Municipality Characteristics and Math Achievement: A Multilevel Analysis of Mexican Secondary Schools

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Abstract

This study examines the impact of the municipality level characteristics on the average Math achievement of students in third year of lower secondary schools in Mexico. Using data from different Mexican and international sources and multi-level regression models the present work shows that municipality characteristics provide additional explanation of the unexplained variability in educational achievement controlling for school-level factors and even without accounting for student characteristics. Although school factors are highly correlated with municipality's characteristics, the present study finds that unobservable characteristics of the municipality are playing an important role in Mexican students' achievement which goes beyond the possible impact that school factors have on achievement.

Introduction

Diversity pervades every aspect of Mexico; communities in the country are culturally, socioeconomically, and environmentally diverse. Education represents one of the characteristics with significant between-community disparities. The Mexican education system has been characterized by its deep and geographically reproduced inequality(Gutiérrez, Giorguli, & Sánchez, 2010). While there have been studies of the influence of family and schools on educational outcomes, examinations of the influence of community factors on educational outcomes are rare for developing countries (Buchmann & Hannum, 2001). In Mexico, municipality is the smallest unit of government with the authority to implement public policies and as such municipalities influence the schools under their jurisdiction. Knowing the extent to which municipalities influence school effectiveness could guide the targeting of policies to improve Mexican education. The present study focuses on the mechanisms through municipality characteristics may impact the mean school achievement of secondary school students in Mexico.

Literature Review

A number of studies examine how family characteristics such as socio-economic status, family structure and household resources influence students' outcomes. Family socio-economic status (SES), in particular, has a significant effect on achievement (Baker, Goesling, & Letendre, 2002; Buchmann, 2002; FLACSO, 2007; Lubienski & Lubienski, 2006; Park & Sandefur, 2006). Although multilevel studies demonstrate that family factors have the strongest influence on achievement, aggregated SES by school or community level effect has also been demonstrated to influence children's educational outcomes (Chinen, 2006; INEE, 2008). Few studies focus on how community SES influences achievement.

In general, research on community effects on educational outcomes needs to be developed (Epstein & Sanders, 2000). While the interaction of individual and school-level characteristics has received great attention (Baker, et al., 2002; Battistich, Solomon, Kim, Watson, & Schaps, 1995; FLACSO, 2007; Lubienski & Lubienski, 2006; Park & Sandefur, 2006; Programa de Desarrollo Humano Oportunidades, 2010) the how this interaction is embedded in the community sphere has not been examined. Studies which include community variables such as region or state have found a small yet significant effect of community on achievement characteristics (Chinen, 2006; INEE, 2006).

Two studies highlight the importance of the spatial dimension in education research. These studies analyze educational inequality using educational outcomes and labor market characteristics derived from census data at the municipal level (Gutiérrez, 2010; Gutiérrez, et al., 2010). Gutierrez (2010) claims that the spatial dimension must be included as a contextual variable rather than just as a control variable because inequality is structured and reproduced geographically. These studies use census data and their outcome measure is therefore limited to educational attainment which measures only quantity of education not quality.

Santibañez (2008) explains that measuring educational inequality as number of years of education could yield to misleading results. She states that "the knowledge acquired by a child with 7 or 8 years of schooling in Mexico is not the same as the knowledge acquired by a child with the same number of years of schooling in South Korea or Finland, which is why quality seems to be a more important factor than the number of years of education".

Context

In 2005, Mexico had a population of 103.3 million people distributed into 31 states and one Federal District (INEGI 2005). In this year, Mexican Gross Domestic Product (GDP) per capita was 12,461 USD (OECD 2010). The average number of years of schooling in 2005 was 8.1, the literacy rate was 91.6%, more than 75% of people 15 years old or older had completed primary school, almost 54% of this population had completed secondary school, and 32% had completed high school. Enrollment in school differs in each age group. Almost all children between 6 and 12 years old attend school (96.1%), 82.5% of the teenagers between 13 to 15 years old, 47.8% of the teenagers between 16 to 19 years old, and 20.8% of adults between 20 and 24 years old are enrolled in school (INEGI 2005).

As other countries in Latin America, Mexico has experience a historical inequality in the distribution of its population, wealth and education. This uneven distribution becomes evident when data are analyzed using different layers such as poverty level or urban or rural areas.

Population distribution

In 2005, Mexican population was distributed among 187,938 localities; 23.5% of this population lived in 184,748 localities with less than 2,500 inhabitants (INEGI 2005). Around 12.9% (13.4 million people) of the population was indigenous and around 12% of this indigenous population does not speak Spanish. 73.5% of the indigenous population is concentrated in 11 of the 32 states (CONAPO 2005).

Wealth distribution

The generation of wealth is also unequal as 85% of GDP is produced in urban areas and only 15% in rural areas. At the individual level inequality is more evident, according to the National Council for the Evaluation of Social Development Policy (CONEVAL, its acronym in Spanish), in 2005, on average the income of the richest 5 percent of the population was 52.7 times higher than that of the poorest 5 percent (CONEVAL 2007). Furthermore, CONEVAL reports that in this year 17.4% of the total population was below the food poverty line, 24.7% suffered from poverty of capacities, while 47.2% were below the patrimony poverty line (2007). The percentage of the population in poverty conditions in rural settings is much higher than the percentages observed in urban areas. In rural areas 28% percent of the population was below the food poverty line, 36.2% were below the capacities poverty line and 57.4% below the patrimony poverty line, whereas only 11% of the people in urban areas were below the food poverty line, 17.8% and 41.1% were below the capacities and patrimony lines respectively.

