste+

Institute of International Education, Department of Education, Stockholm University, 106 91 Stockholm, Sweden

Abstract

This article considers two issues regarding language-in-education (LiE) policies in the African postcolonial context. First, it explores the factors affecting the choice of a LiE policy. In that effort, the literature from the sociolinguistics is reviewed towards the design of a conceptual and theoretical framework identifying the different influential parameters on LiE policies. That framework is then tested empirically on 35 African countries. The results show that the countries adopting a unilingual education system put different weights on the influential parameters than countries adopting a bilingual education system. Second, the article investigates how the decision makers can ensure an optimal choice of language(s) of instruction by developing a non-cooperative game theoretic model with network externalities. The model shows that it is never optimal for two countries to become bilingual, or for the majority linguistic group to learn the language of the minority group, unless there is minimum cooperation to ensure an equitable redistribution of payoffs.

JEL classification: I21; I28.

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+ Corresponding author: Tel: +46-8163208; Fax: +46-8153133; Email address: garrouste.norelius@interped.su.se (C. Garrouste).

1. Introduction

The globalization of the debate around language policy options emerged at the end of the Second World War as an indirect consequence of the major economic and social recession that reached as far as the participating countries' economic partners and colonial territories. In the early 1960s, occidental economists – among whom Schultz, Becker, Mincer, Weisbrod and Denison – started to study the elements affecting the capacity of production of human beings and their effect on production. Analyzing the quantitative and qualitative characteristics of a population (e.g., health, migrations, information and education) as production factors implied incorporating their contribution to economic growth into a production function. These works led to the theorization of human capital, which received major echoes in the political occidental world and it became soon commonly admitted that the pursuit of education leads to individual and national economic growth. This new approach aroused the interest of governments to analyze the causes of the human skills deficit characterizing most post-war economies. Consequently, large literacy assessment surveys were developed, especially in North America, and international campaigns for universal literacy[1] were launched in most developing countries.

These efforts have led to different explanations of human skills deficit, among which one of the most recurrent is the fact that the education of indigenous peoples and minorities in large parts of the world has so far been organized in direct contradiction to our best scientific knowledge of how it should be organized (Skutnabb-Kangas, 2001). More specifically, the assumption that literacy is limited to a single language is particularly pernicious, because of its political, social and educational implications (Kaplan & Baldauf, 1997, 146).

In order to understand what motivates most governments around the world to opt for such language policies, it is important to keep in mind the economic stimuli that lay behind. Language policy and planning[2] is primarily an outgrowth of the positivist economic and social paradigms which dominated the 1950s and 1960s. As a result, "most of the motivation for language planning, during its early development as a discipline in the

[1] In this context, 'literacy' refers to the ability to deal with written text – both to encode and decode it. In other words, literacy consists of the set of skills, required by any given society, of individuals who wish to function above the subsistence level. Unequivocally, the teaching of literacy has passed over time to the professional education sector, whose main function is to ensure the dissemination of an appropriate literacy through the population (Kaplan & Baldauf, 1997: 143-145).

[2] Originally designated 'language engineering', the discipline emerged as an approach to articulating programs (usually in newly independent 'developing countries') for 'language problems' solving (Kaplan & Baldauf, 1997, xi).

1960s and 1970s, was socio-political and focused on nation building, primarily using the nineteenth century European model of one state, one language, one culture, regardless of how inappropriate such a model might have been for the new emerging multilingual polities" (Kaplan & Baldauf, 1997, 153).

The consequences of this political orientation were dramatic. Nyati-Ramahobo (1999) argues that the recurrent underachievement that characterizes African education systems and continues to exclude many children from economic performance ensues from the use of a foreign language as medium of instruction. In Van Dyken's (1990) words, "the [African] continent's limited literacy is related to the degree to which the mother tongue has been ignored in favor of the international colonial languages" (Van Dyken, 1990, 40). Nowadays, it is widely admitted that the adoption and elevation of an African language to "official status" constitutes a positive step for literacy (Bhola, 1981; Kagan, 1982; Ouane, 1990), identity building, cultural reaffirmation and group identity, thereby for democracy; and the existence of a positive relationship between literacy in local languages and economic growth is well recognized. More generally, language is today commonly viewed as a special commodity necessary for national and international development and communication (see, for instance, Jernudd, 1981; Baldauf & Jernudd, 1983; Jernudd & Jo, 1985; Swales, 1985; and Kaplan & Baldauf, 1997).

In view of the spectacular evolution that has taken place in the contextual settings for the decision-making of language planners over the past decades, several African countries have moved from unilingual planning to multilingual approaches. Yet, still today, among the 2011 languages (i.e. 30 percent of the world's languages) counted for the 56 African Nation-States, only 14 have an official status, of which French still dominates in 23 countries, English in 19 countries, Portuguese in 5 countries, and Spanish (including Canary Islands) in 2 countries (Grimes, 2000; Leclerc, 2006). Hence, in view of the remaining dominance of colonial languages with official status, the rationales behind this evolution of choice remain obscure.

This paper aims, therefore, at lifting the shade on the rationales ruling decisions on language-in-education (LiE) policies in post-colonial Africa. In that effort, this paper divides this issue into two sub-issues: (1) What are the most influential factors affecting the decision process of African policy makers? (2) How can a policy maker choose the most privately and socially optimal subset of languages of instruction?

To answer the first question, a conceptual framework is designed building on findings from sociolinguistics (section 2), which is then tested empirically on 35 African countries selected on the basis of the availability, reliability and comparability of their data (section 3). Finally, to answer the second question, a game-theoretical model is developed (section 4). This paper deviates from previous research mainly by its cross-disciplinary theoretical and methodological frameworks.

2. Conceptual framework

2.1 Conceptualizing language-in-education (LiE) policies

In order to understand what language-in-education policy embeds it is essential to understand the terms 'language planning' and 'language policy'. On the one hand, 'language planning' is an activity – most visibly undertaken by governments because of the massive changes it involves in a society – that aims at changing the linguistic behavior of a speech community. On the other hand, 'language policy' refers to the "body of ideas, laws, regulations, rules and practices intended to achieve the planned language change in the society, group or system" underlying the actual language planning process (Kaplan & Baldauf, 1997, xi). Hence, "the exercise of language planning leads to, or is directed by, the promulgation of a language policy by government (or other authoritative body or person)" (ibid.).

The term 'language planning' includes both structural ('form') and contextual ('function') aspects of language planning (Haugen, 1966 and 1983) and differentiates between 'corpus planning' and 'status planning' (Kloss, 1969). Whereas corpus planning is concerned with the internal structure of the language, status planning[3], in contrast, refers to all efforts undertaken to change the use and function of a language (or language variety) within a given society (Mesthrie, Swann, Deumert & Leap, 2000, 385). More recently, two additional dimensions of language planning have been identified, namely 'acquisition planning' (Cooper, 1989) and 'prestige planning' (Haarmann, 1990). Whereas acquisition planning covers the efforts to spread and promote the learning of a language mainly through language-in-education planning, prestige planning is directed towards creating the favorable psychological background necessary for a sustainable success of the language

[3] Usually the term 'status' is used to mean 'rank', '(social) position' or even 'prestige'. Kloss, however, uses the term as a synonym of 'function' or 'domain' (Mesthrie *et al*., 2000, 418).

planning activities (Mesthrie *et al.,* 2000). Interested specifically in the use of language as medium of instruction, i.e. LiE policies, this paper retains 'acquisition planning' as the third dimension of language planning (after corpus and status planning) and deliberately ignores Haarmann's prestige planning.

Even if LiE planning takes place at only one level of the language planning process (i.e. acquisition planning), its efficiency depends on its ability to proceed interdependently with the other two dimensions of the system (i.e. the corpus and status planning). Hence, the legitimacy of a LiE planning requires first the existence of a national language planning and then the adoption of a LiE policy. In return, all decisions taken at the educational level should be reported to the national language planning organ.

2.2 Rationales to LiE policies

In 1974, Fishman commented on the necessity to add to the language policy analysis even the most technical aspects of language planning in a social context as "there are always habits and attitudes and values and loyalties and preferences, not only in the target populations, but among the planners themselves" (Fishman, 1974, 19). Fishman's (1974) argument is supported by many critical linguists, such as Garvin (1974) and Joseph & Taylor (1990), for whom language issues can not be addressed without considering their relationship with power and ideology. Hence, because language planning process is affected by social variables such as attitudes, power and authority relationships, as well as ideologies, a language policy should integrate factors such as the viability, historical presence, geographic importance and demographic and political status of the language(s) involved. Indeed, as Mackey (1992) stresses, the making of a language policy is not a mere academic exercise, but more often a practical response to social, economic and political pressures.

In his analysis of the relationship between hegemony and curriculum, and referring to Williams (1976), Apple (1990) explains that the interrelationship between all these variables is related to the existence of a strong hegemonic power in all educational policies. Schools do not only process people, they process knowledge as well[4]. They act as agents of cultural and ideological hegemony, in Williams' words, as agents of 'selective tradition' and of 'cultural incorporation', helping to create people with the meanings and

[4] This idea has been defended by most British sociologists. See, for instance, Young (1971).

values required by the economic environment. As a consequence, the socially 'legitimate' knowledge taught in schools depends on the school's cultural, political and economic position (Apple, 1990, 6-7). Applied to language-in-education, this hypothesis can be illustrated by the sustainable relative power of colonial languages in African education in favor of the promulgation of elite status.

As Goke-Patriola (1993) highlights in the context of post-colonial states in Africa, "one of the things which educational systems do is to define the 'legitimate language'" and as a consequence "all other varieties of speech are subject to sanctions which are either externally imposed (by the authorities and the reality of the market, for example) or they are self-imposed" (p. 97). This can be explained by what Bourdieu (1991) refers to as 'the laws of the transmission of linguistic capital', which have the following consequences:

> As a linguistic market strictly subject to the verdicts of the guardians of legitimate culture, the educational market is strictly dominated by the linguistic products of the dominant class and tends to sanction the pre-existing differences in capital. The combined effect of low cultural capital and the associated low propensity to increase it through educational investment condemns the least favored classes to the negative sanctions of the scholastic market, i.e. exclusion or early self-exclusion induced by lack of success… those least inclined and least able to accept and adopt the language of the school are also exposed for the shortest time to this language and to educational monitoring, correction and sanction (Bourdieu, 1991, 62).

In addition to this internal hegemony, Goke-Patriola (1993) highlights the influence of external hegemony and power in African societies, characterized by economic, cultural and psychological dependency on foreign culture and powers. This external dependency is largely favored by the inherited educational systems and their LiE policies.

Alongside this global understanding of the construct of LiE policies, Lewis (1980) explains that the significance of bilingualism and bilingual education[5] is determined by its relation to the 'total structure' of political, economic and religious institutions. Within this total social structure, differences in language can occur, led by, or leading to, a complex system of heterogeneities in the formulation of bilingualism and the implementation of LiE policies. Lewis (1980) identifies the nature of linguistic heterogeneity using the following sets of variables: 1) diffusion variables, 2) setting variables, and 3) mobility variables (see Figure 1).

[5] If we understand bilingual education as the use of two or more languages as media of instruction, then bilingualism and multilingualism become synonymous. This amalgam is used throughout this paper.

This classification has the advantage of covering all the factors and dimensions highlighted by the literature reviewed above. By weighting each set of variables for a sample of ten countries applying official bilingual education programs, Lewis' (1980) study was the first of its kind to offer an international comparative picture of the determinants of bilingual education policies. In this paper we adapt this classification to any type of LiE policy.

The combination of all these environmental settings influences the choice of language policy and in turn, of LiE policy, which can range from multilingual education programs to unilingual education programs (see Figure 2 for a classification of language policies and corresponding LiE programs based on the definitions by Leclerc, 2006; Trueba, 1979; and Skutnabb-Kangas & Garcia, 1995). Whereas unilingual education programs consist in the use of one single language as medium of instruction, usually the national language or majority language, multilingual education programs imply the use of two (or more) languages of instruction in connection with teaching other than language per se (Fishman, 1979).

Figure 1 summarizes these contributions into a concept map[6] serving as a reference framework within which the findings of the present investigation will be examined, quantified and interpreted. The inter-concept relationships are ruled by the sociolinguistic theories presented in this section. Figures 1 and 2 show that the environmental settings defined by Lewis (1980) have an impact on the nature of the language policy which in turn defines the LiE policy. The LiE policy can then be implemented by bilingual or unilingual programs according to the orientation of the language policy. The environmental settings are composed of three sets of variables: (1) diffusion variables; (2) setting variables (composed of behavioral, external, community-type, institutional and historical settings); and (3) mobility variables.

The first set of variables is 'diffusion variables', which refers to the influence of international practices on the provision of bilingual education in a given country. Although Lewis (1980) defines diffusion variables in terms of increase of inter-nation communication, he does not specify the nature of these diffusion variables. Therefore, in the current study, we choose to define Lewis' concept of 'diffusion' as a synonym of policy borrowing or lending. In her book *The Global Politics of Educational Borrowing*

[6] This concept map was designed using CmapTools, which is a software environment developed by the Institute for Human and Machine Cognition (IHMC).

and Lending, Steiner-Khamsi (2004) alongside other educationalists analyzes the effects of globalization on education in terms of 'borrowing' and 'lending' of education policies. She defines the concept of 'borrowing' as "what can be learned and imported from elsewhere" and the concept of 'lending' as "what can be taught and exported to elsewhere" (ibid, 1-2). In this context, diffusion can be understood in terms of degree of openness to new political inputs. A proxy indicator of such openness is the Index of Economic Freedom which takes into account ten different types of freedoms ranging from trade freedom to investment freedom. If a country presents a high degree of freedom then we assume that its openness for import or export of education policies will be high.

The second set of variables identified by Lewis (1980) targets the 'settings' of bilingual education policies, i.e. the historical, institutional, behavioral, external, and community-type settings. These 'settings' embody "the differences in the immediate context of the provision of bilingual education in different countries or for different ethnic groups within a single country" (ibid., 6). More specifically, *historical settings* can be determined by the study of historical antecedents such as colonization. They help identifying the chances of national acceptability of any kind of bilingual education among succeeding generations. Moreover, *institutional settings* cover the rules and measures developed by political institutions to guarantee the implementation of bilingual education. Here, we adapt this definition to the needs of our study by measuring institutional settings in terms of the relevance of the languages chosen for instruction to the needs of the labor market, where the more common languages between the education sector and the labor market the more positive the expected effect of the institutional settings. Furthermore, *behavioral settings* reflect the way in which systems behave towards target groups of bilingual education, rather than the way in which students, teachers, or parents, behave. For instance, Lewis shows that a comparative study may reveal whether causal relations exist between the demand for bilingual education (emphasizing the vernacular) and levels of economic advance and types of educational philosophy adhered to. He shows that in the case of the United States economic advances are correlated to the homogenization of education systems, including the homogenization of LiE policies. In the African context, however, this type of homogenization has proven to be instead correlated to the colonial era, which is not a sign of economic development. Therefore, we decide instead to understand behavioral settings as the efforts made by the African authorities to implement bilingual programs that incorporate mother-tongue instruction. In turn, *external settings*

have to do with a country's relationship with other states, far and near. For instance, external settings include commercial and financial dependency towards other states. Then, *community-type settings* characterize the type of bilingual community for which bilingual education is thought desirable, with an emphasis on geographical situation (isolated communities, enclaves, bounded communities, and segregated communities). However, in this paper, we define community-type in terms of scope of applicability of the LiE policy (for all vs. for a specific group).

Finally, the third and last set of variables identified by Lewis (1980) is 'mobility variables', which depict movements within and across linguistic, ethnic and national boundaries. Movements can be classified into two main types according to their within or across national boundaries nature: nomadism and seasonal migration or commuting, and voluntary vs. involuntary migration. All these types of migrations may have different effects on the nature of languages (i.e. corpus planning) and language needs (i.e. status and acquisition planning). However, Lewis added this category in the context of occidental countries. In the African context, it does not bring in anything specific, since all the countries have been similarly positively influenced by such flows of populations. We, therefore, treat this parameter as a constant and not as an explicative variable.

The objective of this section was to review the contributions of the sociolinguistics to our research question. What emerged from this review is the fact that sociolinguistics provides specifically strong insights into the influence of a combination of pedagogical rationales and powerful contextual social, economic and political forces on decisions about medium of instruction (Tollefson & Tsui, 2004). Nevertheless, sociolinguistics could not provide for deeper analysis of the explicit mechanisms characterizing the identified relationships. The methodological tools necessary for such inquiry (i.e. for the quantification of the above mechanisms) are instead to be found in the positivist economic paradigm.

3. How much do environmental settings affect the nature of LiE policies in postcolonial Africa?

This section aims at quantifying the relationships identified in Figure 1. In that effort, 35 African countries have been selected based on the availability, reliability and comparability of their data. These countries are Angola, Benin, Botswana, Burkina Faso,

Burundi, Cameroon, Central Africa (Republic of), Congo-Brazzaville, Congo-Kinshasa, Cote d'Ivoire, Egypt, Gabon, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Libya, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leona, Swaziland, Tanzania, Togo, Tunisia, South Africa, Zambia, and Zimbabwe.

The empirical model estimates an ordered logistic regression, where the independent variable is the type of LiE policy adopted, defined as four categories: 0. unilingual policy; 1. bilingual (excluding mother-tongue instruction); 2. bilingual (including mother-tongue instruction); 3. trilingual. This formulation gives equal weight to all categories. It orders the different types of LiE policies from the weakest to the strongest category of multilingual policies (see Trueba, 1979 and Skutnabb-Kangas & Garcia's, 1995, classifications of multilingual programs presented in Figure 2).

The explanatory variables are defined as follows[7]:

- *L* is a count of the number of languages that the schools can officially choose among as media of instruction.
- *E* measures the external settings, i.e. a country's relationship with other states, far or near. It is defined as the proportion of linguistic commonalities with the exportation and importation main partners, and the main bilateral donor. Here, we assume all the languages to have the same weight. The linguistic commonality takes values ranging between 1, when all the languages of instruction are common to the languages of the main export partner (or main import partner or main bilateral donor), and 0 if none of the languages of instruction is common to any of the languages of the main partner.
- *C* is the community-type settings, i.e. the type of language ideology applied, namely pluralism, vernacularization, assimilation, separatism or internationalization (see previous section). It takes the value of 1 if it is designed to cover the whole school population (e.g., assimilation/integrative approach) and 0 if it only targets a distinctive community or a non-compulsory level of education (e.g., separatism approach, such as Apartheid).
- *I* covers the institutional settings, i.e. the rules and measures developed by political institutions to guarantee the implementation of bilingual education. It is defined as the proportion of languages taught in school that are common to the languages spoken on the labor market. This variable is used as a proxy of the capacity of the LiE policy to respond to the linguistic needs of the labor market. The value of *I* ranges between 1, if

[7] See Annexes A and B for a detailed outline of the sources of computation of these variables.

all the labor market languages are taught in school, and 0, if none of the languages of the labor market are offered by the education system.

- *H* refers to the historical settings, i.e. the colonial influence on the LiE policies. It is defined as the portion of colonial languages in the total number of languages of instruction defined in the LiE policy.
- *D* measures the diffusion variables, i.e. the influence of external practices on the provision of a type of LiE policy. This parameter is measured by the 2006 Index of Economic Freedom, which measures and ranks 161 countries based on their overall percentage of freedom calculated across 10 specific freedoms equally weighted. These freedoms are business freedom, trade freedom, monetary freedom, freedom from government, fiscal freedom, property rights, investment freedom, freedom from corruption and labor freedom. This index is a good proxy of the degree of openness of a country to new ideas and practices[8].

From our theoretical framework, we expect a negative sign for the *L*, *I*, *H* and *D* estimates and a positive sign for *E* and *C*. In other words, we expect that the higher the weight of *L*, *I*, *H* and *D* the higher the probability that the country will opt for a unilingual policy; and reciprocally, the higher the weight of *E* and *C* the higher the probability for the implementation of a multilingual policy.

Among the thirty-five countries of our sample, ten are Francophone unilingual[9], six are English-speaking unilingual[10], four are Arabic-speaking unilingual[11], three are Lusophone unilingual[12], one is solely Francophone and English-speaking[13], one is solely Francophone and Arabic-speaking[14], six are bilingual in English and a national language[15], two are bilingual in French and a national language[16] and two are trilingual (in at least 1

[8] For more details about the computation of the Index of economic Freedom see http://www.heritage.org/index/

[9] The 10 Francophone unilingual countries of the sample are Benin, Burkina Faso, Congo-Brazzaville, Congo-Kinshasa, Cote d'Ivoire, Gabon, Mali, Niger, Senegal and Togo.

[10] The 6 English-speaking unilingual countries of the sample are Botswana, Gambia, Ghana, Nigeria, Sierra Leona, Zambia.

[11] The 4 Arab-speaking unilingual countries of the sample are Egypt, Libya, Morocco and Tunisia.

[12] The 3 Lusophone unilingual countries of the sample are Angola, Guinea-Bissau and Mozambique.

[13] The only solely Francophone and English-speaking country of the sample is Cameroon.

[14] The only solely Francophone and Arab-speaking country of the sample is Mauritania.

[15] The 6 countries bilingual in English and a national language are Kenya, Lesotho, Namibia, South Africa, Swaziland and Tanzania.

[16] The 2 countries bilingual in French and a national language are Burundi and Central Africa.

national language)[17]. The gathered information is coded using the principles for each parameter outlined above and displayed in Table 1. The data sources used to compute Table 1 are the CIA (2006) World Fact Book, Leclerc's (2006) online dataset on language policies across the world, the OECD (2006) statistics on Gross Bilateral ODA, the WTO's statistics on bilateral trade from March 2006 and the 2006 Index of Economic Freedom by the Heritage Foundation & the Wall Street Journal, as well as consultations of official documents in all the sampled countries.

Table 2 presents the sample means and Table 3 shows the results of the estimated ordered logistic model (complete and reduced forms).

In the complete model, which includes all the above defined variables, the variable *H* (historical settings) appeared non-significant. A test for collinearity revealed it to be highly negatively correlated with the community-type settings *C* (r = -.5815). After testing for different specifications of the model, the exclusion of the *H* variable from the regression proved to be the only option to improve the fit of the model as a whole. Therefore, the historical settings *H* are thereafter assumed to be partly embedded in the community-type settings *C*.

