FACTORS AFFECTING LEARNING OF MEXICAN PRIMARY SCHOOL CHILDREN

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Resumen: Se analizan los factores que afectan la tasa de repetición del año escolar en escuelas primarias en México, y sus resultados en la educación, medidos a través de las calificaciones de un examen estandarizado de gramática y matemáticas. Estimamos una función de producción econométrica para la educación primaria, donde las variables endógenas son los logros en gramática y matemáticas de un niño, y la probabilidad de que repitiera el año. Los resultados indican que el sexo del niño, su nivel socio-económico, el grado de educación de los padres, y reiteradas repiticiones de un año escolar, son determinantes significativas de las variables endógenas. Este trabajo también muestra que un aumento en el número de horas de enseñanza, y en la interacción entre maestra y alumno, junto con mejores bibliotecas e infraestructura elevan las calificaciones en gramática y matemáticas de los niños. Se discuten brevemente las implicaciones de este trabajo para la politica educativa.

Abstract: This paper isolates factors affecting Mexican primary school children's grade repetition rates and their educational outcomes, as measured by reading and math scores on a standardized test. We estimate an econometric production function for primary school education where the endogenous variables are language achievement, math achievement and grade repetition for individual children. The empirical results indicate that gender, socioeconomic status, parental education levels and past repetition of a grade are significant and common determinants of the endogeneous variables. This study also shows that more teaching hours and increased student-teacher interaction, coupled with improved facilities and libraries, improve children's math and language achievement scores. Policy implications flowing from these results are outlined.

Fecha de recepción: 23 de agosto de 1999
Fecha de aceptación: 7 de febrero del 2000

* I wish to thank Raquel Ahuja, Universidad Iberoamericana, for her efforts in directing the data gathering for this project; Dr. Laura Randall, of the City University of New York, for her comments and insight, and my research assistant, Victor Shafor for his contributions. I am also indebted to the Ford Foundation and Tinker Foundation for funding this project. joana@acusd.edu

1. Introduction

Primary school education is fundamental for creating economic development and growth. Studies of US growth in the 20^{th} century found that education is more important than increases in capital accumulation in accounting for worker productivity and US economic growth. (Denison, 1974 and 1985). In developing countries Tilak (1989) indicates that social returns to education are at least as high as any reasonable measure of opportunity cost of capital and are greater for primary education than for secondary and higher education. In Latin America social returns to primary education are high, over 17%, according to a recent estimate for 14 Latin American countries (Wolff, Schiefelbein and Valenzuela, 1994).

Mexico's economic development is hampered by a high degree of income inequality that causes potential labor resources to be wasted. A better educated, and thus more productive, labor force would be better paid, leading to a reduction in levels of poverty and improving the distribution of income. Although investment in education takes 10 to 15 years to affect labor productivity, designing and implementing programs to ensure that more Mexicans complete a quality primary education may be the single most important measure that can be taken to ensure continuing economic development in Mexico.

For this investment to be effective it is important to understand the factors which affect educational quality. The purpose of this paper is to isolate factors affecting the grade repetition rates and educational achievements of Mexican primary school children, as measured by reading and math scores on a standardized test, using econometric analysis. The empirical results suggest ways in which school-policy changes might improve performance. This paper's analysis focuses on 5^{th} grade children in urban schools in Leon, Guanajuato.

Access to primary education in Mexico has improved. In 1995, 92% of children ages 6-11 were enrolled in a primary education program. However, completion rates for a 6 year term are estimated at 57%, and the illiteracy rate, though it varies widely across Mexico's 32 states, nears 8% (Prawda and Psacharopoulos 1993). It takes the average Mexican student 7.8 years to complete a 6 year primary school program (World Bank tables 1990, UNESCO 1990). In 1996-1997, 11% of all first graders repeated that grade, down from 17.6% in 1990 (Schmelkes, 1999). For the 1995-1996 school year, national terminal efficiency, which is equal to the percentage of sixth grade graduates divided by the number of newly enrolled first graders six years prior, was two thirds, an increase of a little more than ten percentage points in comparison with the 1990-1991 school year (Bracho, 1999).