Education

Educational outcomes

Although Mexico has improved its educational outcomes -such as literacy rates, average number of years of schooling, and attainment rates- over time those improvements have not been equally distributed among the population. In 1921, 66% of the population was illiterate whereas in 2005 8.4% was. However, the percentage of illiterate people in rural areas in 2005 was 18.9% and only

5.3% in urban areas. Comparing population by poverty condition, the difference is even large 20.9% of the people below the capacities poverty line were illiterate while only 3.4% among the non-poor were[1]. Additionally, 67% of the illiterate population between 15 and 34 years old is concentrated in 8 states: Chiapas (15.7%), Veracruz (11.9%), Puebla (8.2%), Guerrero (7.8%), México (6.7%), Oaxaca (6.6%), Michoacán (5.5%), and Guanajuato (4.4%).

The national average number of years of schooling in 2005 was 8.1 compared with the national average of 2.6 years in 1960 the improvement is clear, but this change has not been equal across the country. For instance, in the country's capital (Distrito Federal), the average was 10.2, while Chiapas' averaged only 6.1. As with the illiteracy rate, inequality becomes more noticeable when comparing poor and non-poor[2] population. While non-poor average 9.6 years of education, poor people only have 5.2 years, and as Table 1 shows these differences are more pronounced for older people[3].

Table 1. Average number of years of schooling by poverty condition.

Age group	Poor	Non-poor	Total
15 – 24	7.2	10.5	9.4
25 – 34	6.1	11.2	9.4
35 – 49	4.5	10.0	8.5
50 and older	1.7	6.7	5.2
Total	**5.2**	**9.6**	**8.1**

Mexican Educational System

The Mexican Education System consists of three levels of education: basic, upper secondary and higher education. These levels provide different services which take into account the needs of the general population, the indigenous groups; disperse rural population, and migrant groups. Table 2 shows all the available services that the Ministry of Public Education provides each level.

[1] Author's calculations using micro data from Conteo 2005.

[2] In the present document poor people are those below the line of capacities poverty defined by CTMP.

[3] Author's calculations using micro data from Conteo 2005.

Table 2. Mexican Educational System

Education	Level	Services
Basic Education	Preschool	General Communitarian Indigenous
	Primary (6 years)	General Communitarian Indigenous
	Lower secondary (3 years)	General Technical Telesecundary
Upper secondary[4]	High School	General Technological
	Technical professional	CET, CECYTE, CONALEP and others
Higher education	Technical University	Technical universities and others
	Bachelor's Degree	Normal[5] University Technological
	Graduate School	Specialization Masters Doctorate

In 1992, the federal government, the governments of the 31 states and the teachers' union signed the National Agreement for the Modernization of Basic Education. The main objectives of this agreement were reorganization of the educational system through decentralization and social participation, restatement of educational contents and materials, and revaluation of the role of teachers (Zorrilla and Barba, 2008). The Reform decentralized the Mexican Education System, renewed the curricula, created new materials, started compensatory programs and a new financing system, included evaluation, extended compulsory education to nine years, and increased the number of school days (Zorrilla, 2002). These changes were legitimized with the amendment to Article 3 of the Constitution which includes the compulsory lower secondary education and the enactment of the Education Act adopted in 1993.

Lower secondary[6] level of education is the third and last level of compulsory education. It is completed in three years. It is a requirement to enter upper secondary. There are three different types of secondary schools: General, technical and Telesecondary. General secondary is the most

[4] High school is a three-year program which is a requirement to Higher education. Technical professional education consists on terminal programs which usually last three years, and they intended to train students for technical employment.

[5] Higher education for primary and secondary teachers.

[6] The term secondary is going to be used in the present study instead of lower secondary.

common type which provides general studies to fulfill the required knowledge to enter the following level. Technical secondary provides a technical degree which allows students to enter the job market after finishing it. The telesecondary (or Telesecundaria) was launched in 1968 as a means of extending lower secondary school learning with television support to remote and small communities at a cost inferior to that of conventional secondary schools. In 2005, 54% of the secondary schools were telesecondaries but only 20.6% of the students attend this kind of school (SEP 2007).

Table 3. Lower secondary education, 2005

Type of school	Students	%	Schools	%
General	3,061,435	51.2	10,439	32.6
Technical	1,683,959	28.2	4,280	13.4
Telesecondary	1,233,862	20.6	17,293	54.0
Total	5,979,256	100	32,012	100

Although secondary is considered compulsory since 1993, universal attainment has not been reached by 2005 (INEGI 2005, INEE 2006, Salinas and Potter 2008). Yet between 2000 and 2005 the percent of children who attend secondary went from 67.9% to 77.6%. The telesecondary plays an important role in the increase of secondary attainment. However, this type of secondary offers a very low quality education which results in poor outcomes in international and national evaluations (INEE 2006, Salinas and Potter 2008, Chinen 2006).