In the reduced model (which excludes *H)*, all estimates present the expected sign. For instance, for a one unit increase in *E*, the expected ordered log odds increases by 6.07 as we move to the next higher category of LiE policy. For one unit increase in *C*, we expect a 4.42 increase in the expected log odds as we move to the next higher category of LiE policy. Whereas *E* and *C* appear strongly significant statistically (at the .05 and 0.1 levels respectively), there is no statistically significant effect of *L*, *I* and *D* (which is actually not surprising given the extremely small size of our sample).

Nevertheless, the likelihood ratio chi-square of 19.68 with a p-value of .0014 tells us that our model as a whole is statistically significant. Moreover, the tests conducted on the proportional odds assumption, namely the likelihood ratio test and the Brant test, both confirm that our model does not violate the proportional odds assumption; and the robust test applied to test for the presence of heteroskedasticity also confirmed the absence of correlation between the error term and the explanatory variables.

Hence, what comes out from this analysis is that Lewis' framework (or at least, our arbitrary numerical interpretation of it) appears suitable to explain the contextual factors influencing the choice between different types of LiE policy in post-colonial Africa.

[17] The 2 trilingual countries are Rwanda and Zimbabwe.

According to this model, "unilingual" countries may justify their choice by either a strong inclination for a separatist language ideology (*C*); low initial linguistic commonalities with their main external economic or financial partner (*E*), strong degree of influence from external ideologies and practices (*D*), which corresponds to a high inclination to policy borrowing; perfect institutional settings (*I*) with the same language being taught at school and used on the labor market; or a too high number of official languages to choose between as media of instruction (*L*).

The opposite set of explanations applies to "multilingual" countries, who may justify their choice by either a strong inclination to the vernacularization of languages (C); high initial linguistic commonalities with their main external economic or financial partner (*E*), low degree of influence from external ideologies and practices (*D*), which corresponds to a low inclination to policy borrowing; weak institutional settings (*I*) with the need to improve the adequacy between the languages being taught at school and the languages used on the labor market; or a reasonably low number of official languages to choose between as media of instruction (*L*).

All the above results can partly be indirectly imputed to the distribution of countries within each group, with a majority of English-speaking countries among the bilingual countries, and all Lusophone and Arabic-speaking and most Francophone countries among unilingual countries. The English-speaking countries are still influenced by the British colonial education system, which privileged bilingual mother-tongue instruction. At independence, English-speaking countries opted therefore for a democratization of the learning of English to the whole population and kept the teaching of the mother tongues (which also explains the high weight of the community-type settings *C*). On the contrary, the French and Portuguese colonial policies privileged unilingual education systems with instruction exclusively in the colonial language[18]. The remaining unilingualism of these countries is therefore also an indirect heritage of the colonial era but with opposite consequences as for former British colonies.

Finally, all the results presented here should be taken with cautiousness because of the exploratory nature of this empirical application, which implies questionable definitions of the estimated parameters. The most explicit example is the use of the Index of Economic Freedom as a poor proxy of degree of openness to new ideas and practices. Because

[18] See Gifford & Louis, 1971; Kelly, 2000; and Lin & Martin, 2005, for an extended overview of colonial and postcolonial education in Africa.

specification errors in the parameters may increase the risk for collinearity and endogeneity which may bias the results, further research should attempt to improve the definition of these parameters.

Hence, by providing some exploratory insights on the role played by environmental settings on the number of potential languages of instruction and thereby on the type of LiE policy (e.g., unilingualism vs. bilingualism), the model tested in this section answered partially the question of which factors may affect the LiE policies in postcolonial Africa but it did not tell us whether or not the decision taken was rational. It is, therefore, now important to find out which combination of languages, i.e. which LiE policy, would theoretically produce an optimal outcome to the community. This second question is answered in the next section.

4. What is the optimal decision for a LiE policy-maker?

This section is concerned with how a LiE policy-maker can select the languages of instruction that will optimize the utility of its community. A non-cooperative game with network externalities is developed as a suggestive option to answer this issue. We rely mainly upon the works by Selten & Pool (1991), Church & King (1993) and Dalmazzone (1999) who explored the concept of network externalities and how it applies to public investments in language knowledge and language learning. More specifically, it relies upon Selten & Pool's (1991) game equilibrium of the distribution of foreign language skills, as well as Church & King's (1993) game-theoretical model of bilingualism and network externalities and Dalmazzone's (1999) discussion of the use and usefulness of network externalities to address second language (i.e. any language additional to the mother-tongue) issues.

4.1 Network externalities approach

Dalmazzone (1999) explains that, in the specific context of languages, the network externalities approach builds on the assumption that the 'user-value' of belonging to a given linguistic group increases with the size of the group itself. Hence, learning a language means becoming part of a *network*, that is "a community made up of complementary components in which every new entrant, besides gaining access to the

benefits of a set of services, also adds to the potential benefits of all other members (i.e., generates an *external effect*)" (Dalmazzone, 1999, 63).

The external effects can be both direct and indirect. The direct external effect is the communication value associated with a language, when it is used to serve as an interface in the largest possible number of potential interactions. Indeed, in order to benefit from the knowledge in a language, one needs to interact with at least one other person who knows that language. In a community of *n* individuals speaking the same language, there are *n(n-1)* potential binary interactions. Further, an additional *(n+1)th* individual speaking the same language would yield direct benefits to all others by adding *2n* potential new interactions. This means that once a language has acquired an advantage over other potential alternatives, its comparative advantage tends to become greater and greater (e.g., this is the case of English, which is now the most commonly studied foreign language and the most used language of commerce, communication and information storage[19]).

In addition to this direct effect, an additional member of a linguistic group can also provide an indirect benefit to other members by increasing the demand for language-sensitive goods and services (schools, libraries, bookstores, broadcasting, theatre, productions, etc.) and thereby, if economies of scale are present, improving the supply and possibly the variety of such services within the community. Although it is generally assumed that externalities associated to a network are positive, they can become negative when the exposure of a small country to a larger linguistic community's culture and ideologies leads to the loss of its indigenous culture and set of beliefs. In this particular case, not belonging to the linguistic network would be more beneficial since it would provide that country with a natural protection against cultural colonization and other unwanted foreign mass cultural products.

An important point highlighted by Dalmazzone (1999) is the fact that the number of speakers alone is not necessarily the only, nor always the most, fundamental factor in determining the communication value of a language. Rather, it is important to take into account factors such as the variety of the potential interactions, the particular purpose or job for which the language is to be used, the geographic and economic position of a country, etc.

[19] English counts 397 million secondary speakers, and 70 percent of the world's mail and about 80 percent of all information stored in data banks are estimated to be in English (Dalmazzone, 1999).

Selten & Pool's (1991) predictive model of some general features of distributions of non-native[20] language skills demonstrates the role played by the size of a language community in determining the strategic choice to learn a foreign language. Their model defines the learning costs, communicative benefit and payoffs at individual, group and aggregated levels. Finally, they provide a proof of the existence of equilibrium points for every aggregated game. This very theoretical work is a solid input in the research on language acquisition as a network externality game.

Finally, building on Selten & Pool (1991), Church & King (1993) derived a formal proof that the private optimum of foreign language learning and the collective optimum may not coincide[21] by applying conclusions reached by the literature on network externalities to problems of language. Their result implies that the maximization of collective welfare, in the presence of externalities in a language market, requires collective institutions capable of internalizing the externality (i.e. capable of correcting the inefficiencies in the aggregated result of individual choices) (Dalmazzone, 1999). In other terms, languages are public goods and require LiE policies to maximize their utility.

In his analysis of knowledge as a global public good, Stiglitz (2006) insists on two critical properties of public goods: non-rivalrous consumption and non-exclusivity. Non-rivalrous consumption occurs when the consumption of one individual does not detract from that of another (i.e. the marginal cost of usage is zero), and non-exclusivity means that it is difficult, if not impossible, to exclude an individual from enjoying the good. It is easy to see how the knowledge of languages satisfies both attributes: if I teach you a language, I continue to enjoy (even more) the knowledge of the language at the same time as you; and, by the same token, once the language is accessible for learning in all schools, anyone can enjoy the language, i.e. no one can be excluded, so everyone might want to enjoy it. Hence, the central public policy implication of public goods is that the state must play some role in the provision of such goods to make sure they will not become undersupplied. One way of financing this type of investment is by charging a monopoly price on the language. Carr (1985) was the first to defend this idea that the market of languages is similar to a natural monopoly.

[20] The terminology "native" versus "non-native" languages is used by Selten & Pool (1991) to designate "mother-tongues" versus "foreign languages".
[21] Whereas the private optimum results from the uncoordinated investments of individuals maximizing their own utility, the collective optimum maximizes total social welfare (see Church & King, 1993, for further details).

Dalmazzone (1999) builds upon this monopoly assumption and highlights that the presence of positive effects related to network size can give rise to a "critical mass", which corresponds to a minimum size for a linguistic group, relative to the whole population, necessary to be sustained in equilibrium. Hence, minority languages of small populations can easily be assimilated if they are not effectively protected, because the return on a human capital investment in these languages is perceived as low, *ceteris paribus* ("all other things being equal"), relative to the yield on other languages. Conversely, once diffusion has reached a given level, further expansion may be self-sustaining.

This theoretical hypothesis seems to fit rather well the context of selection and use of African languages, which appear to have been successful only when the given languages were spoken by large numbers of people. Swahili has been successfully used in Tanzania and Kenya. Similarly, Hausa, which is spoken by more than 8 million people in Nigeria, is serving both the purposes of literacy and national integration at least in the northern parts of Nigeria and in neighboring Niger (Ntiri, 1993, 363). Moreover, the decision to adopt an African language for an educational purpose is often not based on the mother tongue criterion (how large a number of people speak the language as a mother tongue) but on the community language criterion (the function of the language as the dominant means of communication in a certain area of the country), which refers to the network externalities approach. In this context, there are about 159 languages identified as community languages that serve the purposes of general communication over fairly wide areas within countries in Africa (UNESCO/BREDA, 1985, 10). Twenty-three of these are shared community languages, that is, they are spoken in more than two countries. For example, Fulfulde is spoken in 10 countries and Kiswahili and Malinke in six. Monolingualism in an African language is reported for only seven countries, namely: Cape Verde, Comores, Lesotho, the Seychelles, Somalia, Swaziland and Madagascar. All others adopt more than one African language for educational purposes (ibid, 13).

Dalmazzone (1999) summarizes the prerequisites for efficient public intervention in the provision of public goods that embed complex systems, such as culture, traditions and languages, by referring to Arthur's (1988) four generic conditions: (1) large set-up or fixed costs; (2) learning effects; (3) coordination effects; and (4) adaptive expectations.

Whereas *large set-up and fixed costs* such as those associated with the investment necessary to the maintenance and development of a modern language give the advantage of falling unit costs as the size of the speech community expands, *learning effects* improve

the efficiency of investments in language capital, provision of language-related services and, more generally, activities meant to promote a language diffusion and export. Moreover, *coordination effects* refer to the advantages associated with undertaking actions and making choices synergetic to those of the other individuals in the same environment. These effects result from the application of cooperative games, i.e. "the formation of coalitions in which participants must work together to maximize a payoff, which will later be divided among members" (Cornes & Sandler, 1996, 18)[22]. Finally, *adaptive expectations* account for the fact that the increased prevalence of a language enhances beliefs of further prevalence.

From Selten & Pool's (1991) and Church & King's (1993)[23] game-theoretic models of bilingual education policies we know that if the available policy instruments affect all members of a language group homogeneously, then policies that effectively subsidize language acquisition are warranted only for the majority language (i.e. the language with the largest number of speakers). The analysis run in the previous section verifies this assumption (see effect of $C = 1$ on logLiE). Hence, we expect that the belonging to a large linguistic network will be more prized than the willingness to give equal status to all languages independently of the size of the linguistic population.

This supports as well what Dalmazzone (1999) explains with regard to the potential negative nature of network externalities, that is that the belonging to networks has a negative impact on the survival of endogenous languages in the formulation of national LiE policies. Again, this is confirmed by the analysis run in previous section where the languages of instructions are often the same as the languages of the former colonial power, or trade partner or donor partner. African countries tend to opt for bilingual education systems mainly to support/facilitate the learning of a colonial language or international trade language[24]. For instance, among the few bilingual Francophone countries, only one is bilingual in a national language, namely Burundi. All the others are bilingual in French and English or French and Arabic, which are all international languages.

[22] Although pure public goods are often associated with non-cooperative games, it is expected that the repetition of plays of the games might elicit the cooperative strategy as players see that cooperation will augment everyone's payoffs when compared with non-cooperation (see Prisoners' Dilemma) (Cornes & Sandler, 1996).

[23] We strongly recommend the reading of Selten & Pool's (1991) and Church & King's (1993) respective article for an appreciation of the game-theoretic models they have developed and upon which this study relies.

[24] As shown in Table 2A, whenever used, mother-tongue instruction is merely used in pre-primary education and first cycle of primary education before transiting to a colonial or international language.

Hence, the high weight put on colonial and trade networks confirms Selten & Pool's (1991), Church & King's (1993) and Dalmazzone's (1999) common hypothesis that the incentive to learn a language increases with the size of the network.

4.2 The model

Based on the theoretical principles of the public goods' network externalities approach presented above, this paper proposes to develop a non-cooperative game model describing how an African policy-maker can choose optimally the languages of instruction in schools depending on the strategy adopted by the other policy-makers, e.g., former colonial powers, trade partners, main foreign investors and bilateral donors.

From Selten & Pool's (1991) model, we keep three important assumptions: (1) we impose no limit on the number of languages in existence; (2) we assume that there is a positive number of languages in the world; and (3) we treat as fixed the distribution of native languages, assuming that everyone has one and only one native language[25]. These restrictions allow Selten & Pool to partition the world population into communities, each community consisting of the native speakers of a particular language.

However, whereas Selten & Pool and Church & King assume that a member of language community *i* always learns language *i* and has no choice in this respect (which delimitates their analysis to second language acquisition), our model assumes that the learning of language *i* is conditioned by the individual strategy (hence, it is not obvious). This assumption is necessary to reflect the reality in African countries where individuals are not necessarily taught in their native language (see results from previous section in that matter). Therefore, our model aims at broadening the scope of Selten & Pool's and Church & King's studies.

The game takes place in a world with m languages, 1, …, m. Every individual has one and only one of these languages as his native language. He is a native speaker of that language. Every language other than an individual's native language is a foreign language for that individual. Let M be the set $\{1, \ldots, m\}$ of all languages. All languages are perfect substitutes. This assumption was applied by Church & King (1993) to overcome the

[25] In addition to the three assumptions presented here, Selten & Pool (1991) also identify a fourth assumption, namely they permit languages with native speakers and languages without native speakers to exist. Although this assumption may be justified by attempts to create non-native languages such as "Esperanto" to play the role of international lingua franca, no such language actively belongs today to the languages of the world (see Grimes, 2000). This assumption has therefore no rationality in our model.

difficulties raised by the fact that some languages may be more efficient communicative media than others and that some languages might beneficiate from particular intrinsic value. Here, "no one cares if one language disappears, and no one prefers communicating in one language rather than in an other" (ibid, 343)[26].

The set of all individuals with native language *i* is the community *i*. Each language community *i* is described as a continuum of individuals represented as points in an interval $[i, i + a_i]$, with $a_i > 0$. Each member of the *i*th community is identified with a number *s* such that $i \leq s \leq i + a_i$. The measure of all individuals is normalized to 1:

$$\sum_{i=1}^{m} a_i = 1. \qquad (2.1)$$

We call a_i the size of language community *i*. The players of the game are the members of the language communities 1, …, *m*. Geometrically, the world community can therefore be represented as a set of *m* line segments, where *m* is the number of communities. The *i*th community is represented as a line segment from *i* to $i + a_i$. Figure 3 replicates the example given by Selten & Pool (1991) of such a geometric representation for a world of four communities. The sum of the lengths of the four line segments is 1.

Each individual must know at least one language to be able to communicate with others. We assume that all members of the language communities are identical except for their language endowment[27]. Each player can choose between three pure strategies. He/she can learn his/her native language (i.e. mother-tongue) at a learning cost c_i and remain unilingual. He/she can learn a non-native language (i.e. foreign language) at a cost c_j (where *j* is any other language than *i*) or decide to learn both his/her native language and a non-native language (and thereby become bilingual) at a cost c_{i+j}, where $c_i < c_j$ and $c_{i+j} = c_i + c_j$. The benefit of language *i* is a function of the size of the community *i*, a_i and the cost of learning a language is a function of the degree to which the language learnt is

[26] For analyses not treating languages as perfect substitutes, see Marschak (1965), Sabourin (1985) and Grin (1992).
[27] Church & King (1993) use this assumption.

different from the native language[28]. Hence, the cost of learning the native language (or mother tongue) will be assumed to tend towards null and the cost of learning a foreign language to tend towards 1.

A member s_i obtains utility $v(a_i)$ if he learns only his native language *i*, $v(a_j)$ if he learns only a foreign language *j* and $v(a_i + a_j)$ if he learns both his native language and a foreign language *j*. It is the fact that we assume that the utility of each member increases with the size of the community, i.e. $v' > 0$, that creates the existence of the network externality underlying this model. Hence, the payoff of s_i associated with learning a language is affected by the learning decisions of all other individuals, including the member of his own community *i*.

To solve the equilibrium of this game let us fix the number of world languages to two, i.e. $m = 2$. Hence, a member s_1 obtains utility $v(a_1)$ if he learns only language 1 (i.e. his mother tongue), $v(a_2)$ if he learns only language 2 and $v(a_1 + a_2)$ if he learns both languages.

4.3 Equilibrium

By assuming that no agent learns unless there is a strictly positive net benefit from doing so, we can formulate the best-response functions as the following decision rules:

(2.2a) any member s_1 learns language 1 iff $v(a_1) - v(a_2 + \hat{a}_2) > c_1$;

(2.2b) any member s_1 learns language 2 iff $v(a_2) - v(a_1 + \hat{a}_1) > c_2$;

(2.2c) any member s_1 learns languages 1 and 2

iff $v(a_1 + a_2) - v(a_1 + \hat{a}_1) > c_1 + c_2$;

and reciprocally,

(2.2a)' any member s_2 learns language 1 iff $v(a_2) - v(a_1 + \hat{a}_1) > c_2$;

[28] Selten & Pool (1991) opt for a similar assumption, focusing however, on the differences of learning costs between foreign languages, whereas Church & King (1993) opt for identical costs of learning for all languages. Here, we opt for a differentiation of learning costs between native and foreign languages, assuming the learning cost of all foreign languages to be identical.

(2.2b)' any member s_2 learns language 2 iff $v(a_1) - v(a_2 + \hat{a}_2) > c_1$;

(2.2c)' any member s_2 learns languages 1 and 2

iff $v(a_1 + a_2) - v(a_2 + \hat{a}_2) > c_1 + c_2$;

where $\hat{a}_1$ and $\hat{a}_2$ are the number of individuals from the other community that choose to speak language 2 and the number of individuals from the other community that choose to speak language 1, respectively, in equilibrium.

We now assume that the language community 1 is larger than the language community 2 ($a_1 > a_2 \Leftrightarrow v(a_1) > v(a_2)$) and the cost of learning a mother tongue is much less than the cost of learning a foreign language ($c_i < c_j$). For simplification we assume that the learning cost of learning a mother-tongue is equal to zero and the learning cost of learning a foreign language is equal to 1 ($c_i = 0, c_j = 1$) The Nash equilibrium of this game is characterized by proposition 1.

PROPOSITION 1:

(i) If $v(a_1 + a_2) - v(a_1) < v(a_1 + a_2) - v(a_2) < c_j$, then ($\hat{a}_1 = 0, \hat{a}_2 = 0$) is the unique pure-strategy Nash equilibrium;

(ii) If $v(a_1 + a_2) - v(a_1) < c_j < v(a_1 + a_2) - v(a_2)$, then there are two pure-strategy Nash equilibria ($\hat{a}_1 = a_1, \hat{a}_2 = 0$) and ($\hat{a}_1 = a_1 + a_2, \hat{a}_2 = 0$);

(iii) If $c_j < v(a_1 + a_2) - v(a_1)$, then there exist three pure-strategy Nash equilibria ($\hat{a}_1 = a_1 + a_2, \hat{a}_2 = 0$), ($\hat{a}_1 = 0, \hat{a}_2 = a_1 + a_2$) and ($\hat{a}_1 = a_1 + a_2, \hat{a}_2 = a_1 + a_2$);

Proof:

(The proof of Proposition 1 follows the same logic as the first proposition of the model by Church & King, 1993)[29] □

According to proposition 1, if the cost of learning a foreign language is too high, then no one learns a foreign language, which means that unilingualism in mother-tongue is optimal. If the cost of bilingualism pays for speakers of language 2 but not for speakers of language 1 (because $a_1 > a_2$), then there are two pure-strategy Nash equilibrium. The first

[29] See Church & King's (1993) appendix p. 344.

is that all speakers of language 2 learn language 1 (unilingualism in a foreign language) and speakers of language 1 only learn language 1. The second is that all speakers of language 2 learn both language 1 and 2 (bilingualism) and speakers of language 1 only learn language 1. If the cost is very low, then there are three equilibria. In the first equilibrium, all speakers of language 2 learn languages 1 and 2 and speakers of language 1 only learn language 1. In the second equilibrium, all speakers of language 1 learn languages 1 and 2 and all speakers of language 2 learn language 2. In the third equilibrium, all speakers of languages 1 and 2 learn both languages 1 and 2.

Further, let us assume that the decision of any agent of a language community to learn only his mother tongue, only a foreign language or become bilingual is representative of the decision of all the members of that community[30]. Hence, the efficiency of the strategy adopted by a policy maker who wishes to maximize total surplus depends again on the learning costs c_i , c_j and c_{i+j}.