The Mexican education system, which is highly centralized, increased the number of years of compulsory education from six years to ten with the adoption of the General Law of Education in 1993. This includes one year of pre-school, 6 years of primary school and 3 years of secondary education. For many decades, the required primary school cycle in Mexico covered 6 school years, beginning at 6 years of age. Pre-school education varies from one to three years. The "secondary" school cycle includes three school years after primary school and is administered independently of primary school. The Ministry of Public Education, SEP, mandates a school year calendar of 200 days of school with school days of four hours. In the first two grades of basic education, emphasis is placed on teaching Spanish and mathematics, with 9 and 6 hours spent per week, respectively, on these two subjects. In the third year of primary school, the time spent on Spanish and mathematics is reduced to 6 and 5 hours per week, respectively and studies are begun in Natural Science (3 hours), history and geography (1.5 hours each) and civic education (1 hour). Throughout the cycle art and physical education (2 hours) are offered (Bracho, 1999).

Post-basic education includes the higher middle-school levels and higher (post-middle school) general and technical education. These levels of education have much greater institutional, administrative and funding diversity than basic education, and, unfortunately, poor children have very limited access to this level of education. Based on 1990 census figures, the highest proportion of adult population that has some post-primary education, is 42.5% in the Federal District. In the North the proportion is around 30% while in the South (the poorest part of Mexico) it is only 12.8%. In the Center the proportion is 17.1%. In general post-primary education is concentrated in the largest cities. The average schooling of adults in the nation is 6.5 years. Only the Federal District has an average educational level equivalent to secondary school (9 years). For younger population the average is higher than for the total, showing that average levels of education have improved over time (Bracho, 1999).

A population that is less educated is less productive. Were Mexico to decrease its illiteracy and dropout rate, and increase its test scores and secondary education completion rate, the effect on GDP would be immense and prolonged. Repetition and dropout has a large cost for the Mexican economy in general and for its educational system specifically. Students who repeat grades create problems of overcrowding and age heterogeneity, creating additional problems for classroom management. The repeaters do not relate well to younger children in the classroom, aggravating their learning problems. Teach-

ers, in turn, must modify their methods to not only teach the new children but accommodate the retraining of the repeaters (Patrinos, and Psacharopoulos, 1996).

Grade repetition, by increasing the age of the child in school, also increases the opportunity cost for the child to be in school, increasing the probability of dropout (Schmelkes, 1999). Of course, the highest cost of repetition is for the future of the child. Undereducated workers face lower wages, lower quality of living and more difficult and dangerous work. They are less productive, and, as some studies indicate, in turn raise children that are more likely to repeat grades and drop out.

The econometric approach used in this paper to measure the effectiveness of child, family, school and teacher characteristics in urban Mexican public schools will contribute to understanding factors that improve educational output and serve as a guide for policymakers, administrators and executors of school strategies. This study tests the empirical nature and role of theoretically viable personal, socioeconomic and environmental factors that comprise learning and achievement results.

2. Factors affecting educational output

The model tested in this study assumes that learning is affected by a complex set of factors that interact with each other. This study uses Lockheed and Verspoor's (1991) assessment that children's learning depends on the child's teachability, determined by personal and family characteristics, the physical facilities in which learning takes place, curriculum and instructional materials, and teaching quality and style. Following this framework, the model tested in this study assumes that learning is affected by a combination of the child's individual characteristics, including gender and measures of ability; family characteristics, including socioeconomic status and parents' level of education; the quality and effectiveness of the teacher; and the physical environment and facilities of the school, including the materials available to aid learning.

To isolate the effects of each of these, this study will use an econometric education production function model. Educational output, the dependent variable, is measured by three variables: performance on a standardized test for language, performance on a standardized test for mathematics, and whether or not the child has repeated a grade. Repetition has an effect on dropout statistics: it lowers self-esteem

and isolates the student from his/her friends and peers. Schiefelbein and Wolff, 1992 reports that increased on-time entrance in first grade and preschool greatly decrease the dropout rate. He asserts that programs which increase both the attractiveness and possibility of younger children attending pre-school and starting school on time are desirable. The decision to repeat a grade is made mostly by the teacher, and because the child is not considered prepared to benefit from the next grade. There is no national policy of automatic promotion in Mexico.