ENLACE Test

If as Santibañez argues, improving the quality of education yields economic development and equality of opportunities among the population (2008), measuring the quality of education became very important for Mexican educational authorities. Since 2006 the Ministry of Public Education has administered the National Evaluation of Academic Achievement in Scholar Centers (ENLACE for its acronym in Spanish) nationwide. The ENLACE evaluates students at the primary, secondary and upper secondary school levels. Only some grades are evaluated in primary (3rd to 6th grade) and upper secondary levels (only 3rd grade). Since 2009 all grades of the secondary level have been evaluated.

Scores on the ENLACE range between 200 and 800 points and reflect not only the number of correct answers but also the level of difficulty of the questions. In 2006, the national mean score for

Mathematics and Reading in third grade of secondary was 500 with a standard deviation of 100. The ministry classified scores into four levels of achievement based on cut off points:

1. Insufficient: The student has not achieved the required knowledge for the subject. (Score lower than 350).
2. Basic: The student needs to improve her knowledge of the subject. (Score equal or higher than 350 and less than 500).
3. Fair: The student shows an adequate knowledge for the subject. (Score equal or higher than 500 and less than 650).
4. Excellent: The student has mastered the required knowledge for the subject. (Score equal or higher than 650).

The aggregate results by school, type of school, and state are publicly available at the ENLACE website[7]. In addition, students and their parents receive a detailed report of students' test results. Teachers also receive a detailed report on the performance of their class as well as some feedback on what they can do to improve their students' preparation based on their students' mistakes.

According to ENLACE reports, students' achievement varies dramatically between different types of schools. For example, at the secondary level, students in private[8] schools attain the highest scores while telesecondary students the lowest.

Table 4. ENLACE average scores for 3rd grade students in secondary level by type of school, 2006

Type of school	Reading	Math
Private	554	584
General	505	497
Technical	497	490
Telesecondary	461	485
Total	500	500

Source: Ministry of Public Education (SEP)

Municipalities

Municipalities are the smallest political-administrative unit governed by elected authorities with an assigned budget. The importance of municipalities has grown as the country has decentralized and there is evidence that the local administration of education resources can enhance student achievement. Thus, there is reason to expect that wealthier municipalities will have better student

[7] http://www.enlace.sep.gob.mx

[8] Although private schools are general secondary schools, they are classified in its own category due to their different results in terms of achievement.

outcomes. The 1993 education reform codified municipalities' authority over education by assigning them specific responsibilities like improvement and maintenance of school infrastructure. (Ley General de Educación, Article 70).

There are large differences between municipalities as well as within them. Municipalities vary with respect to number of localities, population size, budget, resources, and demographic and socioeconomic characteristics.

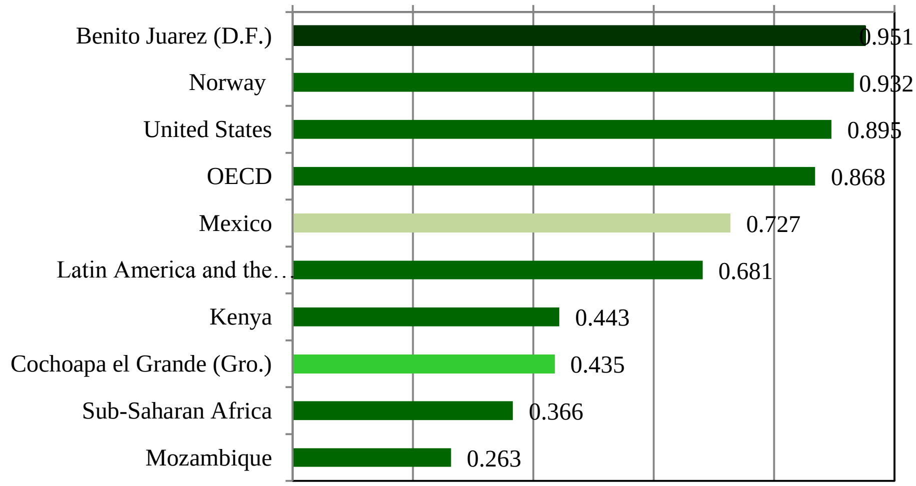
In 2005, Mexico had 2,454 municipalities unequally distributed across the 31 states and the Federal District. The number of municipalities by state varies from 5 in Baja California and Baja California Sur to 570 in Oaxaca. Most of the municipalities include rural and urban communities but 902 municipalities have been classified as fully rural because all localities within them have less than 2,500 inhabitants. Twenty three municipalities are classified as fully urban.

The Mexican National Population Council (Spanish acronym CONAPO) developed a composite index of marginality in order to differentiate states and municipalities according to the impact of scarcity as experienced by the local population. It measures the proportion of people 15 years old and older who are illiterate or did not complete primary education, the percentage of people who live in private homes without services such as piped water, drain or toilet, and electricity, the percentage of people who live in houses with a dirt floor, the percentage of homes with some level of overcrowding, the percentage of the employed population with incomes up to twice the minimum wage, and the proportion of the population who live in localities with less than 5,000 inhabitants in order to describe lack of access to education, residence in poor housing, perception of inadequate monetary income and related residency in small towns. This index classifies municipalities into five levels of marginality: very high, high, medium, low and very low. A municipality with higher marginality is generally worse off than one with lower marginality. According to CONAPO, in 2005 1,251 municipalities, representing 16.5% of the population, had very high or high marginality and 702 municipalities, representing 75.2% of the population, were ranked low or very low marginality (CONAPO, 2007).