Let the total surplus be denoted by W_{NN} if both communities decide to only learn their respective native language (mother-tongue education policy); W_{BB} if both communities decide to become bilingual in languages 1 and 2 (bilingual education policy); W_{BN} if community 1 decides to learn both languages 1 and 2 and community 2 only learns its native language; W_{NB} if community 1 only learns its native language and community 2 decides to become bilingual; W_{12N} if community 1 decides to learn only language 2 and community 2 learns its national language (language 2); W_{N21} if community 2 decides to learn only language 1 (unilingual education policy in foreign language) and community 1 only learns language 1 (mother-tongue education policy); W_{12B} if community 1 learns only language 2 and community 2 decides to become bilingual; and W_{B21} if community 1 decides to become bilingual and community 2 learns only language 1. In this context, $a_1 > a_2$, $c_i = 0$ and $c_j = 1$ yield:

(2.3a) $$W_{NN} = a_1 v(a_1) + a_2 v(a_2);$$

(2.3b) $$W_{BB} = W_{12B} = W_{B21} = 2(a_1 + a_2) v(a_1 + a_2) - (a_1 c_2 + a_2 c_1);$$

(2.3c) $$W_{BN} = W_{12N} = a_2 v(a_2) + (a_1 + a_2) v(a_1 + a_2) - a_1 c_2;$$

[30] This assumption is applied by Selten & Pool (1991) and Church & King (1993).

(2.3d) $$W_{NB} = W_{N21} = a_1 v(a_1) + (a_1 + a_2) v(a_1 + a_2) - a_2 c_1 .$$

PROPOSITION 2:

(i) $$W_{BB} < W_{BN} < W_{NB}$$

(ii) $$W_{NN} < W_{NB} \text{ iff } c_1 < (a_1 / a_2)\left[v(a_1 + a_2)\right] + \left[v(a_1 + a_2) - v(a_2)\right]$$

Proof:

(i) Follows directly from (2.3b), (2.3c) and (2.3d), since $a_1 > a_2$.

(ii) From (2.3a) and (2.3d), $W_{NB} - W_{NN} = (a_1 + a_2) v(a_1 + a_2) - a_2 c_1 - a_2 v(a_2)$ which is positive iff proposition (ii) holds. □

According to proposition 2, when taking into consideration the benefits of communication and the cost of learning a foreign language (assuming the cost of learning a mother-tongue equal to zero), the optimal policy is the one where the community 1 learns its native language (language 1) and the community two decides to learn both languages, or to learn only the language of community 1 (i.e. the language of the majority). This result confirms the ones from Church & King (1993) and Selten & Pool (1991). The reason why it is never optimal for all individuals to become bilingual is because the sufficient condition for all individuals to be able to communicate with each other is that one community becomes bilingual. If more than one community learns both languages, no further gains will be generated (Church & King, 1993, 340).

Moreover, the reason why group 2 should become bilingual and not group 1 is because we assume the size of the language community 1 to be larger than the one of community 2. Hence, only the smallest group should become bilingual or at least learn the language of the majority group (size effect).

Finally, when comparing the private optima (proposition 1) with the social optima (proposition 2), it appears that when the cost of learning is very high it is privately and socially optimal to learn only the native language; when the cost is very low, it is privately and socially optimal for members of communities 1 and 2 to learn language 1. Nevertheless, the private and social equilibria do not coincide anymore when the cost of

learning is close to its maximum border (i.e. $(a_1/a_2)\left[v(a_1+a_2)\right]+\left[v(a_1+a_2)-v(a_2)\right]$. In that case, it is socially optimal for everyone to learn language 1 but it is privately optimal for everyone to only learn the native language. In equilibrium, both groups will therefore learn their native language only. Again this result confirms the findings by Church & King (1993), who explain this divergence between the efficient and Nash equilibrium solutions as a consequence of the existence of network externalities: "when an individual makes the choice whether to learn or not, she does not take into account the benefit that others get from being able to communicate with one additional person" (ibid, 341).

Finally, it is worth noticing that in all cases, it is always more efficient to learn at least the native language (as component of a bilingual education program or as unique language of instruction when the cost of learning a foreign language is too high). However, our model has also shown that the presence of network externalities in cooperative games can cause the extinction of minority languages. As suggested by Dalmazzone (1999), apart from the application of targeted bilingualism to specific linguistic groups, another way to combat this extinction is therefore by applying cooperative games. By forming coalitions, members of minority linguistic groups may work together to maximize a payoff, which could later be divided among members. Both the private and social equilibria could be affected by such cooperation in favor of minority languages. By producing learning effects (through the development of services and media or other diffusion networks in the minority language) the coalitions could even generate sufficient payoff to incite the majority language group to learn the minority language (i.e. $W_{BN} > W_{NB}$, where $W_{BN} = W_{12N}$ and $W_{NB} = W_{N21}$ still hold).

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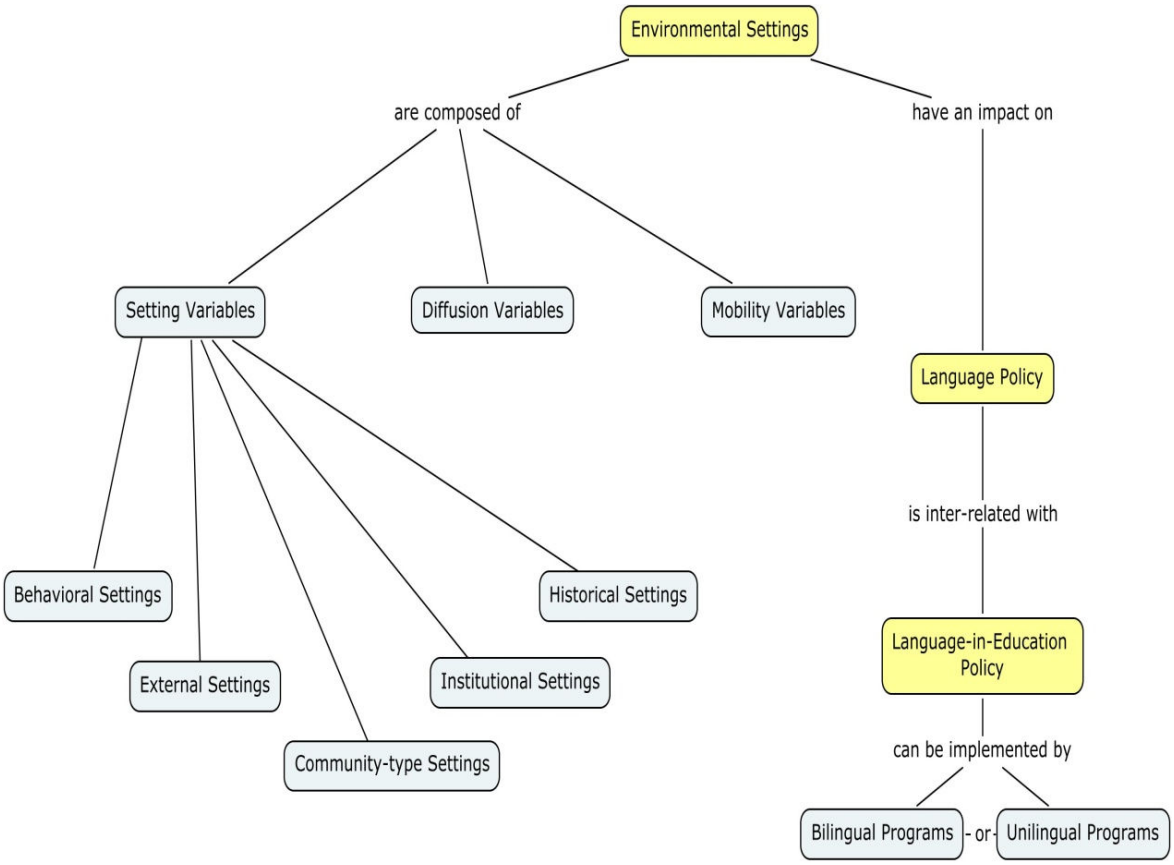

Figure 1

Conceptual framework

Note: See Figure 2 for further details

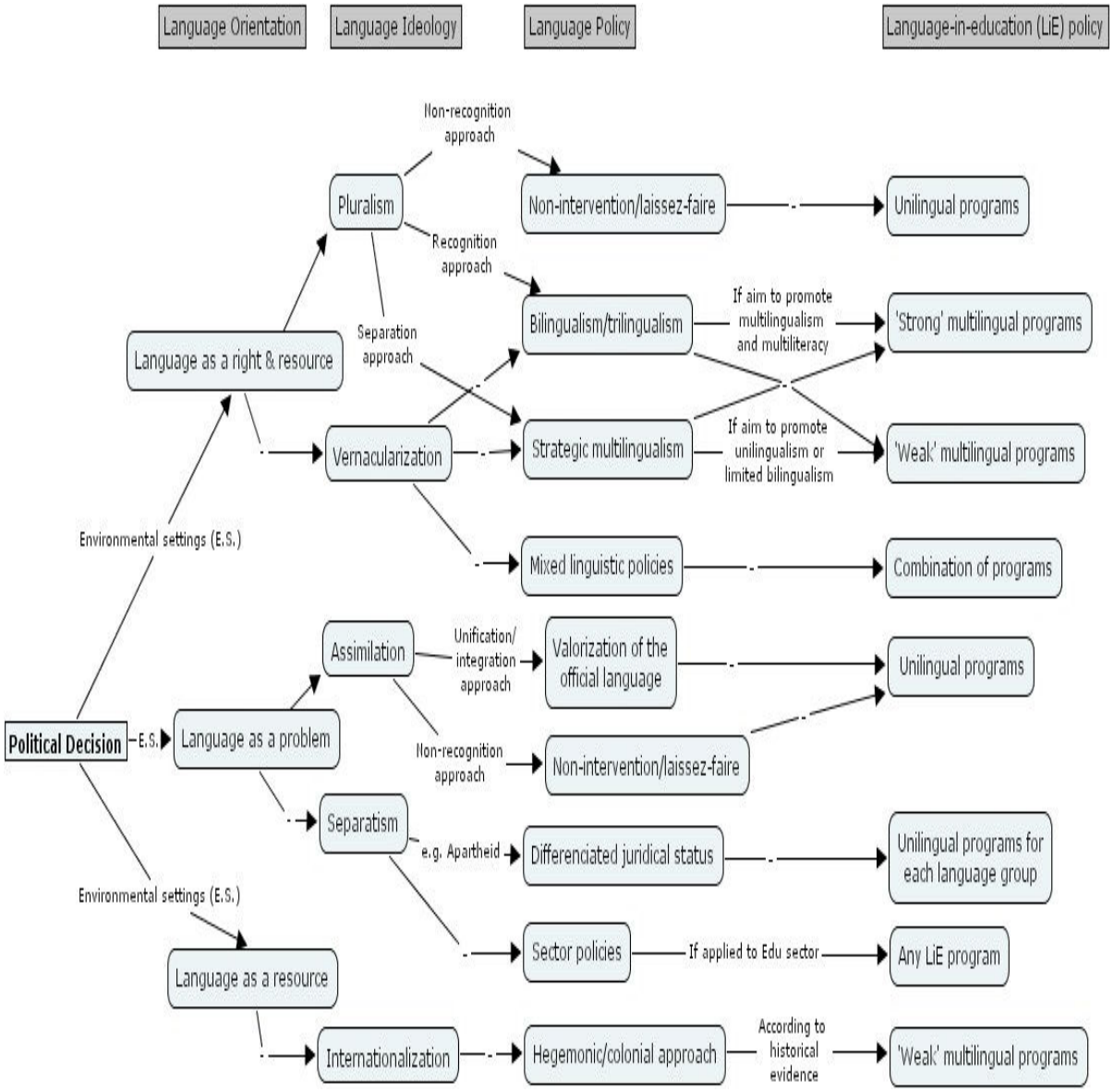

Figure 2

Path towards the adoption of a LiE policy

Note: The environmental settings (E.S.) are composed of diffusion variables (e.g., inter-country communication), setting variables (e.g., historical settings, institutional settings, behavioral settings, external settings, and community-type settings), and mobility variables (e.g., nomadism vs. seasonal migration, and voluntary vs. involuntary migration). The nine types of language policies are derived from Leclerc (2006) and the LiE policies from Trueba (1979) and Skutnabb-Kangas & Garcia (1995).

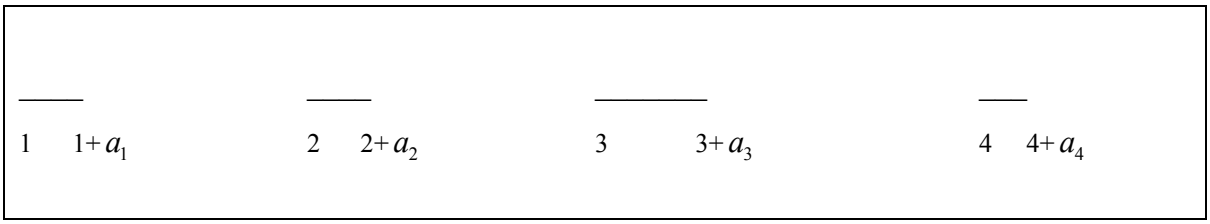

Figure 3

Partition of hypothetical population into native-language communities

(Source: Selten & Pool, 1991, 66)

Table 1

Variable values

	LiEp[a]	*L*	*B*	*E*	*C*	*I*	*H*	*D*[b]
Angola	0	1	0	0.33	0	1	1	0.433
Benin	0	1	0	0.33	0	1	1	0.543
Botswana	0	2	0	1	1	1	0.5	0.703
Burkina Faso	0	4	0	0.67	0	1	1	0.557
Burundi	2	2	1	0.33	1	0.67	0.5	0.496
Cameroon	1	2	0	0.67	1	1	1	0.542
Central Africa	2	1	0	1	0	0.5	1	0.548
Congo-Brazzaville	0	1	0	0.67	0	1	1	0.264[c]
Congo-Kinshasa	0	1	0	0.33	0	0	1	0.436
Cote d'Ivoire	0	1	0	1	0	1	1	0.568
Egypt	0	1	0	0	0	0.5	0	0.522
Gabon	0	1	0	0.67	0	1	1	0.549
Gambia	0	1	0	0.33	0	1	1	0.579
Ghana	0	1	0	0.33	0	0	1	0.567
Guinea-Bissau	0	1	0	0	0	1	1	0.471
Kenya	2	1	0	1	0	0.5	1	0.60
Lesotho	2	2	1	1	1	1	0.5	0.57
Libya	0	1	0	0	0	0	0	0.343
Mali	0	32	1	0.67	0	0.5	1	0.541
Mauritania	1	2	0	0.33	1	0.5	0.5	0.556
Morocco	0	2	0	0	0	0.33	0.5	0.53
Mozambique	0	1	0	0	0	1	1	0.551
Namibia	2	13	1	0.67	1	0.33	0.5	0.609
Niger	0	21	1	1	1	1	0.33	0.536
Nigeria	0	4	0	0.67	1	1	0.5	0.488
Rwanda	3	3	1	0.67	1	1	0.33	0.543
Senegal	0	7	1	0.67	1	1	0.33	0.574
Sierra Leona	0	1	0	0.33	0	0.25	1	0.467
South Africa	2	11	1	0.67	1	1	0.67	0.663
Swaziland	2	2	0	0.67	1	1	0.5	0.622
Tanzania	2	2	0	0.67	1	1	0.5	0.593
Togo	0	3	0	0.67	0	1	1	0.485
Tunisia	0	2	0	0	1	0.33	0.5	0.592
Zambia	0	8	0	1	1	1	0.5	0.591
Zimbabwe	3	9	1	1	1	1	0.33	0.34

Notes: (a) LiEp: 0. Unilingual; 1. Bilingual (excl. Mother-tongue); 2. Bilingual (incl. Mother-tongue); 3. Trilingual. (b). All values of *D* (Index of Economic Freedom) are computed for the year 2006 except for Congo-Brazille (c), for which the latest valid data is from year 2000.

Table 2

Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LiEp	35	.6857143	1.022437	0	3
L	35	4.228571	6.472047	1	32
E	35	.5528572	.3433877	0	1
C	35	.4571429	.5054327	0	1
I	35	.7545714	.3497843	0	1
H	35	.6997143	.3207756	0	1
D	35	.5306286	.0879826	.264	.703

Table 3

Results Ordered logistic regression

a. Complete model

```
Ordered logistic regression                       Number of obs   =         35
                                                  LR chi2(6)      =      19.68
                                                  Prob > chi2     =     0.0032
Log likelihood = -23.071533                       Pseudo R2       =     0.2990

------------------------------------------------------------------------------
        liep |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           l |  -.1735128   .1150151    -1.51   0.131    -.3989383    .0519127
           e |   6.068395*  2.514478     2.41   0.016     1.140108    10.99668
           c |   4.419177** 1.90489      2.32   0.020     .6856611    8.152693
           i |  -3.910656   2.251928    -1.74   0.082    -8.324354    .5030427
           h |   -.008578   2.381896    -0.00   0.997    -4.677007    4.659851
           d |  -6.350042   5.947425    -1.07   0.286    -18.00678    5.306697
-------------+----------------------------------------------------------------
       /cut1 |   .0610169   3.377253                     -6.558277    6.680311
       /cut2 |   .4983525   3.390367                     -6.146645     7.14335
       /cut3 |   3.072046   3.317035                     -3.429223    9.573314
------------------------------------------------------------------------------
legend: * p<0.05; ** p<0.01; *** p<0.001
```

b. Multicollinearity test

```
(obs=35)

             |        l        e        c        i        h        d
-------------+------------------------------------------------------
           l |   1.0000
           e |   0.3100   1.0000
           c |   0.2189   0.3685   1.0000
           i |   0.0263   0.4368   0.2923   1.0000
           h |  -0.1202   0.0485  -0.5815   0.0893   1.0000
           d |   0.1118   0.2374   0.3492   0.1480  -0.0179   1.0000
```

c. Reduced model

```
Ordered logistic regression                       Number of obs   =         35
                                                  LR chi2(5)      =      19.68
                                                  Prob > chi2     =     0.0014
Log likelihood = -23.071539                       Pseudo R2       =     0.2990

------------------------------------------------------------------------------
        liep |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           l |  -.1733908   .1098959    -1.58   0.115    -.3887829    .0420012
           e |   6.067499*  2.501969     2.43   0.015      1.16373    10.97127
           c |   4.422515** 1.664344     2.66   0.008     1.160461    7.684569
           i |  -3.911179   2.247007    -1.74   0.082    -8.315232    .4928752
           d |  -6.353552   5.866549    -1.08   0.279    -17.85178    5.144673
-------------+----------------------------------------------------------------
       /cut1 |   .0666254    2.99782                     -5.808993    5.942244
       /cut2 |   .5039706    3.01121                     -5.397893    6.405835
       /cut3 |   3.077235   2.988813                     -2.780731    8.935201
------------------------------------------------------------------------------
legend: * p<0.05; ** p<0.01; *** p<0.001
```

STUDY II

The Role of Language in Learning Achievement: A Namibian Case study*

Christelle Garrouste+

Abstract

This study investigates the role played by home language and language proficiency on learning achievement. It compares characteristics of 5048 Grade-6 learners in 275 Namibian schools. The outcome variable is the standardized SACMEQ mathematics achievement score collected in year 2000. Hierarchical linear modeling is used to partition the total variance in mathematics achievement into its within- and between-school components. The social distribution of achievement in each school is represented by a within-school model regressing mathematics achievement on home language, gender, social class (SES), grade repetition and reading test scores. The between-school model serves in turn at explaining heterogeneities as a function of school characteristics. An explanatory model is developed to identify specific features of school's academic organization and normative environment that are expected to contribute to the distribution of achievement. The results of the analysis show that although home language plays a limited role in explaining within-school variations in mathematics achievement and no significant role at the between-school level, language proficiency appears to play a much stronger role in explaining both within- and between-school heterogeneity of scores in Namibia, which confirms the role of language skills in learning achievement.

Keywords: Learning achievement, language skills, multilevel analysis, HLM, Namibia.
JEL Codes: I2, C13, C3.

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+ Christelle Garrouste is Doctoral Candidate at IIE, Stockholm University and Marie Curie Research Fellow at the Department of Economics "Marco Fanno", Padua University (garrouste.norelius@interped.su.se / christelle.garrouste@unipd.it). The author would like to address her gratitude to all the Government Officers, NEPRU and UNAM Researchers, SIDA Officers, School Headmasters, School Inspectors and Students met during her fieldtrips to Namibia in December 2003 and April-May 2004, for their availability and cooperation in providing her with free access to all school databases, official documents and school facilities. Moreover, the author would also like to thank the SACMEQ Coordinating Center of Harare for granting her access to the SACMEQ I and II datasets, as well as the participants to her final research seminar at IIE, Stockholm University, September 25, 2007, and internal seminar at the Department of Economics "Marco Fanno", Padua University, October 16, 2007, for their comments and suggestions on preliminary versions of this paper.

Introduction

The need for reconstruction after the Second World War has rapidly led to a world-wide growth of interest in the application of large-scale scientific survey research techniques to the study of issues related to improving the productivity of workers through an increase of the number of literate people, among which Husén's (1969) work and the international research ran by the Association for the Evaluation of Education and Achievement (IEA) in the early 1970s which encompassed twenty-three countries (see Elley, 1992, 1994; Lundberg & Linnakyla, 1993; Postlethwaite & Ross, 1992). This trend spread progressively to developing countries. In the 1980s the focus of these surveys slowly moved from an increase of quantity of education to an improvement of quality of education. Most occidental countries and an increasing number of developing countries are now applying such techniques to undertake systematic studies of the conditions of schooling and student achievement levels.

Summarizing the results of the IEA and other studies for developing countries, Alexander & Simmons (1975) note the lack of consistency across studies and the conflicting nature of the results. For instance, school-related variables, such as class size, school size, and teacher characteristics, appear to be significant in some countries and non-significant (or negatively significant) in others. Finally, although non-school variables appear of high importance in all the studies, home background seems to have less influence on pupils' performance in developing than in developed countries.