This study will use all three of these measures of educational output since factors affecting language learning may differ from factors affecting math learning, both of which may differ from factors affection grade repetition. The three endogenous variables then will be language score, math score and a binomial variable equal to 1 if the child has ever repeated a grade. The three equations will consist of vectors of variables that can be categorized as vectors of child, family, teacher and school characteristics.

Repeat $= \rho_0 + \rho_1$ (child characteristics) $+ \rho_2$ (family characteristics) $+ \rho_3$ (teacher characteristics) $+ \rho_4$ (school characteristics) $+ \rho_5$ (math achievement) $+ \rho_6$ (language achievement) $+ \varepsilon_\rho$.

Language Achievement $= \lambda_0 + \lambda_1$ (child characteristics) $+ \lambda_2$ (family characteristics) $+ \lambda_3$ (teacher characteristics) $+ \lambda_4$ (school characteristics) $+ \varepsilon_\lambda$.

Math Achievement $= \mu_0 + \mu_1$ (child characteristics) $+ \mu_2$ (family characteristics) $+ \mu_3$ (teacher characteristics) $+ \mu_4$ (school characteristics) $+ \varepsilon_\mu$.

The following describes the theoretical rational for the actual variables contained in each vector.

a) Child Characteristics

The child's teachability is affected by the child's innate ability, his/her IQ and gender, as well as his/her early childhood experiences. A child's gender has long been known to affect learning in the early years of school, apparently since girls mature faster than boys. Lacking a measure of IQ, ability is measured using two proxy variables, the child's past performance in school and the teacher's opinion of the child's ability. Coleman (1997) finds that expectations by teachers

and parents are strongly related to student achievement, absences and work. Within this data set, it was found that the teacher's opinion of ability can be used as a good proxy for ability. It is highly correlated with the child's performance and the socioeconomic status of the child appears to have minimal influence on the teacher's opinion. The alternative proxy for ability, the child's past performance in school is measured by the child's grade averages in language and math over his/her school career.

The experiences of children can also affect their school performance. For example McGinn *et al.*(1992) found that students with one or more years of preschool are less likely to drop out before completing the primary school cycle, and children who have repeated first or second grade are more likely to drop out. Obligations that affect children's out-of-school time could also be important. The need to work can cause children to enter school later and increase the likelihood that they drop out. For some families the high opportunity cost of educating children who can work shortens the length of time they stay in school. This factor prevails even if the child is doing well in school. Extracurricular activities may also affect scholastic achievement. Time spent watching television and listening to the radio, or reading could effect test scores.

b) Family Characteristics

In addition to individual characteristics and experiences, family characteristics have an influence on the level of a child's achievement. Levels of parental education and family income have been shown to affect grade repetition and scholastic performance (Schiefelbein and Wolf, 1992). Poor children receive lower quality instruction and fail to stay in school as long as more affluent peers. In fact, the average years of schooling for 15-year-olds in Mexico differs by almost two years between the highest and lowest income quintiles (Wolff, Schiefelbein, and Valenzuela, 1994).

Past studies have shown that the socioeconomic status of the family, as measured by housing type and density, and income and food expenditures has an important effect on educational achievement. It can be argued that socioeconomic status is a demand variable, and that it does not belong in an educational production function (Dewey, Husted, and Kenny, 2000), since higher socioeconomic status increases the demand for education and not the supply. On the other hand, many other researchers argue that while it does in-

crease demand, it also serves as an input. Families with higher socioeconomic status tend to encourage education, read books to their children, take them on trips to the museums, parks and travel experiences, all of which contribute to a child's ability to learn. Closely associated with socioeconomic status are the educational background of the mother and father and the number of books in the home. These are indicators of family literacy that, all else being equal, decreases the probability of a student repeating and increases their chances for success in school.

Parents schooling, though highly correlated with socioeconomic status is treated separately in an attempt to isolate the effects of parents' education. Binder and Woodruff (1999) show, using Mexican data, that years of parents' schooling is highly significant in explaining the number of years of schooling of their children. Cardemil (1999) finds that the educational climate of family explains between forty and fifty percent of the impact of socioeconomic and family characteristics on achievement. Given the literature on the importance of the level of the mother's schooling (for example see Murnane, 1981), the mother's and father's schooling will be examined separately. In the case of Mexico, where two parent families are the norm, the years of school of the parent with the highest level of schooling may be the critical factor. The expectation is that this parent will take the most active role in encouraging the children's educational attainment.