The United Nations Development Program (UNPD) calculates the Human Development Index which is defined as "a composite measure of achievements in three basic dimensions of human development—a long and healthy life, access to education and a decent standard of living. For ease of comparability, the average value of achievements in these three dimensions is scaled to the range 0 to 1, where higher numbers reflect higher levels of achievement, and aggregated using geometric means (UNDP, 2008)". According to UNPD, Mexico as a whole had a relatively high Human

Development Index (HDI) of 0.727 in 2005. However, at the municipality level Mexico presents a highly unequal face. For example, the municipality with the highest HDI is Benito Juarez, which at 0.951, rates higher than the average of Organisation for Economic Co-operation and Development (OECD) member countries. In contrast, Cochoapa el Grande has the lowest HDI at 0.439, which is similar to countries such as Kenya but still higher than the average of Sub-Saharan countries.

Figure 1. Human Development Index, 2005



Source: Human Development Index report, 2010

Municipal HDI uncovers disparities that cannot be distinguished by just looking at national HDI which classified the country as high human development country or states' HDI for which states are ranked as high or medium development level.

Past Research

Previous research investigating the connection between community-level conditions and student outcomes outside of Mexico has supported the importance of the municipality in education. In an evaluation of El Salvador's EDUCO program, Jimenez and Sawada (1999) use municipality level characteristics to examine how the decentralization of responsibility to communities impact students' outcomes. Bännström (2008) analyzes the effect of neighborhood and upper secondary school characteristics on students' achievement in Metropolitan Sweden. Both studies highlight the importance of the role of municipality in education.

In Mexico, there are some multilevel studies that have analyzed the impact of community on achievement by adding it as a third level of analysis when school is the second level. These studies include state or region level but not municipality because they use sampling data which are not representative at the municipality level. Chinen (2006) adds state as the third level of analysis while INEE (2006) uses region as their third level of analysis.

Gutierrez and coauthors (2010) analyze "the spatial dimension in the relationship between the expected years of schooling for children living in Mexico who completed elementary school and the dynamics of the labor markets, migration and the characteristics of the educational services available at the municipality level." However, the educational variables in this study only consider grade-level attainment and availability of education services. As mentioned above, measurements of how much students learn at school, not just which grade they are in, is vital to efforts to understand the factors that influence this learning process.

It is possible that municipalities explain the relationships between school and community that are lost at state or region level. Using ENLACE data allows for an analysis of the effect of municipality because, as a national evaluation, it is representative at the municipality level. Multilevel analysis enables examination of the role of this interaction in the explanation of students' achievement. Including schools as the first level of analysis enables an examination of whether or not community variation affects school effectiveness.

Research Question

Since there are schools nested in municipalities, the present study seeks to investigate whether or not municipalities' characteristics affect average school achievement as well as how much variance in schools' achievement is explained by characteristics of municipalities.

Specific questions that motivate this study are: How much do municipalities vary in their mean mathematics achievement? Is the strength of association between school characteristics and math achievement similar across municipalities? Do schools in municipalities with higher standards of living also have better mathematics achievement?

From these questions and the conceptual framework described above the following hypotheses can be addressed:

1. Since municipalities are so different, it is likely that their mean mathematics achievement varies significantly between municipalities.
2. Variability in municipal HDI highlights disparities among municipalities which could impact education. So, it is reasonable to think that schools in more developed municipalities could have an advantage over schools in less developed municipalities after controlling for school characteristics.

3. Municipalities with the highest living standards are likely to have schools with more educated and experienced teachers, which could positively influence student achievement. Thus it can be expected that municipalities with better living conditions will have higher student achievement.

Data and Methods

Data

The analysis utilizes national data sets from five different sources. School information is obtained from two national data sets. The ENLACE dataset provides the results of the national Math and Reading examinations and the Public Education Ministry's administrative records, known as Format 911, provides responses from a survey of school administrators describing number of students, type of school, number of shifts, number of teachers and employees, level of education of teachers and staff, students by age and grade, etc.

The National Count of Population and Housing 2005, known as Conteo, provides socio-demographic data for each municipality in the country. In addition, CONAPO's municipal marginality index dataset is also used. The Human Development Index Report 2005 provides the HDI index by municipality, another important covariate in the present work. The municipality-level Gini coefficient measure of inequality is provided by CONEVAL.

In 2006, ENLACE was not applied in Michoacán and Oaxaca because local teachers' union refuse to be evaluated in Michoacán and teachers were on strike in Oaxaca. The effect of municipality in these states may differ due to the power of local teachers' union. It is also possible that schools performance is worse than the country average. Both states were excluded of the analysis.

Variables

The outcome variable is the average math score in every school of the students in the last grade of secondary in 2006. Since the method requires two levels of data, the variables are classified by level.