In 1983, Heyman & Loxley examined the effects of socioeconomic status and school factors on students' science achievement in primary school in sixteen low-income countries and thirteen high-income countries. They observed that the influence of family background varies significantly with national economic development between countries, and that the percentage of achievement variance explained by school and teacher variables is negatively correlated with the level of a country's development. This result is confirmed by Saha (1983) and Fuller (1987) who examined the effects of school factors on student achievement in the Third World. Fuller concluded that "much of this empirical work *suggests* that the school institution exerts a greater influence on achievement within developing countries compared to industrialized nations, after accounting for the effect of pupil background" (pp. 255-6; italics in original).

Further studies have highlighted the role of language proficiency on academic achievement. For instance, Geary, Bew-Thomas, Liu & Stigler (1996) found that the language structure of Asian number names assisted Chinese children in developing meaningful early number concepts. Valverde (1984) noted that differences in English and Spanish contributed to Hispanic Americans' poor performance and involvement in mathematics (see also Bush, 2002, for similar conclusions).

More recent international survey data have attempted to improve the quality of sampling methods to enable the run of more valid and sophisticated forms of statistical analyses. One example of such effort is the cooperative project launched in 1991 by the International Institute for Educational Planning (IIEP) together with a number of Ministries of Education in the Southern Africa Sub-region for the establishment of long-term strategies for building the capacity of educational planners to monitor and evaluate basic education systems. In 1993, an association was created to extend the reach and formal status of that work, namely the Southern Africa Consortium for Monitoring Educational Quality (SACMEQ), and in 1995 the first SACMEQ survey project was launched in six Southern African countries. The SACMEQ I project was completed in 1998 followed by the SACMEQ II project launched in 2000 in fourteen Southern and Eastern African countries.

By 2005, all fourteen national reports presenting the results from SACMEQ II had been released. What emerged from these results was the fact that most countries were still demonstrating large between- and within-school variations. Within-school variation is an indication of differences in abilities among learners within each school, and between-school variations, an indication of equity problems within the education system. South Africa, followed by Uganda and Namibia, demonstrated then the highest percentage of between-school variation.

More specifically, the Namibian results display very poor learners and teachers reading and mathematics scores, a definite decline in reading scores between the first SACMEQ study of 1995 and the second one of 2000 and considerable variation among regions (Makuwa, 2005). These results deserve further investigation in view of the high resource allocation efforts made by the Namibian authorities to launch substantial education reforms since independence in 1990, including the adoption of a bilingual language-in-education policy aiming primarily at facilitating the cognitive development

and, hence, the learning process of pupils, and with regard to the ambitious National Plans formulated since 1999.

Hence, after a short review of the status of Namibian schools and political agenda at the time the SACMEQ II was conducted (i.e. year 2000), this paper attempts to investigate the main factors explaining the poor scores of Namibian Grade-6 learners. More specifically, the objective is to see whether the home language and language proficiency constitute a significant discrimination factor in mathematics achievement to explain the within-school and between-school variations. The method used is an adaptation of the Hierarchical Linear Modeling (HLM). This paper follows the theoretical steps enounced by Bryk & Raudenbush (1988) and Hox (1995) for the use of the HLM method for education analyses.

Namibia's School Structure and Policy Agenda at the Time of the Study

The Republic of Namibia is situated on the south west coast of Africa and is bordered by the Atlantic Ocean to the west, the republics of Angola and Zambia to the north and north-east respectively and the republics of Botswana and South Africa to the east and south respectively. It obtained national independence from former apartheid South African government on March 21, 1990, after many years of political, diplomatic and armed, national liberation struggle. Even if the country is well endowed with good deposits of uranium, diamonds, and other minerals as well as rich fishing grounds, there are wide disparities in the distribution of incomes. With a per capita income of US$2,000 Namibia may be regarded as a middle income country. Yet, the richest 10 percent of the society still receives 65 percent of the incomes. As a consequence, the ratio of per capita income between the top 5 percent and the bottom 50 percent is about 50:1 (Makuwa, 2005). This provides a brief understanding of the socio-economic context under which the education system has to develop in Namibia.

Since independence, Namibia has made strides in the provision of basic education, which by 2001 had resulted in a primary education net enrolment of 94 percent of all children aged 7-13 (in Grades 1-7), and by 2006 Namibia ranked among the top eight African countries in term of primary completion rate (> 80 percent) (Vespoor, 2006). While much seems to have been achieved in terms of access to schooling, the quality of

education, efficiency and equity issues are since the late 1990s at the center of political preoccupations.

Because Article 20 of the Constitution of the Republic of Namibia provides for free and compulsory education for all learners between the ages of 6 and 16 or learners from Grade 1 up to the end of Grade 7; and because the government has declared education to be a priority among all other priorities in Namibia, education has received since independence the largest share of the national recurrent budget. For instance, out of the estimated total government current expenditure of N$8.35 billion for the 2001/2002 financial year, N$1.86 billion, i.e. about 20 percent of the budget, was earn-marked for basic education only. Of the total amount allocated for basic education, N$986.56 million was earn-marked for primary education and the rest for secondary education. Yet, almost 90 percent of the money allocated for primary education was spent on personnel costs (e.g., salaries and/or subsidies to teachers in a number of private schools), leaving only about 10 percent for all the other services and school supplies (Makuwa, 2005). As a consequence, the financial allocation per learner ratio is more favorable to regions with more qualified staff and fewer learners than to rural regions with more unqualified teachers and large pupil-teacher ratios. Finally, the authorized practice of collect by schools of school development funds from parents is again more favorable to schools in urban areas where parents have an income than to schools in more remote areas.

In addition to these obvious resource allocation issues, it is also important to highlight the many changes that took place in the education sector between 1995 and 2000. As explained in Makuwa's (2005) report, there were for instance more learners and more schools in 2000 than in 1995; the department of Sport was added to the Ministry of Basic Education and Culture; and, more important, the HIV/AIDS pandemic became a national problem affecting infected administrators, teachers, learners and/or parents. In view of these new contextual settings, the Ministry of Basic Education, sports and Culture (MBESC) defined eight new national priority areas in its "Strategic Plan" for the period 2001-2006: equitable access; education quality; teacher education and support; physical facilities; efficiency and effectiveness; HIV/AIDS; lifelong learning; and sports, arts and cultural heritage.

Finally, to understand the context framing the data used in this study, it is also essential to give an overview of the structure of the Namibian primary school system. The primary phase consists of the Lower Primary (Grades 1-4), during which mother tongue is

used as medium of instruction, and Upper Primary (Grades 5-7), during which English becomes the medium of instruction up to Grade 12. By the year 2000, there were 998 primary schools hosting a total of 406,623 learners, of which 952 were government schools and the rest were private schools. Nearly two thirds of all primary schools were located in the six most populated northern regions namely, Caprivi, Kavango, Ohangwena, Oshikoto, Oshana and Omusati.

It is in the above milieu that the second SACMEQ survey used in the present paper was conducted and it is therefore in that frame that the results of the analysis should be interpreted.

Data and method

The sampling procedure for the SACMEQ II survey was geared by methodological recommendations to all participating countries, but with certain flexibility to take into account contextual differences. Hence, as for all other participating countries, the desired target population in Namibia was all learners enrolled in Grade 6 in the ninth month of the school year (i.e. in September 2000). The net enrolment ratio for the age group 7-13 years old who were enrolled in Grades 1 to 7 in Namibia in 2000 was 91.3 percent. However, in Namibia it was decided to exclude certain learners namely, learners in schools with less than fifteen Grade 6 learners, learners in "inaccessible" schools, and learners in special schools. A two-stage cluster sampling was employed using approximately equal size clusters stratified into the 13 educational regions, which led to a final sample of 5048 learners and 275 schools (Makuwa, 2005).

The HLM6.0 program is used in this study to partition the total variance in mathematics scores into its within- and between-school components. The HLM framework was developed during the 1980s by Aitkin & Longford (1986), DeLeeuw & Kreft (1986), Goldstein (1987), Mason *et al*. (1983) and Raudenbusk & Bryk (1986). As explained by Raudenbush & Bryk (1995), these procedures share two core features. First, they enable researchers to formulate and test explicit statistical models for processes occurring within and between educational units, thereby resolving the problem of aggregation bias under appropriate assumptions. Second, these methods enable specification of appropriate error structures, including random intercepts and random coefficients, which can solve the

problem of misestimated precision that characterized previous conventional linear models and hindered their capacity to test hypotheses[1].

Among the empirical works using this approach on international survey data is the study by Lamb & Fullarton (2002) which compared mathematics achievement in Australia and the U.S. using the HLM on TIMSS data. The results found that classroom differences accounted for about one-third of the variation in student achievement in the U.S. and over one-quart in Australia. Most of the classroom variation in both countries was due to compositional and organizational factors, very little due to differences between teachers. Moreover, Howie (2002, 2005) and Gustafsson (2007) used HLM on TIMSS and SACMEQ data, respectively, to understand school production in South Africa. Howie (2002, 2005) applied multilevel analysis (2002, 2005) on TIMSS data to show that significant predictors of between-school variations include pupils' performance in the English test, pupils' SES (to a lesser extent), pupils' self concept, pupils' perception of the importance of mathematics, their exposure to English, how pupils' math teachers perceive their professional status, pupils' math teachers beliefs about mathematics, the location of the school, the extent to which English is used in the classroom, the amount of time teachers spend working and the amount of time teachers spend in lesson planning. More recently, Gustafsson (2007) applied HLM to South Africa's SACMEQ II data and found that physical infrastructure, textbooks, nutrition budgets, correct allocation of teaching and management time in schools, less learner repetition, and better teaching methodologies are important factors of variations in mathematics scores within and between South African schools. This last study respects the theoretical steps of multilevel analysis more reliably than Howie's works but does not include any language related variable.

The theoretical framework of HLM modeling applied in the present study is the one derived from Bryk & Raudenbush (1988) and defined by Hox (1995) consisting in 5 steps: (1) the Null Model; (2) the estimation of the fixed effects of the within-school model; (3) the estimation of the variance components of the within-school model; (4) the exploration of between-school effects; and (5) the estimation of the cross-level interactions between the within- and between-school variables. Note that relevance to the Namibian context, correlations with test scores and correlations between input variables were taken into

[1] Lynch, Sabol, Planty & Shelly (2002) confirm the strength of HLM models compared to other multilevel models to produce superior unbiased estimates of coefficients and robust standard errors even when the assumptions required by OLS are violated.

account in the selection of all the parameters retained for this model. Table 1 displays the descriptive statistics relative to each parameter.

Results

The Null Model

The first step in fitting an HLM model is to analyze a model with no explanatory variables. The output variable is pupil's total raw score in mathematics at the SACMEQ test (*MATOTP*). The SACMEQ II Mathematics test is composed of three domains, namely (1) number (i.e. operations and number line, square roots, rounding and place value, significant figures, fractions, percentages, and rations); (2) measurement (i.e. measurements related to distance, length, area, capacity, money, and time); and (3) space-data (i.e. geometric shapes, charts and data tables)[2].

This intercept-only model is defined by:

$$\begin{cases} y_{ij} = \beta_{0j} + R_{ij} \\ \beta_{0j} = \mu_{00} + U_{0j} \end{cases} \quad (1)$$

Hence,

$$y_{ij} = \mu_{00} + U_{0j} + R_{ij}\,. \quad (2)$$

In this intercept-only model, which is the null model of our analysis, the base coefficient β_{j0} is defined as the mean mathematics score in school j. It is a standard one-way random effects ANOVA model where schools are a random factor with varying numbers of students in each school sample (Bryk & Raudenbush, 1988, p.75).

Whereas the within-school variance $\text{var}(R_{ij})$, i.e. the variability in student mathematics scores around their respective school means, is estimated to 25.556, the between-school variance $\text{var}(U_{0j}) = \text{var}(\beta_{0j})$, i.e. the variability among school means, is

[2] For a detailed overview of the levels and items composing the SACMEQ II Mathematics test, see the blueprint in Makuwa (2005, p. 31).

estimated to 36.020. Consequently, the intra-school correlation ρ, i.e. the ratio of the between-school variance over the sum of the between- and within-school variances, is .585, which implies that approximately 58.5 percent of the variance in mathematics scores occurs between schools. This result confirms the proportion of between-school variations estimated by Makuwa (2005) in Namibian mathematics and reading scores, namely approximately 60 percent between-school variation against 40 percent within-school variation. What remains to be done is to explain these variations by fitting a model with the highest explanatory propension.

The Full Maximum Likelihood (FML) estimation method is used to calculate the value of deviance of this intercept-only model, which is a measure of the degree of misfit of the model (McCullagh & Nelder, 1989; Hox, 1995). We get a deviance of 31575.86 (number of estimated parameters = 3). Each of the following steps of this HLM analysis will now aim at fitting a model with a lower deviance value.

The Within-School Model: Unconditional Model

The next phase is to analyze a model with pupil-level (within-school) explanatory variables fixed. This implies that the corresponding variance components of the slopes are fixed to zero. This fixed within-school model yields:

$$\begin{aligned} y_{ij} &= \beta_{0j} + \beta_{1j} X_{ij} + R_{ij} \\ &= \mu_{00} + \mu_{p0} X_{pij} + U_{0j} + R_{ij} \end{aligned} \quad , \tag{3}$$

where the number of within-school explanatory variables is $p = 1,\ldots,n$.

This model identifies five explanatory variables (i.e. six parameters when including the intercept namely, the base score):

ENGLISH is a dummy variable that takes the value of 1 if the pupil speaks English sometimes or always at home and the value of 0 if never. This variable aims at exploring the role played by the home language in achievement in a country applying a bilingual education policy based on mother-tongue instruction in the early phase of primary education before transiting to English in Grade 5 upwards. It is nevertheless important to highlight that because of the nature of the question – "How often do you speak English at home?" – inconsistency in the responses is plausible. For instance, the fact that 76.9

percent of the sampled pupils answered that they speak sometimes or all the time English at home does not mean that English is the mother-tongue of 76.9 percent of that population. In reality, English is the mother-tongue of only .56 percent of the Namibian population (Gordon, 2005). Moreover, no indication is provided about the nature and the level of communication in English that is occurring at home. Hence, this home language parameter should NOT be interpreted as a proxy of mother-tongue rather as a proxy of the linguistic home background of the pupil.

FEMALE takes the value of 1 if the pupil is a girl and the value of 0 if the pupil is a boy. Entering a gender parameter aims at addressing potential gender gaps in mathematics achievement. In the present case, although the mean mathematics score for boys (= 18.86) is very close to the one for girls (= 18.25) the existence of very high variance for each group (66.41 for boys and 56.45 for girls) justifies further exploration.

SES is a computed variable measuring the pupil's SES (in terms of parents' education, possessions at home, light, wall, roof, floor) that takes values between 1 and 15. Although the link between social background and achievement has been demonstrated to be less strong within-school in less developed countries than in industrial countries (see Heyman & Loxley, 1983; Saha, 1983; Fuller, 1987), it is still essential to include it in our analysis to avoid missing any explanation of between-school variations.

RATOTP is the pupil's total raw score in reading at the SACMEQ test. The reading test scores serve here as a proxy of English language proficiency (see Geary *et al*., 1997; Valverde, 1984; Collier, 1992; Ehindero, 1980; Yip *et al*., 2003; Clarkson & Galbraith, 1992). Note that the strong correlation expected between *RATOTP* and *ENGLISH* is present in our sample with a significance at the .01 level (2-tailed) and that the mean reading score of pupils who never speak English at home (= 29.86) is, again as expected, less than the mean score of pupils speaking sometimes or all the time English at home (= 35.00).

Finally, *REPEAT* is a dummy variable taking the value of 1 if the pupil has repeated at least one class and 0 if not. It provides information on the learning facilities/difficulties of the pupil and serves thereby as a proxy of the pupil's academic background when combined with *RATOTP* (Bryk & Raudenbush, 1988). In our sample the mean mathematics score of grade repeating pupils is 16.66 compared to 20.55 for pupils on-track with much larger variance among the first (= 87.95) than among the latter group (= 29.18).

The predictors *SES* and *REPEAT* are centered around their respective group mean. Figures 2.1-2.5 present the Stem & Leaf plots of Mathematics scores by each parameter. Each figure shows the existence of large variations between and/or within groups, which justify the conduct of the present HLM analysis on these parameters to investigate the source of this variance.

Replacing each parameter by its label-value in equation (3) we get:

$$\begin{aligned} MATOTP_{ij} = {} & \mu_{00} + \mu_{10} ENGLISH_{ij} + \mu_{20} FEMALE_{ij} + \mu_{30} (SES_{ij} - \overline{SES}_{\bullet j}) \\ & + \mu_{40} (RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) + \mu_{50} REPEAT_{ij} + U_{0j} + R_{ij} \end{aligned} \quad . \qquad (3')$$

The final estimation of these fixed effects with robust standard errors is displayed in Table 2. It appears that the most significant parameters are the pupil's mean mathematics score, gender and reading raw score. The slopes' signs show that, whereas being a girl has an overall negative impact on mathematics scores, a high mean mathematics score in the school attended and a high individual reading score have a positive impact on individual mathematics scores. The lack of statistical significance of the *ENGLISH*, *SES* and *REPEAT* parameters is however not strong enough to justify at this stage a removal from the model. So far, what the model shows is that speaking English at home and a high SES background have a positive impact on mathematics achievement, which confirms the theory. According to previous research on developing countries (Heyneman & Loxley, 1983; Saha, 1983; Fuller, 1987; etc.), it is expected that *SES* and *REPEAT* will remain non-significant.

Moreover, grade repetition has a negative impact on mathematics achievement, which confirms the conclusions reached by Verspoor (2006) in his report for ADEA. However, before claiming that this result either invalidates or confirms the assumption that repetition has a negative effect on pupil's achievement improvement, it is important to highlight that the SACMEQ dataset does not provide for any longitudinal data. This lack implies that it is impossible to know whether the pupil who repeated a grade did improve its mathematics score compared to the previous year or not. All we know from the present analysis is that, overall, pupils who have repeated a grade perform less well than their non-repeating peers. Hence, combined with the *RATOTP* parameter, this gives us an idea of the role of the educational background of the pupil on mathematics scores at a fixed date *t*,

with a higher mathematics achievement when the pupil is on school track (no repetition) and highly proficient in English.

The deviance of this model is 30002.99 (number of estimated parameters = 8) which means an improvement from the null model. This fixed model explains 61.7 percent of the total variance in mathematics scores.

The third step consists now in assessing whether the slope of any of the explanatory variables has a significant variance component between schools. The model considered is:

$$y_{ij} = \mu_{00} + \mu_{p0} X_{pij} + U_{pj} X_{pij} + U_{0j} + R_{ij} . \qquad (4)$$

Replacing the parameters by their label name in equation (4) yields:

$$\begin{aligned} MATOTP_{ij} = {} & \mu_{00} + \mu_{10} ENGLISH_{ij} + \mu_{20} FEMALE_{ij} + \mu_{30} (SES_{ij} - \overline{SES}_{\bullet j}) \\ & + \mu_{40} (RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) + \mu_{50} REPEAT_{ij} + U_{1j} ENGLISH_{ij} \\ & + U_{2j} FEMALE_{ij} + U_{3j} (SES_{ij} - \overline{SES}_{\bullet j}) + U_{4j} (RATOTP_{ij} \\ & - \overline{RATOTP}_{\bullet j}) + U_{5j} REPEAT_{ij} + U_{0j} + R_{ij} \end{aligned} . \qquad (4')$$

The testing of random slopes variations is done on a one-by-one basis. The deviance is now equal to 29663.63 (number of estimated parameters = 28), which implies a further improvement from to the null model. Table 2 presents all the results for the within-school explanatory model unconditioned by the between-school variables.

As explained by Raudenbush & Bryk (1987; 1988; 1992; 1995), the unconditional model is particularly valuable because it provides estimates of the total parameter variances and covariances among the $\beta_{pj.}$ When expressed as correlations they describe the general structure among these within-school effects. Table 2 shows that a high base level of achievement is associated with less grade repetition (r = .974), higher reading scores (r = .915), higher SES (r = .602), and male pupils (r = .650) who do not have English as home language (r = .192). There is also a substantial association between pupil high SES and academic achievement (with a high negative correlation between SES and grade repetition (r = .624) and a positive correlation with reading achievement (r = .278)).

Moreover, HLM derives an indicator of the reliabilities of the random effects by comparing the estimated parameter variance in each regression coefficient, var(β_{ij}), to the

total variance in the ordinary least square estimates. These results are also displayed in Table 2. As expected, the base score is rather reliable, .788, and the regression coefficients are less reliable ranging from a low of .036 for pupils' SES to a high .315 for reading raw score. This relatively low reliability may express the fact that much of the observed variability among schools in regression slopes is due to sampling error that can not be explained by within-school factors.

Finally, the results of the homogeneity-of-variance tests provide statistical evidence of significant variation within schools in each of the six random regression coefficients with a very high Chi-square statistic (417.13) with 233 d.f.. The probability of the observed variability in these coefficients, under a homogeneity hypothesis, is less than .001 for β_0, and β_4 and less than .20 for β_5. Hence, it appears that schools vary significantly in the degree to which achievement in mathematics depends on the child's reading score and repetition status, i.e. on the child's academic background, which confirms the findings by Raudenbush & Bryk (1988). Despite marginal significance, the pupil's gender, SES and home language status, are still retained as random parameters because of previously reported school effects (i.e. between-school variability) on each of them.

The Between-School Model: Conditional Model

Next, the higher level explanatory variables Z_{qj} (i.e., school-level factors) are added to equation (4) to examine whether these variables explain between-school variation in the dependent variable. This addition yields:

$$y_{ij} = \mu_{00} + \mu_{p0} X_{pij} + \mu_{0q} Z_{qj} + U_{pj} X_{pij} + U_{Oj} + R_{ij}, \qquad (5)$$

with q between-school explanatory variables Z, $q = 1,\ldots,m$.

The between-school variables add information about the quality of teaching and the learning environment. In this model $q = 11$ and the Z_{qj} include the following class-room and school parameters:

TOTENROL which measures the size of the school in term of total enrolment;

PTRATIO providing the pupil-teacher ratio in each mathematics class;

STYPE, a dummy variable taking the value of 1 when the school is governmental and 0 when private;

SLOC, a dummy variable taking the value of 1 when the school is situated in an urban area and 0 when in a rural or isolated area;

PRACAD, a measure of the proportion of pupils on track (no grade repetition) in each school *j*;

DISCLIM which measures the overall discipline climate of the school. It is computed as the average value of the following dummy variables: pupil arrive late, pupil absenteeism, pupil skip class, pupil dropout, pupil classroom disturbance, pupil cheating, pupil language, pupil vandalism, pupil theft, pupil bullying pupils, pupil bullying staff, pupil injure staff, pupil sexually harass pupils, pupil sexually harass teachers, pupil drug abuse, pupil alcohol abuse, pupil fights, teacher arrive late, teacher absenteeism, teacher skip classes, teacher bully pupils, teacher harass sexually teachers, teacher harass sexually pupils, teacher language, teacher drug abuse, and teacher alcohol abuse. Each variable takes the value of 1 if the answer is "never"; and 0 if the answer is "sometimes/often".

LGMNTY, a dummy variable taking the value of 1 when 40 percent or more of the pupils speak English at home in school *j* and the value of 0 when less than 40 percent never speak English at home. This computation follows Raudenbush & Bryk's (1988) computation of racial minority in the U.S. context.

MSES, the mean SES in school *j*;

TSEX taking the value of 1 when the mathematics teacher is a female and the value of 0 when a male;

TSATPLRN taking the value of 1 when the mathematics teacher considers the pupils' learning as very important and 0 when not important or of some importance; and

MATOTT, the mathematics raw score of the teacher, which serves as a proxy of the teacher's qualifications based on its mastery of the subject.

The predictors *TOTENROL*, *PTRATIO*, *MSES* and *MATOTT* are centered around their respective grand mean.

Replacing these variable labels into equation (5) yields the following model:

$$
\begin{aligned}
MATOTP_{ij} = {} & \mu_{00} + \mu_{10} ENGLISH_{ij} + \mu_{20} FEMALE_{ij} + \mu_{30}(SES_{ij} - \overline{SES}_{\bullet j}) \\
& + \mu_{40}(RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) + \mu_{50} REPEAT_{ij} + \\
& \mu_{01}(TOTENROL_j - \overline{TOTENROL}_{\bullet}) + \mu_{02}(PTRATIO_j - \overline{PTRATIO}_{\bullet}) \\
& + \mu_{03} STYPE_j + \mu_{04} SLOC_j + \mu_{05} PRACAD_j + \mu_{06} DISCLIM_j \\
& + \mu_{07} LGMNTY_j + \mu_{08}(MSES_j - \overline{MSES}_{\bullet}) + \mu_{09} TSEX_j \\
& + \mu_{010} TSATPLRN_j + \mu_{011}(MATOTT_j - \overline{MATOTT}_{\bullet}) + U_{1j} ENGLISH_{ij} \\
& + U_{2j} FEMALE_{ij} + U_{3j}(SES_{ij} - \overline{SES}_{\bullet j}) + U_{4j}(RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) \\
& + U_{5j} REPEAT_{ij} + U_{0j} + R_{ij}
\end{aligned}
\qquad (5')
$$

The FML estimation method is again used to test (with the global chi-square test) the improvement of fit of the new model. After adding the between-school explanatory parameters, the deviance is 29495.19 (degree of freedom = 39), which improves again the null model. Table 3 presents the results for this conditional model. What appears from that analysis is that the proportion of students on track, the mean pupil's SES and the level of mathematics of the math teacher explain very significantly (significant at the .001 level) variations in the individual mathematics scores. At a lesser level, the school's overall disciplinary climate and the type of school also play a significant role, with *t*-values of 1.812 and -1.281 respectively. The negative slope of the type of school indicates that private schools perform on average better than governmental schools.

The Final Model: Cross-Level Interaction Model

Finally, cross-level interactions between explanatory school-level variables and those pupil-level explanatory variables that had significant slopes variation in equation (4) are added. This last addition leads to the full model formulated in equation (6):

$$
y_{ij} = \mu_{00} + \mu_{p0} X_{pij} + \mu_{0q} Z_{qj} + \mu_{pq} Z_{qj} X_{pij} + U_{pj} X_{pij} + U_{Oj} + R_{ij}, \qquad (6)
$$

which yields equation (6'):

$$
\begin{aligned}
MATOTP_{ij} = {} & \mu_{00} + \mu_{01} STYPE_j + \mu_{02} SLOC_j + \mu_{03} PRACAD_j + \mu_{04} (MSES_j - \overline{MSES}_\bullet) \\
& + \mu_{05} (MATOTT_j - \overline{MATOTT}_\bullet) + \mu_{10} ENGLISH_{ij} + \mu_{11} STYPE_j ENGLISH_{ij} \\
& + \mu_{12} DISCLIM_j ENGLISH_{ij} + \mu_{20} FEMALE_{ij} \\
& + \mu_{21} (MSES_j - \overline{MSES}_\bullet) FEMALE_{ij} + \mu_{30} (SES_{ij} - \overline{SES}_{\bullet j}) \\
& + \mu_{31} DISCLIM_j (SES_{ij} - \overline{SES}_{\bullet j}) + \mu_{40} (RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) \\
& + \mu_{41} (TOTENROL_j - \overline{TOTENROL}_\bullet)(RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) \\
& + \mu_{42} STYPE_{1j} (RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) + \mu_{43} PRACAD_j (RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) \\
& + \mu_{44} (MSES_j - \overline{MSES}_\bullet)(RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) \\
& + \mu_{45} (MATOTT_j - \overline{MATOTT}_\bullet)(RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) + \mu_{50} REPEAT_{ij} \\
& + \mu_{51} STYPE_j REPEAT_{ij} + \mu_{52} (MSES_j - \overline{MSES}_\bullet) REPEAT_{ij} + U_{1j} ENGLISH_{ij} \\
& + U_{2j} FEMALE_{ij} + U_{3j} (SES_{ij} - \overline{SES}_{\bullet j}) + U_{4j} (RATOTP_{ij} - \overline{RATOTP}_{\bullet j}) \\
& + U_{5j} REPEAT_{ij} + U_{0j} + R_{ij}
\end{aligned}
$$

Here again, the FML estimation method is used to derive the global chi-square test to formally test the improvement of fit. The deviance is now 29354.015 (number of estimated parameters = 44), which means a 7.57 percent improvement compared to the null model. The OLS regression of the full explanatory model improves the capacity of explanation of the variations in mathematics scores by almost 2 percent (R^2 = .635 percent). The results of the final explanatory model are displayed in Table 4.

Table 4 shows that the base score differences between private and public schools (*STYPE*) disappear once the school location (*SLOC*), the portion of pupils on track (*PRACAD*), the mean SES (*MSES*) of the school and the mathematics score of the math teacher (*MATOTT*) are taken into account. The negative slope of the school type means that greater mathematics achievement is associated with private schools situated in urban areas, with a high proportion of pupils on track, a high average SES and a good mastery of mathematics by the teacher. The effect of the school type (public or private) on the attraction of home English speaking pupils disappears once the disciplinary climate (*DISCLIM*) is taken into account. Home-English speaking pupils tend to attend private schools where the disciplinary climate is safer. Furthermore, low average school SES tends to be more associated with boys than with girls (*FEMALE*), and pupil's SES is associated to important disciplinary problems. Greater reading scores are associated with public schools if they are of small size (*TOTENROL*), if the proportion of pupils on track is high and the school average SES is not too low. In addition, great reading scores are also

associated with a good mastery of mathematics by the math teacher. Finally, there seems to be less grade repetition in public schools and in schools with a lower average SES.

The last panel of Table 4 compares the residual parameter variances from the explanatory model with the total parameter variances estimated in the unconditional model. The proportion reduction in these parameter variances can be interpreted as an indicator of the power of the explanatory model. The fitted model accounts for a substantial percentage of the variance (percent of R^2) of each within-school parameters ranging from 33.94 percent for *ENGLISH* to 72.72 percent for *RATOTP*.

Finally, the most rigorous test of the explanation power of the final model involves acceptance of the homogeneity of residual variance hypotheses, i.e. "after modeling each β_{jk} as a function of some school-level variables, is there evidence of residual parameter variation in the β_{jk} that remains unaccounted?" (Bryk & Raudenbush, 1988, p. 79). Table 4 shows evidence of significant residual variation (high Chi-square) in base achievement score and academic background (*RATOTP* and *REPEAT*). Moreover, the homogeneity hypothesis for the home language ($p > .500$), gender ($p > .500$) and social differentiation ($p > .500$) are still not sustained[3]. This means that the remaining variance in β_{pj} might be due to sampling variance arising because $\hat{\beta}_{pj}$ measures β_{pj} with error (i.e. $\hat{\beta}_{pj} = \beta_{pj} + R_{pj}$) and because of the existence of correlation between X_{pij} and U_{pj} (i.e. $E\left\{U_{pj} \middle| X_{pij}\right\} \neq 0$) (see Pedhazur, 1982, for a comprehensive discussion of measurement errors, specification errors, and multicollinearity). In microeconomics modeling, the existence of a "non-zero" correlation between X_{pij} and U_{pj} violates one of the basic validity conditions. It is however a very common issue in most empirical applications and especially in multilevel linear models (Billy, 2001). Indeed, it implies that pupils' performance and school quality can be positively correlated, which means that the residual variability across schools with respect to U_{pj}, remaining after accounting for the observable heterogeneity X_{pij}, understates the true variability of U_{pj}. For instance, pupils with better than average characteristics might be better informed and thus more able to choose the best school ("pupils self-selection"), and schools that attract better pupils (because of a better location, better status – private vs. public – or better organizational characteristics) also tend to attract better teachers ("teachers self-selection"). Moreover, schools with better teachers and management are in

[3] The test of homogeneity of level-1 variance gives a Chi-square statistic of 417.13 for 233 d.f. and a P-value = .000.

a position to recruit better students and "weed out" less promising cases ("creaming"), as it is the case for Namibian private schools (see Grilli & Rampichini, 2007; Fielding & Steele, 2007; Peng, 2007; Frank, 2005; Rettore & Martini, 2001; Mason, 2001; and Willms & Raudenbush, 1989; for methodological discussions and statistical proposals or attempts to solve this endogeneity bias).

In the case of this paper, the existence of potential endogeneity bias has partially been accounted for by the computation of the indicator of the reliabilities of random effects. This indicator examines the reliability of the ordinary least squares (OLS) estimate and the correlation among the model's parameters at the pupil and school levels. The reliability of the level-2 outcome variables (which are the input variables of level-1) is expected to ensure that the data can detect systematic relations between within- and between-school variables (Raudenbush & Bryk, 1992). The reliabilities depend on two factors: first, the degree to which the true underlying pupil parameters vary from school to school; and, second, the precision with which each school regression equation is estimated. For each school at Level-2,

$$\text{reliability}(\hat{\beta}_{pj}) = \frac{\tau_\beta}{\tau_\beta \Big/ [\tau_\beta + \sigma^2 \big/ t_{jk}]} \tag{7}$$

is the reliability of the schools' sample mean as an estimate of its true mean. The average of these reliabilities across schools presented in Tables 2-4 provide summary measures of the reliability of the school means (Xiao, 2001).

This indicator demonstrates weak reliability of all regression coefficients, except $\hat{\beta}_{0j}$, and a decrease of overall reliability between the final model (Table 4) and the unconditional model (Table 2), which confirms the presence of potential underestimation bias of the size of the random effects on the outcome variable. However, it is worth noticing that the bias is small when the number of Level-1 observations is large and the number of Level-2 groups is small (Miller & Phillips, 2002), which is exactly the case in our study (5048 pupils in Level-1 and 275 schools in Level-2).

Hence, although the sampling error and endogeneity bias should be accounted for when interpreting the results presented in this paper, it is reasonable to assume that the bias size is not problematic in this application.

Conclusions

In sum, this HLM analysis provides empirical support for the contention that academic organization and normative environment of schools have a substantial impact on the social distribution of achievement within them. At the individual level, the base mathematics score of the school, followed by the academic background of the pupil (*RATOTP* and *REPEAT*), its gender as well as its home language play a statistically significant role in the individual mathematics achievement. The only non-significant parameter is the SES of the pupil. At the school level, the analysis shows that, overall, individual mathematics achievement is facilitated in schools with a higher proportion of students on-track (*RATOTP*), a higher average SES and a strong mastery of the subject by the mathematics teacher (*MATOTT*). Pupils also tend to perform better in private schools than in governmental schools (*STYPE*) which confirms the observed tendency for higher achievement in schools with less disciplinary problems (*DISCLIM*). The home language parameter looses of its significance when comparing between-school variations which could be due to the specification problems of the variable *ENGLISH* as explained earlier. However, the language proficiency parameter (*RATOTP*) increases even more its explanatory capacity at the between-school level which makes it one of the most significant explanatory variables of this model and confirms the role played by language skills in learning achievement.

The policy implications of these results are a necessary improvement of the quality of resource allocations in teacher training to improve the subject mastery of teachers and, more generally, in the development of better supervision structures to improve the disciplinary climate in governmental schools. Moreover, it is important to investigate further the potential negative direct (on the targeted pupil) and indirect (via peer-effect) role played by high repetition rates in primary education. Lastly, the positive results reached by this study on the role played by linguistic parameters on learning achievement should guide decision makers in their search for optimal solutions for school effectiveness. Hence, this study wants to underscore the need for more and better information about pupils' and teachers' home language and mother-tongue in further international surveys in Africa to investigate deeper the actual efficiency of bilingual and multilingual education programs on overall learning achievement.

Finally, although assumed to have a potential positive effect on the fit of the final model in view of the HIV/AIDS pandemic affecting the whole country, the health status of the pupils could not be accounted for by this study. Because less than half[4] of the pupils sampled (*N*=2199 out of 5048) answered the question related to the reasons of their absenteeism (illness, work, family or fee not paid), and because of the very unspecific nature of the question, this parameter could not be included in this analysis. Moreover, in absence of information about the type of illness or the duration of absenteeism in the SACMEQ II dataset, the choice of this parameter as a proxy of the potential role of HIV/AIDS on learning achievement would have been highly questionable. Further research should therefore attempt, first of all, to collect appropriate data on this phenomenon in the frame of larger international surveys such as SACMEQ and, second, to include this parameter in an HLM analysis to respond to the concerns raised by many African Governments about the negative effects of the HIV/AIDS pandemic on school effectiveness.

[4] The parameters retained in this HLM analysis suffered no missing data, except for the outcome variable. In the case of the total raw mathematics scores of the pupils, 58 cases (1.1 percent) were missing because of non-completion of the test but these data could be recomputed by estimating a probabilistic value from the school mean and the grand mean.

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Table 1

Sample Descriptive Statistics

Variables	*N*	Minimum	Maximum	Mean	Std.	Skewness	Kurtosis
MATOTP	5048	4.00	57.00	18.54	7.835	1.706 (.034)	3.649 (.069)
ENGLISH	5048	.00	1.00	.77	.421	-1.280 (.034)	-.363 (.069)
FEMALE	5048	.00	1.00	.51	.500	-.049 (.034)	-1.998 (.069)
SES	5048	1.00	15.00	6.85	3.39	.315 (.034)	-.896 (.069)
RATOTP	5048	4.00	78.00	33.81	13.617	1.258 (.034)	.922 (.069)
REPEAT	5048	.00	1.00	.52	.500	-.063 (.034)	-1.997 (.069)
TOTENROL	5048	112.00	1510.00	594.61	297.186	.705 (.034)	-.074 (.069)
PTRATIO	5048	8.05	53.93	30.20	6.797	.239 (.034)	1.061 (.069)
STYPE	5048	.00	1.00	.95	.209	-4.338 (.034)	16.825 (.069)
SLOC	5048	.00	1.00	.44	.496	.257 (.034)	-1.935 (.069)
PRACAD	5048	.00	1.00	.48	.190	.150 (.034)	-.239 (.069)
DISCLIM	5048	.00	.92	.49	.180	.151 (.034)	-.427 (.069)
LGMNTY	5048	.00	1.00	.05	.226	.3.953 (.034)	13.630 (.069)
MSES	5048	1.89	13.58	6.85	2.722	.527 (.034)	-.731 (.069)
TSEX	5048	.00	1.00	.46	.499	.154 (.034)	-1.977 (.069)
TSATPLRN	5048	.00	1.00	.94	.231	-3.845 (.034)	12.786 (.069)
MATOTT	5048	7.00	41.00	23.24	.343	.343 (.034)	-.439 (.069)
Valid *N* (Listwise)	5048						

Note: The skewness and kurtosis' Standard Errors are displayed in brackets.

Table 2

Unconditional Model

Fixed Effects			Estimated Coefficient	Robust Standard Error	*t*-Ratio
Base score, μ_0			18.578	.433	42.875
ENGLISH, μ_1			.397	.163	2.441
FEMALE, μ_2			-.673	.125	-5.349
SES, μ_3			.045	.029	1.541
RATOTP, μ_4			.252	.010	22.562
REPEAT, μ_5			-.381	.139	-2.742
Random Parameter		Estimated Parameter Variance	Degrees of Freedom	Chi-square	*P*-Value
Base score, β_0		43.570	233	1335.669	.000
ENGLISH, β_1		.439	233	216.276	>.500
FEMALE, β_2		.682	233	242.089	.327
SES, β_3		.012	233	215.688	>.500
RATOTP, β_4		.011	233	409.413	.000
REPEAT β_5		.880	233	252.234	.185
Correlation Matrix of Random Effects	β_0	β_1	β_2	β_3	β_4
Base score, β_0					
ENGLISH, β_1	-.192				
FEMALE, β_2	-.650	-.540			
SES, β_3	.602	-.601	.092		
RATOTP, β_4	.915	.118	-.864	.278	
REPEAT β_5	-.974	.193	.617	-.624	-.866
				Reliability of Within-School Random Effects	
Base score, β_0				.788	
ENGLISH, β_1				.050	
FEMALE, β_2				.119	
SES, β_3				.036	
RATOTP, β_4				.315	
REPEAT β_5				.127	

Notes: All estimates for two-level models reported in this article were computed using the HLM6.0 program. The reliability estimates reported above are based on only 234 of 270 units that had sufficient data for computation. Fixed effects and variance components are based on all the data.

Table 3

Between-School Effects: Conditional Model

Fixed Effects	Estimated Coefficient	Robust Standard Error	*t*-Ratio
Base score, β_0			
INTERCEPT(*)	17.5982	1.977	8.901
TOTENROL	-.0004	.001	-.464
PTRATIO	.0207	.0325	.594
STYPE	-2.4568	1.918	-1.281
SLOC	.4107	.511	.804
PRACAD	5.0594	.966	5.239
DISCLIM	2.0183	1.114	1.812
LGMNTY	-.2038	.667	-.306
MSES	.8508	.127	6.668
TSEX	.3916	.375	1.043
TSATPLRN	-.4477	.569	-.787
MATOTT	.1051	.030	3.548
ENGLISH, β_1			
INTERCEPT(*)	.3433	.162	2.123
FEMALE, β_2			
INTERCEPT(*)	-.6484	.127	-5.106
SES, β_3			
INTERCEPT(*)	.0527	.030	1.758
RATOTP, β_4			
INTERCEPT(*)	.2695	.011	24.184
REPEAT β_5			
INTERCEPT(*)	-.3063	.133	-2.299

Random Parameter	Estimated Parameter Variance	Degrees of Freedom	Chi-square	*P*-Value
Base score, β_0	17.300	222	651.016	.000
ENGLISH, β_1	.383	233	216.635	>.500
FEMALE, β_2	.740	233	242.144	.326
SES, β_3	.012	233	216.462	>.500
RATOTP, β_4	.011	233	397.302	.000
REPEAT, β_5	.716	233	252.032	.187

	Reliability of Within-School Random Effects
Base score, β_0	.615
ENGLISH, β_1	.044
FEMALE, β_2	.128
SES, β_3	.037
RATOTP, β_4	.318
REPEAT β_5	.106

Notes: (*) *INTERCEPT* corresponds to the base score.

The reliability estimates reported above are based on only 234 of 270 units that had sufficient data for computation. Fixed effects and variance components are based on all the data.

Table 4 (1/2)

Final Explanatory Model of Mathematics Achievement

Fixed Effects	Estimated Coefficient	Robust Standard Error	*t*-Ratio
Base score, β_0			
INTERCEPT	19.799	2.639	7.501
STYPE	-4.568	2.704	-1.689
SLOC	.210	.519	.405
PRACAD	6.405	1.088	5.884
MSES	1.392	.145	9.568
MATOTT	.147	.032	4.585
ENGLISH, β_1			
INTERCEPT	-1.786	1.352	-1.321
STYPE	2.247	1.333	1.686
DISCLIM	-.029	.651	-.045
FEMALE, β_2			
INTERCEPT	-.675	.119	-5.673
MSES	-.237	.053	-4.442
SES, β_3			
INTERCEPT	-.169	.082	-2.054
DISCLIM	.436	.165	2.636
RATOTP, β_4			
INTERCEPT	.091	.044	2.037
TOTENROL	-.000029	.000024	-1.215
STYPE	.061	.039	1.553
PRACAD	.213	.049	4.326
MSES	.018	.004	4.390
MATOTT	.004	.001	3.552
REPEAT β_5			
INTERCEPT	-1.706	.814	-2.095
STYPE	1.423	.833	1.707
MSES	-.256	.059	-4.359
	Reliability of Within-School Random Effects		
Base score, β_0	.576		
ENGLISH, β_1	.034		
FEMALE, β_2	.061		
SES, β_3	.021		
RATOTP, β_4	.133		
REPEAT β_5	.051		

Table 4 (2/2)

Final Explanatory Model of Mathematics Achievement

Random Effects	Estimated Parameter Variance	Degrees of Freedom	Chi-square	*P*-Value
Base score, β_0	14.494	228	554.245	.000
ENGLISH, β_1	.290	231	213.203	>.500
FEMALE, β_2	.323	232	230.790	>.500
SES, β_3	.007	232	214.036	>.500
RATOTP, β_4	.003	228	275.374	.017
REPEAT, β_5	.321	231	241.338	.307

	Percentage of Variance Explained											
	Base score		ENGLISH		FEMALE		SES		RATOTP		REPEAT	
MODEL	var(β_0)	%R²	var(β_1)	%R²	var(β_2)	%R²	var(β_3)	%R²	var(β_4)	%R²	var(β_5)	%R²
Unconditional	43.570	…	.439	…	.682	…	.012	…	.011	…	.880	…
Explanatory	14.494	66.73	.290	33.94	.323	52.64	.007	41.67	.003	72.72	.321	63.52

Notes: (*) *INTERCEPT* corresponds to the base score.