School level

Since schools are the first level of analysis, a number of characteristics of schools are included to control for the impacts of between-school variation. The most important characteristic of the school is the type of school: Private, general, technical or telesecondary.

To estimate the socioeconomic status (SES) of schools, traditional multilevel analyses use the average SES of students. In this case, SES will be estimated using one of the variables included in the Format 911. At the end of this format the school administrator completes a section which was created to measure the average SES of the students' households by estimating the average amount that parents spend every school year; this amount includes average expense on schools supplies, any school fees that parents must pay such as Parents' Association (if applicable), and tuition and transportation in the case of private schools. The composite index of this section is included in the present analysis as a covariate of SES at the school level.

Teachers' quality is measured with two variables: the average number of years of education of the teachers in the school and the number of teachers who participate in the Carrera Magisterial program.. Mexico's Carrera Magisterial (CM) is an incentive program instituted in 1992 and designed jointly by the federal education authorities, state authorities, and the teachers' union as a horizontal promotion system that rewards teachers with salary bonuses on the basis of their performance. Teacher performance is evaluated through a series of assessments, including tests of both teachers and students (Santibañez et al., 2007). At present more than 600,000 teachers are formally incorporated in this program.

The present analysis also includes variables to capture characteristics of the school such as total number of students (size), number of teachers, whether or not the school has Oportunidades Program beneficiaries, the school dropout rate, the school failure rate, and the type of locality (rural or urban) where the school is located. Additionally, schools are categorized by the time at which instruction occurs, either in the morning or afternoon. For schools with both morning and afternoon shifts, each shift is modeled separately.

Municipality level

The present analysis uses CONAPO's marginality index that takes into account proportion of illiterate adults, proportion of adults with incomplete secondary education or less, proportion of the population who work in agricultural activities, proportion of households with services such as electricity, water and sewage as well as proportion of household with dirt floor and provides a proxy for SES at municipal level. As described before, very high marginality corresponds to the lowest SES.

Gini coefficient is an income concentration measurement derived from the Lorenz Curve. This coefficient considers values from 0 to 1; the highest (closer to 1), the greater inequality in the distribution of income. This measurement is included at the municipality level to represent inequality.

In Mexico, the Federal government and the National Teachers' Union (SNTE, its acronym in Spanish) negotiate teachers' salaries and benefits; as a result, teachers' salaries are similar across the country and salaries do not depend on teacher's quality (Santibañez 2008). Therefore, one important source of variation affecting the ability of municipalities to attract better teachers might be the living conditions offered by the community and thus the best teachers might be found in the communities with higher living standards. For the purpose of this work, Human Development Index will be considered a measure of living standard. High levels of HDI imply better life conditions. For instance, a municipality with a HDI equal to 0.727 has better conditions than all municipalities with a lower HDI.

The proportion of the population who speak an indigenous language is included in the analysis because the indigenous population tends to have lower levels of education and higher levels of poverty and thus municipalities with higher concentration of indigenous populations have lower achievement. One aim of this analysis is to see if these disadvantages remain after controlling for poverty and type of school.

Method

To assess the association of municipalities on the average achievement in schools, multilevel modeling is used. This technique facilitates the statistical analysis of data sets with hierarchical structure.

In this case, the first level of analysis is the school while the second level of analysis is the municipality. The first model estimated is the unconditional model with no explanatory variables. This unconditional means model is used to estimate the overall mean school achievement by municipality and to estimate and test the parameter variance. The unconditional model can be defined as follows:

Level-1or school-level model is

$$Y_{ij} = \beta_{0j} + r_{ij}$$

- Y_{ij} is the mean achievement score for school *i* within municipality *j*,
- β_{0j} is the mean of school mean achievement scores for municipality *j*,

- r_{ij} is the difference between a given school's mean achievement score (Y_{ij}) and the average mean achievement score for that school's municipality (β_{0j}). It is assumed that $r_{ij} \sim N(0,\sigma^2)$ for $i = 1,\ldots,n$ schools in municipality *j*. Where σ^2 is the school-level variance.

Level-2:

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

- γ_{00} is the mean of the school means for the municipality *j.* u_{0j} is the difference between the mean achievement score for municipality *i* (γ_{00}) and the mean achievement for school *i*. It is assumed that $u_{0j} \sim N(0,\tau_{00})$. Where τ_{00} is the municipality-level variance.

The unconditional model allows for an empirical confirmation of the need to use a multilevel model. A multilevel model is needed if the variances of both levels differ statistically from zero. Once the pertinence of multilevel modeling is confirmed by the unconditional model, the conditional model can be stated.

The conditional model includes the explanatory variables and is used to estimate and test the impact of the explanatory variables.

Conditional model:

Level-1:

$$Y_{ij} = \beta_{0j} + \beta_{1j}X_{1ij} + \beta_{2j}X_{2ij} + \ldots + \beta_{nj}X_{nij} + r_{ij}$$

- Y_{ij} is the mean achievement score for school *i* within municipality *j*,
- β_{0j} is the mean of school mean achievement scores for municipality *j*,
- β_{nj} is the slope of the explanatory variable *n* for municipality *j*,
- X_{nij} is the explanatory variable *n* for school *i* at municipality *j*.
- r_{ij} is the difference between a given school's mean achievement score (Y_{ij}) and the sum of the average mean achievement score for that school's municipality (β_{0j}) and all of the β_{0j} X_{nij} terms for school *i*. It is assumed that $r_{ij} \sim N(0,\sigma^2)$ for $i = 1,\ldots,n$ schools in municipality *j*. Where σ^2 is the school-level variance.