The reliability estimates reported above are based on only 234 of 270 units that had sufficient data for computation. Fixed effects and variance components are based on all the data.

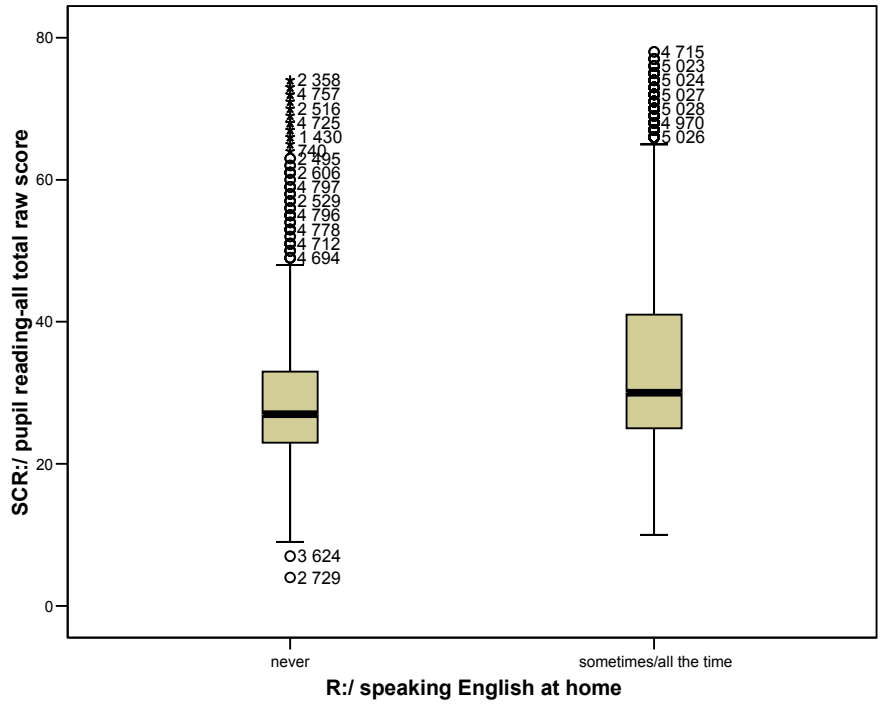

Figure 1. English Proficiency by Home Language Stem-and-Leaf Plots

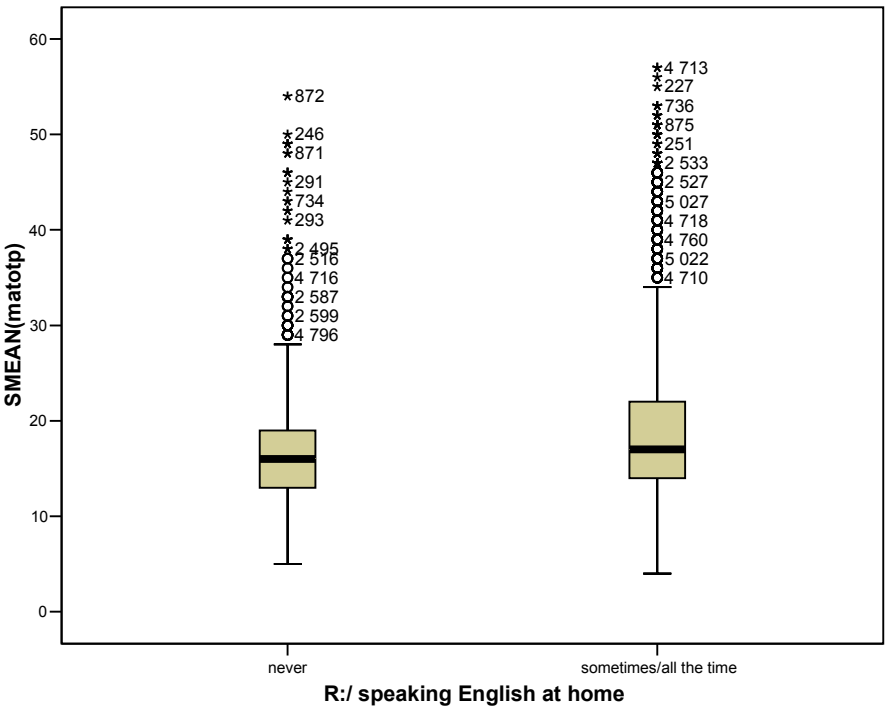

Figure 2.1 Mathematics Achievement by Home Language Stem-and-Leaf Plots

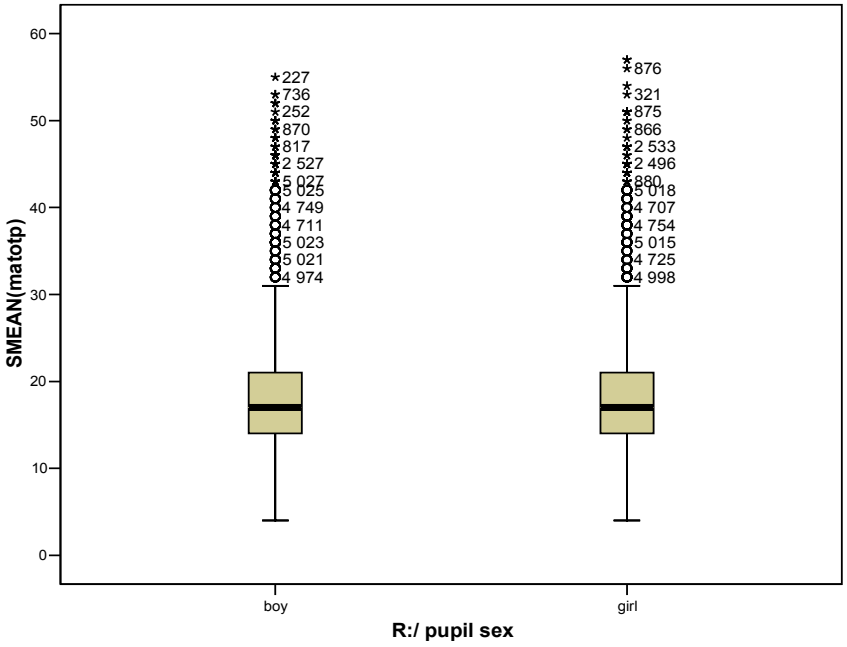

Figure 2.2 Mathematics Achievement by Pupil's Gender Stem-and-Leaf Plots

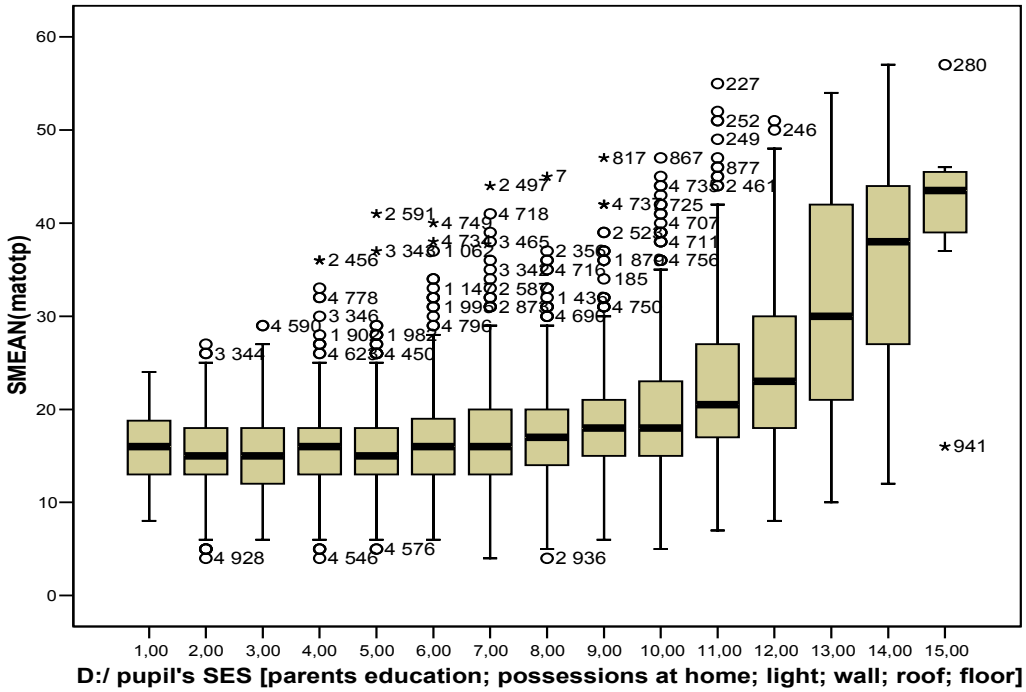

Figure 2.3 Mathematics Achievement by Pupil's SES Stem-and-Leaf Plots

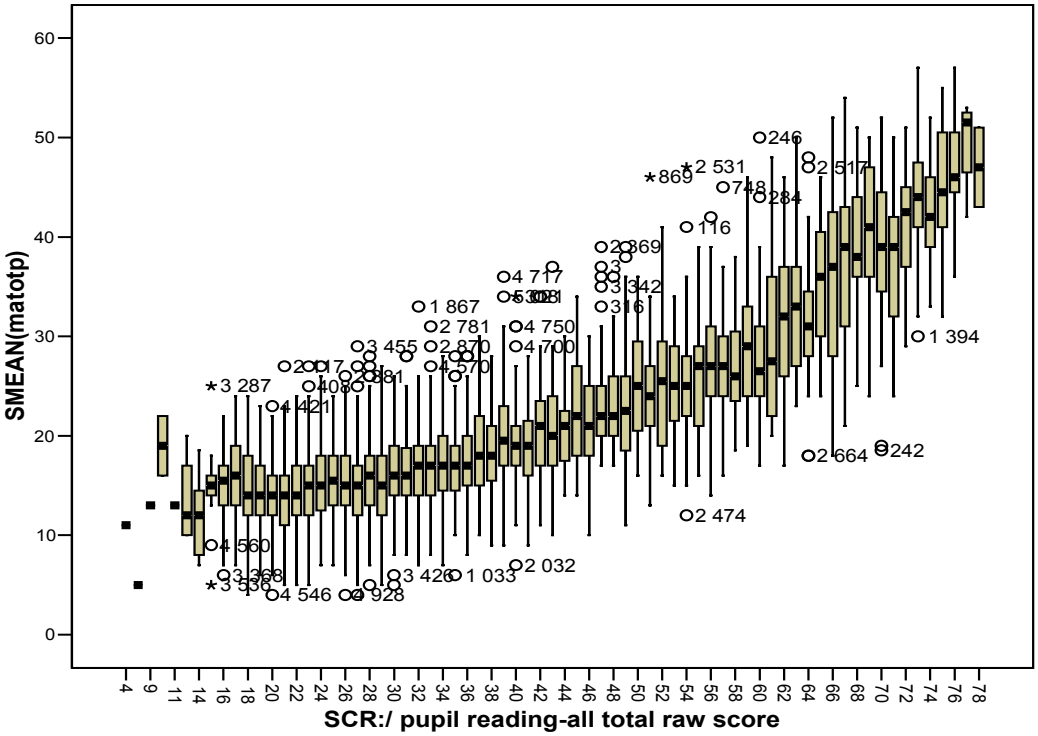

Figure 2.4 Mathematics Achievement by English Proficiency Stem-and-Leaf Plots

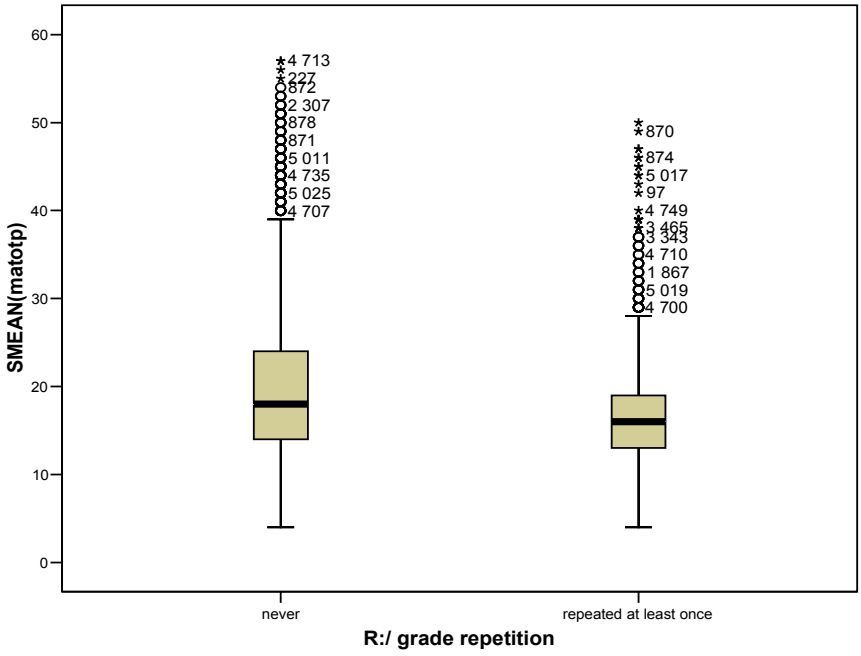

Figure 2.5 Mathematics Achievement by Grade Repetition Stem-and-Leaf Plots

STUDY III

Language Skills and Economic Returns[*]

Christelle Garrouste[+]

Institute of International Education (IIE), Department of Education, Stockholm University, 10691 Stockholm, Sweden

Abstract

This paper focuses on the contributions from the positivist epistemological approach, endorsed by the economics of language and the economics of education, to study the returns to language skills, assuming that language competencies constitute key components of human capital. It presents results on economic returns to language skills in eight countries enrolled in the International Adult Literacy Survey (IALS) – Chile, Czech Republic, Denmark, Finland, Hungary, Italy, Norway and Italian-speaking Switzerland. The study shows commonalities between countries in terms of language skills valuing, beyond the type of language policy applied at the national level. In each of the eight countries compared, skills in a second language are estimated to be a major factor constraining positively wage opportunities.

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1. Introduction

At the dawn of the new millennium, debates on language policy are more and more focused on the role of multilingualism and multiculturalism in the globalization process. The complexity of this issue lies mainly in the fact that the process of globalization at the cultural level produces contradictory behaviors. As Stromquist & Monkman (2000) explain:

> While the world is becoming smaller and more homogeneous at some levels, in a variety of ways local cultures are making efforts to retain their identity and, in some cases, even to rediscover it (Stromquist & Monkman, 2000, p. 7).

Hence, Cvetkovich & Kellner (1997) claim that:

> Although global forces can be oppressive and erode cultural traditions and identities they can also provide new material to rework one's identity and can empower people to revolt against traditional forms and styles to create new, more emancipatory ones (Cvetkovitch & Kellner, 1997, p. 10).

This paradox is very well captured by Pattanyak (1984) in his overview of the different positions in the current debate:

> The dominant monolingual orientation is cultivated in the developed world and consequently two languages are considered a nuisance, three languages uneconomic and many languages absurd. In multilingual countries, many languages are facts of life; any restriction in the choice of language is a nuisance; and one language is not only uneconomic, it is absurd (Pattanyak, 1984; quoted by Skutnabb-Kangas & Garcia, 1995, p. 221).

In the face of this complicated climate, where, on the one hand, the labor market is required to homogenize to its maximum its communication tools (i.e. languages of trade) and, on the other hand, the national political leaders are fighting for the preservation of the cultural and linguistic identity of their people, the education sector serves as the mediator between these two parties[1]. Hence, the sociology of learning in schools is built on the assumption that a polity targeting sustainable-development needs to focus on providing

[1] Educationalists, such as Giddens, 1994, and Stromqvist & Monkman, 2000, are increasingly interested in the role of globalization in the re-conceptualization of knowledge.

children with the knowledge, skills and values needed to make them become competent adult members of the society (Broadfoot, 1994). And so, by definition, the type of language-in-education policy (if any) adopted by a government reflects its ambition to educate a skilled and attractive labor force. As Marland (1977) highlighted in his advocacy for language across the curriculum (LAC):

> If a school devotes thought and time to assisting language development, learning in all areas will be helped; if attention is given to language in the content and skill subjects, language development will be assisted powerfully by the context and purpose of those subjects (Marland, 1977; quoted by Froese, 1994, p. 3205).

Building on the hypothesis that bilingual education programs favor cognitive learning, and thereby literacy (Jacob, 1994; Ogbu, 1994; Pease-Alvarez, 1994), and given the contradictory linguistic interpretations of globalization, the question of which languages to choose as part of a bilingual education policy confronts two main linguistics theorist groups, namely the 'free-market' theorists and the 'green' theorists. On the one hand, the 'free-market' theory of unfettered capitalism defines linguistic geo-strategy as a race for 'market share' ran by the governments representing the major international languages. On the other hand, the 'green' theory of ecological protection advocates for a linguistic geo-strategy of "protection of endangered languages undertaken by linguists and by those interested in linguistic human rights" (Kibbee, 2003, p. 47).

Although the emergence of this debate results from works in sociolinguistics and linguistics, this paper aims at showing that economics of education and economics of language contribute to this debate principally via their fundamental assumption that an optimal combination of languages exists for each labor market (Vaillancourt, 1982/1983, p. 167). This hypothesis, which supports the 'free-market' theory, has inspired Vaillancourt (1980) and Lacroix & Vaillancourt (1980, 1981) to elaborate a framework transforming this demand for language skills into a demand for individuals embodying language skills, thereby allowing them to make predictions on the relative earnings of Anglophone and Francophone salaried in Quebec. A similar framework was used by Boulet (1980) to examine the situation in Montreal. In total, more than two dozen studies have been conducted since 1970 based on this hypothesis and using either a 1/100 sample drawn from the 1971 Census of Canada or data from large-scale surveys. Vaillancourt (1982/1983)

highlights that "[a]ll studies make use of regression analysis, usually linking the logarithm of earnings to individual characteristics such as education and age, in addition to language skills" (p. 168). This method is derived from the 'mincerian' specifications of human capital. The principle is to add to his Mincer's (1974) specification of the link between income and its determinants, one or several variables denoting linguistic competences (Grin, 1999, p. 30). The inherent hypothesis is that the higher the level of language competences, the higher the wages.

These studies have the advantage of coherently supporting the validity of the above framework to predict the relative returns to language skills, even when taking into account the level of knowledge of these languages (e.g., Boulet, & Castonguay, 1979; Chizwick & Miller, 1992; Fixman, 1990; Grenier & Vaillancourt, 1982; Grin, 1999; Sabourin, 1979; Veltman, Vaillancourt & Pes, 1980). On the other hand, their weakness lies in their use of datasets that are nationally designed and thereby not internationally comparative.

The purpose of this paper is therefore to go beyond this limitation by testing the 'free-market' theory on eight countries, using the database provided by the International Adult Literacy Survey (IALS), ran between 1994 and 1998. Three countries (Finland, Hungary and Norway) officially apply a bilingual education policy and five (Chile, Czech Republic, Denmark, Italy and Italian-speaking Switzerland) officially apply another type of language-in-education policy. Table I presents the language policy of all IALS countries covered by this study. Note that these countries have been selected among the twenty-one countries participating in the IALS, based on availability and reliability of data.

Among the linguistic factors influencing wages, the level of literacy in the working language (which is assumed to be the national official language) and the number of languages spoken are retained for this study. One of the objectives is to test the assumption that proficiency in the national language is more significant to immigrants (measured as not born in country of survey) than to native individuals. Further, the number of languages spoken serves to test the assumption that globalization requires skills in foreign languages (free-market theory).

Building the hypotheses mainly on results found by previous studies in the United States and in Canada in the past twenty-five years (with the exception of the works by Grin in Switzerland), this study attempts to test their generalizability at the international level. Interestingly, the studies conducted so far show rather mixed results. For instance, some find that a variable measuring English proficiency is not statistically significant in influencing hourly wages. In the U.S., such findings include the studies by Borjas (1984) using the 1976 Survey of Income and Education (SIE) for various Hispanic groups, Reimers (1983, 1985) for males and females in the SIE data set, and Gwartney & Long (1978) and Carliner (1980) using Census data. In Canada, Bloom & Grenier (1992), Chizwick & Miller (1992), Grenier (1987), Robinson (1988), Shapiro & Stelcner (1987) and Vaillancourt (1992) failed to find strong language effects on earnings outside Quebec (where the returns to bilingualism in French and English are generally positive), confirming thereby the findings from the U.S.

On the other hand, research by Grenier (1984), Kossoudji (1988), McManus et al. (1983), Rivera-Batiz (1990), Tainer (1988), have found significant positive effects of English language proficiency on earnings in the U.S. Moreover, in Canada, Christofides & Swidinsky (1998) have shown that, relative to the earnings of unilingual Anglophones, the returns to bilingualism have increased significantly between 1971 and 1991 in both Quebec and the Rest-of-Canada, which alters previous results. Further, Grin's (1999) study on the returns to proficiency in a foreign language (namely, English) in Switzerland confirms a significant effect on earnings.

Rivera-Batiz's (1990) and Grin's (1999) studies differ from the other studies in their use of test-based measurements of language proficiency, rather than self-assessed subjective measurements. The present study offers similar reliability for skills in the official national language(s) by using the test-based measurement of prose, document and quantitative literacy computed by the IALS. However, skills in foreign languages are based on self-assessment.

Because the aim of this study is to test the free-market theory, this paper addresses the following specific questions:

1) Does proficiency in the official national language(s) play a significant role on wages?
2) Does this result differ by gender and between native and non-native individuals to the country of survey?
3) Are language skills more rewarded in countries applying an official bilingual policy than in countries applying another type of language policy?

2. The empirical model

This study applies the following empirical human capital model, estimated separately for men and women, and native and non-native individuals in each country of the sample:

$$\log W_{ijk} = \beta' X_{ijk} + U_{ijk},$$

where W_{ijk} is the estimate of personal income from only wages, salary or self-employment in the year of the survey received by individual *i* of gender *j,* and place of birth *k* (i.e. in or not in country of survey); β is a vector of coefficients to be estimated; X_{ijk} is a vector of human capital and demographic characteristics affecting wages; and U_{ijk} is a stochastic disturbance.