Level-2:

$$\beta_{nj} = \gamma_{00} + \gamma_{nj}W_{1j} + \ldots + \gamma_{nj}W_{nj} + u_{nj}$$

- γ_{00} is the mean of the school means for the municipality *j*,
- γ_{nj} is the slope of the explanatory variable W_n for municipality *j*,
- W_{nj} is the explanatory variable *n* for municipality *j*.
- u_{nj} is the difference between school *i*'s mean achievement score and the mean of all school's mean achievement scores for municipality *j* plus the covariate terms for school *i*.

Results

Table 5 shows the descriptive statistics for the school level variables. The mean school math scores is 493.71, which falls below the national mean score of the students (500). Around 12% of the schools are private schools, while 23% are general schools, 12% are technical schools, and 53% are telesecondary schools.

Table 5. Descriptive statistics for school level variables

Variable	Mean	Std. dev	Minimum	Maximum
Spanish mean score	481.92	63.08	279.99	797.17
Math mean score	493.71	61.36	321.53	823.21
Private	0.12	0.32	0.00	1.00
General	0.23	0.42	0.00	1.00
Technical	0.12	0.33	0.00	1.00
Telesecondary	0.53	0.50	0.00	1.00
School SES	317.00	1,155.64	0.00	74,829.17
Number of teachers	8.64	7.98	0.00	66.00
Number of teachers in CM	2.50	4.04	0.00	42.00
Teacher's average education (years)	15.61	0.77	3.00	20.00
Number of students	196.15	220.43	1.00	2,706.00
Morning shift	0.88	0.33	0.00	1.00
Dropout rate	7.89	8.57	0.00	95.70
Failure rate	11.93	13.07	0.00	93.30
With Oportunidades beneficiaries	0.85	0.36	0.00	1.00
Rural school	0.56	0.50	0.00	1.00
N	26,631			

In this analysis, the number of teachers reflects the number of teachers actively instructing students per school (as opposed to teachers performing administrative functions). Here the mean number of teachers instructing students is almost 9. On average, 2.5 teachers in each school were in the Carrera Magisterial Program, and the average school has teachers who average 15.61 years of education

The average number of students is more than 196. 88% of the schools are in a morning shift. The average dropout rate is 7.89%, and the average failure rate is almost 12%. 85% of the schools have at least one student who receives Oportunidades benefits, and 56% of the schools are in rural areas.

Table 6 shows the descriptive statistics for the municipality level variables. The schools reported in the data set used in this work are distributed into 1,751 municipalities. The average population size of these municipalities is 54,630 inhabitants but the variation in this variable is large. There are communities with less than 250 inhabitants and communities with more than 1.5 million people. On average, the number of communities in these municipalities is almost 98 and the average number of rural communities by municipality is 96.

Table 6. Descriptive statistics for municipality level variables

Variable	Mean	Std. dev	Minimum	Maximum
Population size	54,629.67	146,456.85	242.00	1,820,888.00
Number of communities	97.64	142.51	1.00	1,569.00
Number of rural communities	96.01	141.85	0.00	1,552.00
Communities with less than 100 inhabitants	72.26	125.46	0.00	1,447.00
Gini coefficient	0.425	0.04	0.26	0.69
IDH	0.763	0.07	0.47	0.95
Marginality index	-0.200	0.97	-2.37	3.36
Proportion of indigenous population	0.137	0.265	0.000	0.999
N	1,751			

The average Gini coefficient is 0.425, which is slightly lower than the Gini coefficient at the national level in 2005 which was 0.501. This could be because the mean reported here is an unweighted average.

The average HDI for the municipalities under study is 0.763, which is slightly higher than the national HDI in 2005 (0.727). Again, this discrepancy could be due to the unweighted averages used in this analysis.

The mean marginality index is equal to -0.2, which means that this group of municipalities has a medium marginality level. However, the highest and lowest values of the index show that there is large variation in level of marginality among the municipalities under study, with some having very high levels of marginality and some having very low levels of marginality. The proportion of indigenous population in these municipalities varies from 0 to 0.999.

Two-level hierarchical linear models (Raudenbush and Bryk 2002) were estimated using HLM 6.08 software to account for the nested nature of the data (i.e., schools within municipalities).