In order to determine the role played by language proficiency on earnings, three human capital equations have been computed. The first one is a 'standard' human capital equation, where vector X_{ijk} includes two key explanatory variables. First of all, years of schooling, *a7*, as an indication of the impact of academic skills on earnings. Moreover, years of on-the-job experience, proxied by the variable *exper*, measured as age minus years of schooling minus six[2], to incorporate the effect of non-academic skills on wages.

The second human capital equation adds to the previous the scores received by individuals in literacy, as measured by the IALS. The IALS defines three domains of literacy:

[2] On average, compulsory education starts at the age of six at the international level, including in the countries of this sample. It is therefore commonly admitted to define *exper* as age minus years of schooling minus six (Rivera-Batiz, 1990).

a) *Prose Literacy* – the knowledge and skills needed to understand and use information from texts including editorials, news stories, poems, and fiction;
b) *Document literacy* – the knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables, and graphics; and
c) *Quantitative literacy* – the knowledge and skills required to apply arithmetic operations, either alone or sequentially, to numbers embedded in printed materials, such as balancing a checkbook, calculating a tip, completing an order form, or determining the amount of interest on a loan from an advertisement (Statistics Canada, 2002, p. 15; italic in original).

For each of these three scales (prose, document and quantitative), individuals are assigned scores, ranging from 0 to 500, according to how well they perform on a number of tasks of varying difficulty. The scale scores are in turn grouped into five empirically determined literacy levels, each of them implying an ability to cope with a particular subset of reading tasks. Variables *prose*, *doc* and *quant* provide the average score for prose literacy, document literacy and quantitative literacy respectively (see Table II for a definition of each level and score range).

Finally, the third human capital equation adds skills in two languages, proxied by the dummy variable *lang2*, which equals 1 if the person can conduct a conversation in a foreign language in addition to the national official language, and zero otherwise. Although this variable is based on self-assessment, and can therefore not be considered as an evidence of bilingual proficiency, it helps measuring the significance given by the labor market to language competences beyond the official national language.

Only individuals for whom non-zero wages are observed are retained for the analysis. This implies a non-random selection of cases, which biases the error term U_{ij}. This selectivity bias problem could be solved with the two-stage sample selection bias correction procedure postulated by Heckman (1979).

3. Results

The results for the countries of our sample are grouped by type of national language policy (bilingual and other types). Tables III-A and III-B depict the sample means for bilingual and non-bilingual countries respectively for the variables included in the analysis. Tables IV-A and IV-B show the results for native men and women in bilingual and non-bilingual countries respectively. Whenever possible, results have been computed for individuals born in another country than the country of survey to look for eventual differences of results with the individuals born in the country of survey.

For comparison purposes, equation (1) presents the estimated coefficients when all variables on language skills are excluded from the wage equation. Equation (2) then shows the results when the variables in prose, document and quantitative literacy in the official national language are included. Finally, equation (3) presents the results including skills in two languages (see annex). Note that cases with negative adjusted R^2 are not presented in these tables.

Countries applying bilingual (or multilingual) policies are assumed to value skills in two languages more than countries applying other types of language policies. This implies that the significance of *lang2* on wages is expected to be higher in bilingual countries. Conversely, proficiency in the official national language is expected to have a higher significance in countries valorizing their unique official language.

First of all, the results presented in this paper show that the three human capital equations estimated in this study provide a sufficient percentage of explanation of variations in wages only for Finnish men and women born in Finland (between 12.2 and 13.8 percent), Norwegian men born in Norway (between 11.2 and 12.7 percent), Danish men born in Denmark (between 12.5 and 13.3 percent) and women leaving in Italy and born abroad (up to 21.9 percent). For all other cases, the low level of adjusted R^2 highlights the need to refine the estimated equations. However, previous empirical studies applying the same Mincerian approach did not obtain higher explanation degrees, which allows us nevertheless to treat our results as valid.

In the two countries applying a national policy of bilingualism (Finland and Norway) linguistic skills, both in terms of literacy skills in the national official language and skills in a second language, have a significant effect on wages, as demonstrated by the increasing adjusted R^2 when incorporating the linguistic variables. However, the weights estimated for *pros*, *doc* and *quant* are very small compared to the weights estimated for *lang2*. This shows that for individuals born in the country of residency and work, although they can influence the type of work and thereby the income range one is eligible for, literacy skills in the national official language are not a requirement for wage improvements. On the other hand, the weight estimated for second language skills goes pass the weights estimated for educational level and professional experience in both countries. It is however worth noticing that although Swedish is the second official language of Finland, 55 percent of the Finnish population has English as second language (41.7 percent speaks Swedish as second language). The same applies to Norway, with English being spoken by 93 percent of Bokmål-speaking population as the second language.

Moreover, looking at the results for the six countries applying a national language policy other than bilingualism (Chile, Czech Republic, Denmark, Hungary, Italy and Italian-speaking Switzerland), it appears that despite the explicative weakness of the model, the inclusion of language skill variables also improves the adjusted R^2. It is interesting to see that skills in a second language are as praised by the labor market in non-bilingual countries as they are in bilingual countries and that the role played by literacy in the national official language varies strongly between countries and even between types of literacy skills. Furthermore, second language skills are more valued in women's wages than in men's wages in all countries of our sample except Switzerland (Italian-speaking part). These differences could be explained by the distribution of gender by type of professional occupation.

When examining the nature of the second language spoken by the individuals of our sample it is striking to see that English comes first in Chile (58 percent) and Denmark (79 percent), and second in Hungary after German (29 percent versus 52 percent) and in Italy after French (35 percent against 44 percent). The only exception to this trend in favor of English as common communication means are the Czech Republic, where 41 percent of the population still speaks Russian as second language before German (20 percent) -

English comes only in third position with 14 percent -, and the Italian-speaking Switzerland with 58 percent speaking the regional dialect, 24 percent speaking German, and 13 percent French[3] (only 1.5 percent for English). From this distribution of languages it is clear that the choice of the second language is more highly correlated to economic factors than the choice of the first language, which is still very much correlated to socio-cultural and historical factors. This finding for second languages supports the free-market theory, which states that the choice of languages should be ruled by competitiveness.

Finally, although one of the objectives of this study was to compare results for men and women according to their place of birth (assuming that immigrants would be included in the individuals not born in the country of survey), lack of valid data for individuals born outside the country of survey in all countries of our sample - except for Norway and the Italian-speaking Switzerland - hinders us from drawing any conclusions from that angle (see Tables III-A and III-B for sample means by gender and place of birth). In the case of Norway, none of the three human capital equations tested have the capacity to explain more than 0.5 percent of the variations in wages for men born abroad, and in the Swiss case, the inclusion of the linguistic variables diminishes the explanatory level of the model, implying that the sources of variations of wages of non-natives should be sought among other factors.

4. Conclusions

Rare study on economic returns to language skills conducted at the international level, this paper has made use of a test-based measure of literacy skills in national official language and self-assessment measure of competences in a second language to estimate the role played by language skills in explaining earnings in eight countries. This paper thereby contrasts with the previous literature in this field, which has used non-comparative national datasets.

This analysis demonstrates the existence of commonalities between countries in terms of language skills valuing, which go beyond the type of language policy applied at the

[3] Together with Italian and Romansh, German and French are the official languages of Switzerland.

national level. In each of the eight countries compared, skills in a second language are estimated to be a major factor constraining positively wage opportunities.

The initial objective of this empirical study was to test the free-market theory according to which 'competitive' bilingualism or multilingualism needs to prevail 'ecological' multilingualism. Based on the nature of the second languages spoken by our sample, and on their estimated economic return, this study validates fully the free-market theory. However, the returns to literacy skills in the official national language (assumed to be equal to the working language) were expected to be higher. The re-computation of literacy skills as an average of prose, document and quantitative literacy might alter this result in favor of the free-market theory, i.e. in favor of high skills in the language of the market. Finally, a suggestion for further research would be to add a control for the type of professional occupation in order to explain better the differences in returns to language skills by countries, genders, native vs. non-natives, and even individuals of a same group.

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Table I Official language policy of the sample countries

Country	Language Policy
Chile	Mixed policy: Valorization of official language and Differentiate status (minority languages). Non-intervention.
Czech Republic	Mixed policy: Non-intervention (official language) and Sector policy (minority languages).
Denmark	Sector policy.
Finland	Bilingualism based on territorial personal rights.
Hungary	Non-intervention and sector policy (minority languages).
Italy	Unilingualism (valorization of the national official language).
Norway (Bokmål)	Bilingualism based on personal rights.
Switzerland (Italian-speaking)	Unilinguism (territorial borders between official languages).

Source: Based on Leclerc (2001).

Table II Literacy Levels and Score Ranges

Level	Score Range	Definition
		Prose Literacy
1	0 to 225	Most of the tasks at this level require the reader to locate one piece of information in the text that is identical to or synonymous with the information given in the directive. If a plausible incorrect answer is present in the text, it tends not to be near the correct information.
2	226 to 275	Tasks at this level generally require the reader to locate one or more pieces of information in the text, but several distracters may be present, or low-level inferences may be required. Tasks at this level also begin to ask readers to integrate two or more pieces of information, or to compare and contrast information.
3	276 to 325	Tasks at this level generally direct readers to locate information that requires low-level inferences or that meets specified conditions. Sometimes the reader is required to identify several pieces of information that are located in different sentences or paragraphs rather than in a singular sentence. Readers may also be asked to integrate or to compare and contrast information across paragraphs or sections of text.
4	326 to 375	These tasks require readers to perform multiple-feature matching or to provide several responses where the requested information must be identified through text-based inferences. Tasks at this level may also require the reader to integrate or contrast pieces of information, sometimes presented in relatively lengthy texts. Typically, these texts contain more distracting information, and the information requested is more abstract.
5	376 to 500	Tasks at this level typically require the reader to search for information in dense text that contains a number of plausible distracters. Some require readers to make high-level inferences or to use specialized knowledge.
		Document Literacy
1	0 to 225	Most of the tasks at this level require the reader to locate a single piece of information based on a literal match. Distracting information, if present, is typically located away from the current answer. Some tasks may direct the readers to enter personal information onto a form.
2	226 to 275	Document tasks at this level are a bit more varied. While some still require the reader to match a single feature, more distracting information may be present or the match may require a low-level inference. Some tasks at this level may require the reader to enter information onto a form or to cycle through information in a document.
3	276 to 325	Tasks at this level are varied. Some require the reader to make literal or synonymous matches, but usually the reader must take conditional information into account or match on the basis of multiple features of information. Some require the reader to integrate information from one or more displays of information. Others ask the reader to cycle through a document to provide multiple responses.
4	326 to 375	Tasks at this level, like those at the previous levels, ask the reader to match on the basis of multiple features of information, to cycle through documents, and to integrate information; frequently, however, these tasks require the reader to make higher-order inferences to arrive at the correct answer. Sometimes the document contains conditional information that must be taken into account by the reader.
5	376 to 500	Tasks at this level require the reader to search through complex displays of information that contain multiple distracters, to make high-level inferences, process conditional information, or use specialized knowledge.

Table II (Cont'd)

Level	Score Range	Definition
		Quantitative Literacy
1	0 to 225	Although no quantitative tasks used in the assessment fall below the score value of 225, experience suggests that such tasks would require the reader to perform a single, relatively simple operation (usually addition) for which either the numbers are clearly noted in the given document and the operation is stipulated, or the numbers are provided and the operation does not require the reader to find the numbers.
2	226 to 275	Tasks at this level typically require readers to perform a single arithmetic operation (frequently addition or subtraction), using numbers that are easily located in the text or document. The operation to be performed may be easily inferred from the wording of the question or the format of the material (for example, a bank deposit or order forms).
3	276 to 325	Tasks at this level typically require the reader to perform a single operation. However, the operations become more varied – some multiplication and division tasks are included. Sometimes the reader needs to identify two or more numbers from various places in the document, and the numbers are frequently embedded in complex displays. While semantic relation terms such as "how many" or "calculate the difference" are often used, some of the tasks require the reader to make higher-order inferences to determine the appropriate operation.
4	326 to 375	With one exception, the tasks at this level require the reader to perform a single arithmetic operation where typically either the quantities or the operation are not easily determined. That is, for most of the tasks at this level, the question or directive does not provide a semantic relation term such as "how many" or "calculate the difference" to help the reader.
5	376 to 500	These tasks require readers to perform multiple operations sequentially, and they must locate features of the problem embedded in the material or rely on background knowledge to determine the quantities or operations needed.

Source: Statistics Canada (2002).

Table III-A Sample means for wage equations, by gender and place of birth: countries applying a bilingual policy

Variables	Born in country of survey				Not born in country of survey			
	Males		Females		Males		Females	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Finland								
wage	982256	2785377	1038858	2926830	1495678	3536005	1314993	3390997
a7	12.59	3.545	13.11	3.451	13.00	2.867	14.44	2.898
exper	19.29	12.879	18.69	12.904	11.68	10.111	9.69	9.075
prose	291.72	41.78	303.56	39.17	282.70	69.39	311.01	59.69
doc	298.77	47.01	301.23	44.48	290.66	58.67	300.56	59.58
quant	298.43	41.41	291.68	38.96	285.37	55.81	289.30	57.57
lang2	0.51	0.500	0.58	0.591	0.79	0.418	0.88	0.342
Number of observations	1104		1049		28		16	
Norway								
Wage	1107591	2781348	1546490	3427086	1936607	3765607	2203896	4019355
a7	12.53	4.621	12.42	3.705	15.92	8.942	14.71	3.769
exper	20.93	13.726	20.36	13.265	16.01	13.548	16.55	10.754
prose	291.68	37.35	302.31	36.03	266.56	65.42	286.05	62.37
doc	306.91	44.39	305.11	43.41	278.25	77.33	289.97	68.34
quant	308.22	43.65	303.03	40.58	287.56	65.28	290.04	58.38
lang2	0.8215	0,38308	0.8324	0.37367	0.9813	0.13607	0.9740	0.16010
Number of observations	1227		1241		107		77	

Table III-B Sample means for wage equations, by gender and place of birth: countries applying a non-bilingual policy

Variables	Born in country of survey				Not born in country of survey			
	Males		Females		Males		Females	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Chile								
wage	12960155	31289941	17550442	36682533	39025000	50570700	-	-
a7	9.04	4.385	10.47	4.031	13.63	6.093	-	-
exper	22.54	14.317	19.05	13.376	14.13	12.357	-	-
prose	208.57	56.116	228.09	50.262	267.99	52.952	-	-
doc	212.88	55.844	224.11	48.452	276.48	69.506	-	-
quant	203.40	71.569	211.26	64.172	281.06	74.126	-	-
lang2	0.10	0.296	0.08	0.272	0.50	0.535	-	-
Number of observations	1361		873		8		1	
Czech Republic								
wage	2880509	4422884.2	2963418	4498970	2079200	4174691.3	2107485	4085639.4
a7	13.57	4.754	13.02	4.331	10.60	1.430	13.07	3.369
exper	21.75	12.451	22.23	11.864	32.10	10.027	27.53	11.281
prose	274.32	39.326	275.41	37.546	250.11	33.613	258.82	47.891
doc	292.71	49.066	286.00	47.430	270.69	37.604	272.48	68.465
quant	310.20	50.701	301.32	47.657	277.93	45.189	267.78	64.347
lang2	0.55	0.498	0.58	0.494	1.00	0.000	1.00	0.000
Number of observations	1061		1245		10		10	
Denmark								
wage	4806046	19880645	9896876	28032362	7974555	25532464	19440242	37425373
a7	13.14	4.051	13.03	3.893	14.04	3.457	11.83	3.099
exper	19.13	13.299	18.96	12.944	22.30	12.879	23.09	12.979
prose	278.22	32.743	283.46	32.198	259.33	46.675	266.18	39.142
doc	304.47	42.036	297.26	40.577	283.51	59.923	271.71	52.740
quant	310.80	40.365	297.90	39.552	292.40	61.702	281.01	49.656
lang2	0.86	0.349	0.89	0.309	0.96	0.209	0.96	0.209
Number of observations	1318		1197		23		23	
Italy								
wage	273315	414803.94	312356	445827.69	274356	426839.80	410619	491194.95
a7	12.17	4.077	12.26	3.889	13.50	4.194	12.12	4.729
exper	22.18	11.701	19.29	11.306	17.43	8.664	16.20	10.275
prose	258.56	53.078	268.94	51.041	262.46	41.934	250.92	55.253
doc	258.28	53.293	254.60	49.885	265.01	44.743	241.71	61.151
quant	271.12	55.567	263.08	51.892	279.52	42.332	249.17	58.619
lang2	0.32	0.467	0.31	0.464	0.54	0.508	0.76	0.436
Number of observations	971		802		28		25	
Slovenia								
wage	643475	761179.81	542160	643940.61	603367	636767.92	637158	745881.44
a7	11.47	2.844	11.77	2.874	10.84	3.190	10.54	3.242
exper	19.19	11.814	18.20	11.689	22.09	10.599	22.07	9.665
prose	230.46	52.332	249.55	49.802	208.65	60.946	218.84	60.914
doc	240.64	59.646	249.63	56.567	212.98	66.019	212.94	67.370
quant	252.04	64.021	257.46	58.394	225.01	69.251	222.69	64.889
lang2	0.84	0.365	0.73	0.444	0.97	0.172	0.95	0.210
Number of observations	947		904		99		109	

Table III-B (cont'd)

Variables	Born in country of survey				Not born in country of survey			
	Males		Females		Males		Females	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Switzerland								
wage	1567338	3565222.8	1866260	3863863.8	1601025	3615315.4	1645139	3689831.4
a7	13.86	2.860	13.20	5.352	12.12	4.652	11.10	3.785
exper	18.79	12.820	19.65	13.801	26.45	13.440	24.76	12.360
prose	285.16	38.957	282.58	38.746	245.54	53.354	246.63	58.898
doc	292.36	39.293	283.11	39.722	257.36	54.155	246.00	58.454
quant	303.67	43.996	288.88	41.973	262.19	59.373	249.15	60.239
lang2	0.9846	0.12345	0.9883	0.10752	0.9052	0.29425	0.9333	0.25064
Number of observations	324		343		116		105	
Hungary								
wage	20601578	37899973	19202275	36963758	27951944	43043159	13948922	32496006
a7	12.80	7.698	12.93	6.949	13.67	3.559	15.25	3.980
exper	19.64	13.481	19.56	12.728	24.00	15.887	21.92	12.471
prose	241.89	38.27	253.61	37.78	236.11	48.34	282.48	36.63
doc	255.45	48.97	256.61	48.62	250.07	50.21	277.43	44.14
quant	278.04	48.27	278.95	48.57	265.91	53.32	267.40	89.33
lang2	0.19	0.391	0.26	0.438	0.50	0.548	1.00	
Number of observations	752		763		6		12	

Table IV-A Estimated coefficients, human capital wage equations: countries applying a bilingual policy

(Note: only cases presenting positive adjusted R^2 are presented in these tables. For details about cases not presented here, please contact the author)

Finland

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(2) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(3) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	9.446	39.746	0.000	10.486	24.663	0.000	10.366	23.999	0.000
	a7	0.106	7.103	0.000	0.124	7.542	0.000	0.131	7.680	0.000
	exper	0.051	12.279	0.000	0.046	10.134	0.000	0.045	9.785	0.000
	prose				-0.013	-4.391	0.000	-0.013	-4.170	0.000
	doc				0.007	2.143	0.032	0.008	2.209	0.027
	quant				0.002	0.495	0.621	0.001	0.393	0.694
	lang2							-0.179	-1.540	0.124
	Adjusted R^2	0.122			0.136			0.137		
Dependent variable mean: 11.76, Number of observations: 1104.										
Women	*Intercept*	9.644	35.732	0.000	11.253	20.695	0.000	11.289	20.663	0.000
	a7	0.059	3.522	0.000	0.071	4.044	0.000	0.069	3.831	0.000
	exper	0.055	12.269	0.000	0.047	9.001	0.000	0.047	8.991	0.000
	prose				-0.013	-3.787	0.000	-0.013	-3.821	0.000
	doc				0.003	0.872	0.383	0.003	0.833	0.405
	quant				0.004	1.119	0.263	0.004	1.147	0.252
	lang2							0.070	0.693	0.488
	Adjusted R^2	0.125			0.138			0.137		
Dependent variable mean: 11.45, Number of observations: 1049.										

Table IV-A (cont'd)

Norway

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(2) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(3) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	10.816	66.675	0.000	10.963	29.220	0.000	10.976	29.217	0.000
	a7	0.062	6.446	0.000	0.051	5.007	0.000	0.051	4.989	0.000
	exper	0.040	12.292	0.000	0.034	9.465	0.000	0.035	9.444	0.000
	prose				-0.011	-3.595	0.000	-0.011	-3.633	0.000
	doc				0.000	-0.135	0.892	0.000	-0.151	0.880
	quant				0.011	3.859	0.000	0.011	3.812	0.000
	lang2							0.088	0.725	0.469
	Adjusted R^2	0.112			0.127			0.127		
Dependent variable mean: 12.42, Number of observations: 1227.										
Women	*Intercept*	11.419	51.626	0.000	12.153	23.448	0.000	12.173	23.474	0.000
	a7	0.036	2.517	0.012	0.040	2.673	0.008	0.039	2.559	0.011
	exper	0.022	5.603	0.000	0.017	3.793	0.000	0.018	3.924	0.000
	prose				-0.001	-0.366	0.714	-0.002	-0.436	0.663
	doc				-0.006	-1.516	0.130	-0.006	-1.590	0.112
	quant				0.005	1.324	0.186	0.005	1.334	0.183
	lang2							0.164	1.073	0.284
	Adjusted R^2	0.024			0.025			0.025		
Dependent variable mean: 12.31, Number of observations: 1241										
Not born in country of survey										
Men	*Intercept*	11.516	15.840	0.000	10.790	9.823	0.000	12.217	6.988	0.000
	a7	0.037	1.298	0.197	0.024	0.770	0.443	0.029	0.928	0.356
	exper	0.028	1.467	0.146	0.024	1.233	0.220	0.026	1.346	0.181
	prose				0.001	0.110	0.913	0.001	0.122	0.903
	doc				-0.015	-1.456	0.148	-0.015	-1.435	0.154
	quant				0.017	1.647	0.103	0.016	1.586	0.116
	lang2							-1.497	-1.049	0.297
	Adjusted R^2	0.003			0.004			0.005		
Dependent variable mean: 12.56, Number of observations: 107.										