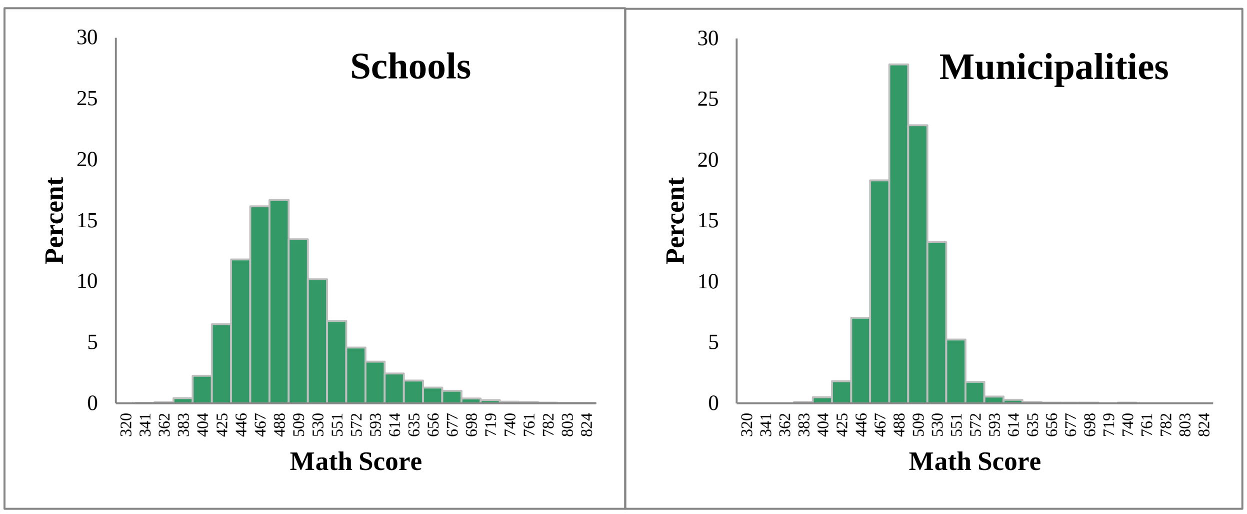
Unconditional Model

A one-way random-effects ANOVA model was fitted in order to determine how much variation in the Math scores lies within and between municipalities.

The municipality average math score for secondary schools is 487.57 (se = 0.727). The estimated variability between municipalities is 487.30 (Ho: , p < 0.001). The fact that this variance is statistically different from zero indicates that municipality-level characteristics have an impact on school mean math scores.

Most of the variance is explained by between school differences (86.8%). However, municipality characteristics explained 13.23% of the variance in schools' mean math scores. Figure 1 shows the distribution of the mean scores between schools and municipalities respectively. The dispersion is lower for the distribution of the mean scores between municipalities.

Figure 2. Distribution of the mean scores between schools and municipalities



Conditional Models

School characteristics

Given the established unconditional effect of municipality characteristics on achievement, another model is specified to assess that effect in the presence of school level controls. This conditional model is needed because schools are not distributed randomly across municipalities. In fact, both the type of school and its characteristics are highly correlated with the characteristics of the community. Thus, the first conditional model showed in Table 8 controls by type of school as a level-1 covariate using private as the reference category. Then, model 2 incorporates the effect of the school SES. Model 3 adds covariates for teachers' characteristics. Finally, model 4 includes the school-level characteristics described above.

Table 8. Conditional models with school-level covariates

Fixed Effects	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Municipality mean achievement, γ00	561.73***	555.86***	522.02***	509.41***
	(1.847)	(2.482)	(8.843)	(8.862)
Type of school				
Private (Reference)				
General	-79.05***	-73.34***	-91.21***	78.73***
	(1.892)	(2.471)	(2.669)	(3.620)
Technical	-83.87***	-78.22***	-96.42***	-89.09***
	(2.238)	(2.661)	(2.653)	(3.556)
Telesecondary	-77.99***	-72.38***	-78.01***	--66.66***
	(1.905)	(2.458)	(2.455)	(3.508)
School SES		0.003***	0.003 **	0.003 **
		(0.001)	(0.001)	(0.001)
Number of teachers			0.40***	-0.15
			(0.086)	(0.098)
Number of teachers in CM			2.34***	1.21***
			(0.127)	(0.139)
Teachers' education			2.27***	2.20***
			(0.551)	(0.548)
Number of students				0.05***
				(0.004)
Morning shift				14.29***
				(1.075)
Dropout rate				-0.123 **
				(0.045)
Failing rate				0.026
				(0.043)
With Oportunidades beneficiaries				-13.04***
				(2.747)
Rural school				1.672
				(0.969)
Random Effects				
Level-2 variance				
Intercept	367.16832	367.2213	16865.24	16731.32
Teachers' education			68.04093	66.37076
Dropout rate				0.28277
Failing rate				0.30222
Level-1 variance				
Schools, σ^2	2659.635	2650.249	2539.33	2419.793
Deviance	287098.1	287022.3	286131.7	285324.2
Parameters	2	2	4	11

*** p<0.001, ** p<0.01, * p<0.05

Municipalities' characteristics

Once the models which control for school characteristics have shown that some variance remain unexplained, adding characteristics of the municipalities might help to explain the school average math score.

Table 9. Correlation matrix for municipality variables

		1	2	3	4
1	Gini coefficient	1.000			
2	HDI	0.083***	1.000		
3	Marginality Index	-0.033	**-0.940*****	1.000	
4	Proportion of indigenous population	-0.170***	-0.583***	0.614***	1.000

Table 9 shows the correlation matrix for the municipality level variables. HDI is significantly related to all other variables except the number of rural communities in the municipality. The correlation with marginality index is very strong, so two separate models were run, one with HDI and the other with the marginality index.

Proportion of indigenous population is strongly and significantly related with the Gini coefficient, HDI, and the marginality index.

Models 5 and 6 include the same school-level variables that were included in Model 4 as well as municipality level variables. They differ in how they include municipality-level measures of living standards.

Model 5 uses HDI to control for living standards in the municipality. HDI has a positive and significant effect on the overall intercept (γ_{00}). That means that better living conditions (higher HDI) yield to a better average achievement in math, holding everything else constant. Proportion of indigenous population has also a significant effect on achievement. On the other hand, model 6 includes marginality index instead of HDI, the coefficient is also significant but in this case the effect is negative, as it was expected, and the magnitude is much lower. In sum, these two models indicate that better living conditions are associated with higher mean test scores even after controlling for school factors.

The effect of the Gini coefficient is positive but it is not significant which means that our analysis did not find support to the hypothesis that higher inequality is associated with higher overall mean test scores.

The proportion of indigenous population, as it was expected, has a negative and significant effect in Model 5 and 6. The magnitude of the coefficients of this variable is very similar in both models. On average, a one unit increase in the proportion of indigenous population the municipality is associated with a decrease in mean achievement (γ_{00}) of 18.9 points (model 5, or 16.7 in model 6) holding everything else constant.

Finally, in Model 7 the municipality level variables are used to model the intercept and the slope of teachers' education and dropout rate, because these variables are assumed to be random factors. Failure rate is also assumed as a random factor but the result of the previous models indicated that this variable does not have a significant relationship with math achievement.

Table 10. Conditional models with school and municipality covariates

Fixed Effects	Model 5		Model 6		Model 7	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Municipality mean achievement, γ00	476.756***	13.513	500.723***	10.822	534.096***	92.430
Proportion of indigenous population	-18.914***	3.195	-16.715***	3.291	-19.126***	3.193
Gini coefficient	11.318	14.104	17.419	14.091	9.892	14.117
Human Development Index	36.504**	11.614			-36.995***	119.399
Marginality Index			-3.277***	0.840		
Type of school						
Private (Reference)						
General	-78.589***	3.599	-78.629***	3.604	-78.598***	3.607
Technical	-88.548***	3.545	-88.547***	3.550	-88.542***	3.549
Telesecondary	-66.471***	3.492	-66.439***	3.496	-66.465***	3.496
School SES	0.003**	0.001	0.003**	0.001	0.003**	0.001
Number of teachers	-0.164	0.098	-0.165	0.098	-0.164	0.098
Number of teachers in CM	1.122***	0.139	1.117***	0.139	1.121***	0.139
Teachers' education	2.230***	0.548	2.242***	0.547	-1.807	5.890
Human Development Index					5.22	7.653
Number of students	0.054***	0.004	0.054***	0.004	0.054***	0.004
Morning shift	14.482***	1.078	14.492***	1.080	14.378***	1.080
Dropout rate	-0.095*	0.045	-0.093*	0.045	0.736	0.509
Human Development Index					-1.065	0.638
Failing rate	-0.009	0.043	-0.013	0.043	-0.007	0.043
With Oportunidades beneficiaries	-12.435***	2.756	-12.344***	2.763	-12.349***	2.764
Rural school	2.364*	0.977	2.463*	0.979	2.337*	0.977
Random Effects						
Level-2 variance						
Intercept,	16455.741***		16453.992***		16254.076***	
Teachers' education,	65.872***		65.979***		64.945***	
Dropout rate,	0.265***		0.271***		0.287***	
Failing rate,	0.277***		0.273***		0.279***	
Level-1 variance						
Schools, σ^2	2421.489		2421.493		2421.153	
Deviance	285217.91		285217.81		285207.85	
Parameters	11		11		11	

*** p<0.001, ** p<0.01, * p<0.05

The results do not provide evidence of a significant relationship between HDI and the effect of dropout rate on mean scores or between HDI and the effect of teachers' education on mean scores. The mean achievement for private schools is 534.1, higher than the mean achievement observed in models 5 and 6. The rest of the coefficients are similar to those in model 5.

Conclusion

Previous research has demonstrated that characteristics of schools better explain mean student outcomes than do characteristics of municipalities. However, substantial variability in mean student outcomes remains unexplained after accounting for characteristics of schools. Some of this unexplained variability could be due to unmeasured heterogeneity at the student level (Chinen, 2006; FLACSO, 2007; INEE, 2008; Park & Sandefur, 2006). The present work demonstrates that, while school-level characteristics are important, municipality characteristics provide additional explanation of this unexplained variability even without accounting for student characteristics. Although the municipality factors explain only 13% of the total variance of the school average score in Math, the models presented provide evidence to support the hypothesis that municipalities vary in their school mean math scores.

The municipality-level variables are highly correlated, and thus each of their individual impacts of school mean test scores is not as strong as was expected, yet there is evidence that municipality-level characteristics do impact school average achievement.

The Human Development Index is the municipality-level variable with the strongest effect on the outcome variable. The effect of the HDI supports the hypothesis that schools in more developed municipalities have an advantage over schools in less developed areas.

In sum, it can be said that municipality factors are important for achievement outcomes although their effect is not outstanding mainly because as other studies conclude individual-level variables have the strongest effect.

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