Table IV-B Estimated coefficients, human capital wage equations: countries applying a non-bilingual policy

(Note: Only cases presenting positive adjusted R^2 are presented in these tables. For details about cases not presented here, please contact the author)

Chile

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic $H_0: \beta = 0$	Prob> |t|	(2) Parameter estimate	*t*-statistic $H_0: \beta = 0$	Prob> |t|	(3) Parameter estimate	*t*-statistic $H_0: \beta = 0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	12.835	69.509	0.000	12.492	41.889	0.000	12.485	41.780	0.000
	a7	0.138	10.915	0.000	0.107	6.032	0.000	0.108	6.035	0.000
	exper	0.015	3.781	0.000	0.015	3.726	0.000	0.015	3.746	0.000
	prose				0.001	0.243	0.808	0.001	0.280	0.779
	doc				0.001	0.403	0.687	0.001	0.373	0.710
	quant				0.001	0.384	0.701	0.001	0.384	0.701
	lang2							-0.063	-0.402	0.688
	Adjusted R^2	0.085			0.087			0.087		
Dependent variable mean: 14.41, Number of observations: 1361.										
Women	*Intercept*	12.073	41.692	0.000	11.454	22.730	0.000	11.490	22.776	0.000
	a7	0.154	7.821	0.000	0.094	3.570	0.000	0.088	3.313	0.000
	exper	0.036	6.065	0.000	0.036	6.141	0.000	0.037	6.150	0.000
	prose				0.004	0.997	0.319	0.005	1.061	0.289
	doc				-0.002	-0.456	0.648	-0.003	-0.497	0.619
	quant				0.004	0.941	0.347	0.003	0.914	0.361
	lang2							0.336	1.300	0.194
	Adjusted R^2	0.069			0.078			0.079		
Dependent variable mean: 14.37, Number of observations: 873.										

Czech Republic

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic $H_0: \beta = 0$	Prob> |t|	(2) Parameter estimate	*t*-statistic $H_0: \beta = 0$	Prob> |t|	(3) Parameter estimate	*t*-statistic $H_0: \beta = 0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	12.192	45.991	0.000	12.685	23.782	0.000	12.732	23.715	0.000
	a7	0.026	1.824	0.069	0.025	1.729	0.084	0.023	1.586	0.113
	exper	0.014	2.474	0.014	0.008	1.356	0.175	0.008	1.404	0.160
	prose				-0.009	-2.392	0.017	-0.009	-2.469	0.014
	doc				-0.012	-3.134	0.002	-0.012	-3.167	0.002
	quant				0.018	5.036	0.000	0.018	5.073	0.000
	lang2							0.108	0.780	0.436
	Adjusted R^2	0.005			0.027			0.026		
Dependent variable mean: 12.84, Number of observations: 1061.										
Women	*Intercept*	12.275	40.892	0.000	13.538	22.796	0.000	13.541	22.802	0.000
	a7	0.032	1.967	0.049	0.031	1.869	0.062	0.029	1.760	0.079
	exper	-0.004	-0.731	0.465	-0.012	-1.986	0.047	-0.012	-1.845	0.065
	prose				-0.010	-2.575	0.010	-0.010	-2.634	0.009
	doc				-0.014	-3.338	0.001	-0.014	-3.360	0.001
	quant				0.019	4.746	0.000	0.019	4.755	0.000
	lang2							0.149	1.078	0.281
	Adjusted R^2	0.004			0.024			0.024		
Dependent variable mean: 12.60, Number of observations: 1245.										

Table IV-B (cont'd)

Denmark

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(2) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(3) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	10.529	58.758	0.000	11.271	27.542	0.000	11.268	27.513	0.000
	a7	0.080	7.184	0.000	0.084	7.117	0.000	0.083	7.052	0.000
	exper	0.045	13.215	0.000	0.045	12.075	0.000	0.045	11.751	0.000
	prose				-0.015	-3.986	0.000	-0.015	-3.985	0.000
	doc				0.009	2.335	0.020	0.009	2.312	0.021
	quant				0.002	0.736	0.462	0.002	0.752	0.452
	lang2							0.032	0.223	0.824
	Adjusted R^2	0.125			0.133			0.132		
Dependent variable mean: 12.43, Number of observations: 1318.										
Women	*Intercept*	11.318	39.978	0.000	12.773	19.817	0.000	12.698	19.717	0.000
	a7	0.048	2.739	0.006	0.064	3.459	0.001	0.063	3.452	0.001
	exper	0.027	5.139	0.000	0.027	4.677	0.000	0.030	5.060	0.000
	prose				-0.011	-2.042	0.041	-0.013	-2.404	0.016
	doc				0.008	1.527	0.127	0.008	1.504	0.133
	quant				-0.003	-0.729	0.466	-0.003	-0.612	0.540
	lang2							0.555	2.423	0.016
	Adjusted R^2	0.021			0.025			0.029		
Dependent variable mean: 12.45, Number of observations: 1197.										

Hungary

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(2) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(3) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	10.984	27.442	0.000	10.299	11.522	0.000	10.476	11.726	0.000
	a7	0.057	3.129	0.002	0.046	2.521	0.012	0.043	2.325	0.020
	exper	0.034	3.292	0.001	0.028	2.539	0.011	0.030	2.682	0.007
	prose				-0.021	-3.183	0.002	-0.021	-3.237	0.001
	doc				0.002	0.413	0.680	0.002	0.305	0.761
	quant				0.019	3.458	0.001	0.019	3.417	0.001
	lang2							0.788	2.529	0.012
	Adjusted R^2	0.015			0.037			0.043		
Dependent variable mean: 12.39, Number of observations: 752.										
Women	*Intercept*	11.517	27.629	0.000	10.129	10.147	0.000	10.199	10.221	0.000
	a7	0.024	1.203	0.229	0.011	0.534	0.593	0.012	0.606	0.545
	exper	0.014	1.347	0.178	0.015	1.323	0.186	0.018	1.591	0.112
	prose				-0.005	-0.758	0.448	-0.006	-0.857	0.391
	doc				-0.005	-0.948	0.343	-0.005	-0.961	0.337
	quant				0.015	2.810	0.005	0.015	2.757	0.006
	lang2							0.481	1.689	0.092
	Adjusted R^2	0.000			0.011			0.013		
Dependent variable mean: 12.10, Number of observations: 763.										

Table IV-B (cont'd)

Italy

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t |	(2) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t |	(3) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t |
Born in country of survey										
Men	*Intercept*	10.257	42.300	0.000	10.090	29.367	0.000	10.086	29.303	0.000
	a7	0.044	3.123	0.002	0.036	2.226	0.026	0.037	2.217	0.027
	exper	0.018	3.586	0.000	0.015	3.010	0.003	0.015	3.007	0.003
	prose				-0.007	-2.682	0.007	-0.007	-2.658	0.008
	doc				-0.002	-0.642	0.521	-0.002	-0.655	0.513
	quant				0.010	2.895	0.004	0.010	2.898	0.004
	lang2							-0.027	-0.226	0.821
	Adjusted R^2	0.014			0.026			0.025		
Dependent variable mean: 11.18, Number of observations: 971.										
Women	*Intercept*	10.563	30.121	0.000	10.850	21.998	0.000	10.863	21.923	0.000
	a7	0.015	0.733	0.464	0.014	0.591	0.555	0.012	0.509	0.611
	exper	0.013	1.795	0.073	0.008	1.107	0.269	0.008	1.116	0.265
	prose				-0.009	-2.364	0.018	-0.009	-2.373	0.018
	doc				-0.008	-1.599	0.110	-0.008	-1.603	0.109
	quant				0.016	3.655	0.000	0.016	3.660	0.000
	lang2							0.046	0.289	0.773
	Adjusted R^2	0.002			0.017			0.016		
Dependent variable mean: 11.00, Number of observations: 802.										

Table IV-B (cont'd)

Switzerland (Italian-speaking)

Gender	Independent variable	Dependent variable: Natural logarithm of annual wage rate (quintile)								
		(1) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(2) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|	(3) Parameter estimate	*t*-statistic H_0: $\beta=0$	Prob> |t|
Born in country of survey										
Men	*Intercept*	9.754	14.325	0.000	10.387	9.896	0.000	9.207	7.090	0.000
	a7	0.079	1.860	0.064	0.093	2.022	0.044	0.083	1.791	0.074
	exper	0.041	4.312	0.000	0.038	3.794	0.000	0.036	3.549	0.000
	prose				-0.005	-0.873	0.383	-0.006	-0.907	0.365
	doc				-0.001	-0.204	0.838	-0.001	-0.223	0.824
	quant				0.004	0.676	0.500	0.004	0.696	0.487
	lang2							1.442	1.538	0.125
	Adjusted R^2	0.049			0.044			0.048		
Dependent variable mean: 11.61, Number of observations: 324.										
Women	*Intercept*	10.543	19.201	0.000	13.125	10.633	0.000	13.142	7.844	0.000
	a7	0.017	0.573	0.567	0.027	0.906	0.366	0.027	0.905	0.366
	exper	0.025	2.204	2.204	0.019	1.535	0.126	0.019	1.530	0.127
	prose				-0.015	-2.079	0.038	-0.015	-2.060	0.040
	doc				0.004	0.438	0.662	0.004	0.434	0.664
	quant				0.002	0.303	0.762	0.002	0.303	0.762
	lang2							-0.018	-0.014	0.988
	Adjusted R^2	0.009			0.024			0.021		
Dependent variable mean: 11.25, Number of observations: 343.										
Not born in country of survey										
Men	*Intercept*	11.578	13.367	0.000	12.154	10.358	0.000	11.829	9.680	0.000
	a7	-0.016	-0.355	0.723	0.033	0.593	0.554	0.028	0.507	0.614
	exper	0.009	0.546	0.586	0.010	0.642	0.522	0.008	0.490	0.625
	prose				-0.027	-2.717	0.008	-0.027	-2.699	0.008
	doc				0.019	1.901	0.060	0.018	1.816	0.072
	quant				0.002	0.261	0.795	0.002	0.279	0.781
	lang2							0.624	0.958	0.340
	Adjusted R^2	-0.011			0.032			0.032		
Dependent variable mean: 11.61, Number of observations: 116.										
Women	*Intercept*	8.643	7.921	0.000	8.586	6.162	0.000	8.381	5.152	0.000
	a7	0.052	0.782	0.436	0.043	0.543	0.588	0.040	0.500	0.618
	exper	0.072	3.527	0.001	0.074	3.517	0.001	0.074	3.485	0.001
	prose				0.009	0.800	0.426	0.009	0.807	0.422
	doc				0.001	0.118	0.907	0.002	0.127	0.899
	quant				-0.010	-0.756	0.451	-0.010	-0.762	0.448
	lang2							0.228	0.247	0.806
	Adjusted R^2	0.098			0.078			0.069		
Dependent variable mean: 11.01, Number of observations: 105.										

ANNEXES

Table A Current language settings of countries in Study I ('U'=Unilingual; 'B'=Bilingual; and 'T'=Trilingual) (1/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
Angola	Portuguese	Portuguese (*de facto*)	Umbundu, Kimbundu, Kikongo, Quioco and Ganguela.	41	Portuguese/Angolan Portuguese	Portuguese unilingual system	Angolan Portuguese	Lusophone (U)
Benin	French	French	> 50, among which Fon, Yorouba, Bariba, Adja, Goun and Ayizo are the most spoken.	51	French (the national languages are only used in non-formal education for adult literacy).	French unilingual system	French	Francophone (U)
Botswana	English	English	Tswana	30	Primary: Tswana; Secondary and upward: English	Bilingual system	English and Tswana	English-speaking (U)
Burkina Faso	French	French	Mooré (or Mossi), Dioula and Foulfoudé (also called Fulbé, Peular or Peul)	71	French and National Languages[1].	French unilingual system	French	Francophone (U)
Burundi	French	Kirundi (de jure) and French (de facto)	N/A	3	Grades 1-3: Kirundi; Grades 4-6: Inclusion of French; Secondary upward: French only	Bilingual system	Kirundi, French (formal and official settings), Swahili (mainly in SME) and English (business and trade)	Francophone (B)

[1] However, in practice, only French is used as medium of instruction in formal education, and the national languages only for literacy programs.

Table A Cont'd (2/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
Cameroon	German, English and French	French and English	280 National languages	279	Primary and Secondary: English or French (according to the linguistic geographic area), and teaching of the other language in Grade 6 upward.	French and British system with national incentive for biculturalism	French and English	Francophone + English-speaking (B)
Central Africa	French	Sango and French	Sango	68	French (Sango is only used in non-formal education for adult literacy)	French unilingual system	French (written) and Sango (oral)	Francophone (B)
Congo-Brazzaville	French	French	Lingala and Munukutuba	60	French	French unilingual system	French (all sectors)	Francophone (U)
Congo-Kinshasa	French	French and English	Kikongo, Lingala, Kiswahili, and Tshiluba.	221	French	French unilingual system	French, English and vernacular languages	Francophone (U)[2]
Cote d'Ivoire	French	French	70 National languages	73	French (English is introduced as compulsory second language at Secondary level)	French unilingual system	French	Francophone (U)
Egypt	French and English	Arabic (*de jure*)	N/A	11	Classic Arabic[3]	Arabization policy	Arabic and English	Arabic-speaking (U)

[2] Congo-Kinshasa is still unilingual although it pursues bilingualism in French and English. In order to reach that goal, it needs to redefine the LiE policy.
[3] Private schools offer instruction in other languages in addition to Arabic (e.g., French, English). These schools are targeted to the socio-economic elite.

Table A Cont'd (3/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
Gabon	French	French	All Gabonese languages	40	French	French unilingual system	French	Francophone (U)
Gambia	English	English (*de facto*)	N/A	20	English	British unilingual system	English	English-speaking (U)
Ghana	English	English (*de facto*)	N/A	72	English[4]	British unilingual system	Akan	English-speaking (U)
Guinea-Bissau	Portuguese	Portuguese (*de facto*)	N/A	23	Portuguese	Portuguese unilingual system	Portuguese	Lusophone (U)
Kenya	English	English (*de facto*) and Swahili (*de facto*)	N/A	61	English (Swahili only taught as second language)	British unilingual system	English and Swahili	English-speaking (B)
Lesotho	English	Sotho and English	Sotho	3	Primary (up to Grade 5): Sotho; Grades 6-7: Progress introduction of English; Secondary: English only (Sotho taught as second language)	Bilingual system	English and Sotho	English-speaking (B)
Libya	Italian, French and English	Arabic	N/A	12	Classic Arabic	Arabization policy	Libyan Arabic	Arabic-speaking (U)

[4] Some vernacular languages, e.g. akan, éwé, ga, etc., are taught.in Primary, but not the local mother-tongues.

Table A Cont'd (4/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
Mali	French	French	All Malian languages	32	Pre-primary: Mother-tongue; Grades 1-3: Mother-tongue; Grade 4 upward: French[5].	Officially: bilingualism; In practice: French unilingual system	French and Bambara	Francophone (U)
Mauritania	French	Classic Arabic	Modern Arabic, Poular, Soninké and Wolof	8	Modern Arabic and French	Bilingual arabization policy	Classic Arabic and French	Francophone + Arab-speaking (B)
Morocco	French	Classic Arabic	N/A	11	Classic Arabic and French (compulsory second language)	Arabization policy	Arabic, French and Berbère	Arabic-speaking (U)
Mozambique	Portuguese	Portuguese (*de jure*)	14 National languages	33	Portuguese[6]	Portuguese unilingual system	Portuguese	Lusophone (U)
Namibia	German and English	English (*de facto*)	12 National languages	28	Grades 1-3: Mother-tongue Grade 4: Introduction of English Grade 5 upward: English	Multilingual system	Afrikaans, English and German	English-speaking (B)

[5] In practice, this bilingual system is only applied in 300 schools over the country and French remains the sole medium of instruction from Grade 1 upward in most schools.

[6] Currently, a new system of education is experimented, including 1 bilingual education program (Portuguese and a Mozambique language); 1 monolingual program where the Mozambique languages are only used as pedagogical support; and 1 unilingual system where Mozambique languages are taught as second languages.

Table A Cont'd (5/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
Niger	French	French	20 National languages	21	Pre-primary: Mother-tongue Grades 1-3: National languages Grade 4 upward: French	Bilingual system	French (written) and National languages (oral)	Francophone (U)
Nigeria	English	English	Hausa, Ibo and Yorouba	470	Grades 1-3: National Languages (English as second language); Grade 4 upward: English	Foreign language priority system	Hausa, Ibo, Yorouba and Pidgin English	English-speaking (U)
Rwanda	French	Kinyarwanda, French and English	N/A	3	Grades 1-3: Kinyarwanda; Grades 4-6: French; Secondary: Kinyarwanda and French (English as second language) Tertiary: French or English[7]	Multilingual system	Kinyarwanda, French and English	Francophone + English-speaking (T)
Senegal	French	French	Diola, Malinké, Poular, Sérère, Soninké and Wolof	39	Pre-primary: Mother-tongue; Grades 1-3: Mother-tongue; Primary and Secondary: Wolof and French	Multilingual system	Wolof and French	Francophone (U)
Sierra Leona	English	English (*de facto*)	N/A	23	English	British unilingual system	English, Kriol, Mendé and Themné	English-speaking (U)

[7] After 1996, the large amount of refugees returning from Uganda and Tanzania has raised a new issue: thousands of children could only read or write in English and not at all in French. Therefore, the Rwandan Ministry of Education has created intensive support classes in French and English in the schools where it was judged necessary (especially at the Secondary and Tertiary levels).

Table A Cont'd (6/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
South Africa	English and Afrikaans	National: English, Afrikaans Provincial: Ndébélé, Sotho, Sesotho, Swazi, Tsonga, Tswana, Venda, Xhosa and Zoulou.	N/A	27	Pre-primary and Primary: mother-tongue instruction (if one of the local official languages) and second language learning (often English or Afrokaans); Secondary upward: Progressive move towards English and/or Afrikaans.	Multilingual system	English	English-speaking (B)
Swaziland	Afrikaans and English	English and Swati (*de jure*)	N/A	3	Primary: Swati (English as second language); Secondary: English (Swati as second language)	Mainly British system	English	English-speaking (B)
Tanzania	English	English (*de facto*) and Swahili (*de facto*)	N/A	131	Primary: Swahili; Secondary: English	Bilingual system	Swahili (oral), English (written)	English-speaking (B)
Togo	French	French	Ewé and Tem	43	Pre-primary: National languages and French; Primary upward: French	French unilingual system	French (written) and national languages (oral)	Francophone (U)
Tunisia	French	Classic Arabic	N/A	9	Pre-primary and Grades 1-3: Arabic; Grade 4 upward: Arabic and French	Bilingual system	Tunisian dialectic Arabic and French	Arabic-speaking (U)
Zambia	English	English	7 National languages	39	Primary: English; Secondary: English and National languages (not applied much in practice).	Bilingual system	English	English-speaking (U)

Table A Cont'd (7/7)

	Colonial Language(s)	*Official Language(s)*	*National Language(s)*	*Total Number of Language(s)*	*Language(s) of Instruction*	*LiE System*	*Language(s) of the Labor Market*	*Linguistic Group (U, B, T)*
Zimbabwe	English and Afrikaans	English, Shona, Ndébélé, Venda, Nambya, Shangaan, Kalanga, Southou and Tonga (*de jure*)	Shona, Ndébélé, and other Zimbabwean languages	19	Pre-primary: National languages (English only in large urban areas); Grades 1-3: Mother-tongue; Grade 4 upward: English.	Multilingual system	English, Shona and Ndébélé	English-speaking (T)

Source: Adapted from Leclerc, J. (2006). *L'aménagement linguistique dans le monde.* Québec: TLFQ, Université Laval. URL: [http://www.tlfq.ulaval.ca/axl.htm] (June 17, 2006).
Note: In all the above countries, wherever applicable, Classic Arabic is the medium of instruction in Qur'anic schools.

Table B Current external settings of countries in Study I

(economic and financial dependency)

	Primary Trade Partners (Export-Import)	*Primary Bilateral Donor*
Angola	US-South Corea	Portugal
Benin	Nigeria-China	France
Botswana	European Free Trade Association (EFTA)-Southern African Customs Union (SACU)	U.S.
Burkina Faso	Ghana-France	France
Burundi	Switzerland-Kenya	U.S.
Cameroon	Spain-France	France
Central Africa	Belgium-France	France
Comoros	US-France	France
Congo-Brazzaville	China-France	France
Congo-Kinshasa	Belgium-South Africa	U.S.
Cote d'Ivoire	France-France	France
Egypt	Italy-US	U.S.
Gabon	US-France	France
Gambia	India-China	Japan
Ghana	Netherlands-Nigeria	Japan
Guinea-Bissau	India-Senegal	Italy
Kenya	Uganda-UAE	U.S.
Lesotho	US-Hong Kong	Ireland
Liberia	Denmark-South Korea	U.S.
Libya	Italy-Italy	France
Mali	China-France	France
Mauritania	Japan-France	Japan
Morocco	France-France	France
Mozambique	Netherlands-South Africa	U.S.
Namibia	South Africa-South Africa	Germany
Niger	France-France	France
Nigeria	US-China	U.S.
Rwanda	Indonesia-Kenya	U.S.
Senegal	India-France	France
Sierra Leone	Belgium-Germany	U.K.
South Africa	US-Germany	U.K.
Swaziland	South Africa-South Africa	Netherlands
Tanzania	India-South Africa	U.K.
Togo	Burkina Faso-China	France
Tunisia	France-France	France
Zambia	South Africa-South Africa	U.K.
Zimbabwe	South Africa-South Africa	U.K.

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