The educational status of siblings, especially whether or not there is a history of grade repetition is also expected to be important. Parent involvement in the school and participation in parent/teacher meetings are indirect measures of parents believing that education is important. Family employment may also be a factor. Children of white-collar workers and/or workers with steady, full time employment may achieve more due to the more stable economic conditions of the household than is true for children whose parents are self-employed on a small scale (vendors, etc.). On the other hand, mothers who stay home, and more time with the children may increase their learning.

c) Teacher Characteristics

Four classroom factors critical to learning are teaching, curriculum, instructional materials and learning time. Davico (1990) and Fuller *et al.*(1999) both found teacher characteristics and teacher or classroom style to be major determining factors affecting educational quality

and grade repetition in Brazil. Factors commonly used to measure the quality of teaching are the education and experience of the teacher. Salary may also affect teacher quality, though this factor is likely to work over a longer period of time, as higher salaries induce people with more skills and talents into the field and help retain the better teachers. Davico reports that poor teachers and low levels of school assistance for underprivileged students lead to increased rates of grade repetition.

Barnes (1999) and Fuller *et al.*(1999) assert that teachers using a traditional didactic and mechanical presentation of lessons such as blackboards and student notebooks, a transmission approach, are less effective than teachers who use a transaction or interactive approach to learning. The transactions approach requires much more interaction between teacher and student, and active learning on the part of students. Students become engaged in projects and "discover" truths rather than being told them. The availability of textbooks and other materials has been shown to be significant for success in learning (Wolff, Schiefelbein, and Valenzuela; 1994). Actual time spent learning appears to be important as well. Lockheed and Verspoor (1991) cite several studies from Asia and Africa that show increased learning with increased instructional time.

d) School Characteristics

School conditions and programs clearly affect the learning process and development of students. Poor, rundown and under-supported schools convey a message to children that school is not important, resulting in higher rates of grade repetition and lower achievement scores. Studies indicate that very poor physical school facilities hinder the ability to learn, and provision of small libraries to classrooms increase student achievement (Castillo, 1999). This study will examine the effect of internal resources such as library books, computers and video equipment as well as the physical condition and socioeconomic stratification of the school. Additional factors that could affect achievement are diversionary and extracurricular events and programs that create communication and interaction between the school and parents, as well as the wider community.

3. The Data

The data were gathered from four schools in Leon, Guanajuato by a team of researchers led by Raquel Ahuja, Universidad Iberoamericana.

Areas Geo- Estadística Básica, AGEB (the Mexican equivalent of a standard metropolitan statistical area, created by the Instituto Nacional de Estadística, Geografía, e Informática), in the city of Leon were classified as poor or non-poor based on cluster analysis of the level of income and of housing, where roof and flooring materials, access to water and plumbing services and number of rooms per person were the key indicators. The initial classification was checked against the opinions of supervisors in an AGEB and where those differed, the classification was changed.

Within each school 20 5^{th} grade students were given the UNESCO exam for math and reading and then the parents of these students were surveyed to gather individual and family information on the child. The study includes a sample of 80 children in all. The teachers were also interviewed on the specifics of the child's classroom behavior, the teacher's background and philosophy and the conduct of the class. The principals of the schools were also interviewed, gathering school level data. In addition the researcher observed classrooms, both during a reading lesson and a math lesson to gain some qualitative insight into the type of classroom interaction. The data gathered represents a pretest of survey instruments for a larger cross-country study that will follow. With only four different schools and teachers in the study some of the school/classroom variables included as regressors are of only limited use in making generalizations, since these variables only take on at most four different values. The emphasis will be on estimating the effects of family and personal variables on language and math performance and then on the interaction of these with a limited number of school and teacher characteristics.

Table 1 presents a list of the variables used in the empirical equations, along with their means and standard deviations. The three endogenous variables are language and math scores and a grade repetition variable. The mean of the UNESCO language test score is 16.3 points with a maximum of 25 points and a minimum of 5. Its distribution is normal. The UNESCO math test's average score is 22.2 points with a maximum of 42 and a minimum of 12 points. Its distribution is skewed to the left. The repeater variable is a 0-1 dummy variable, equal to 1 if the child has repeated at least 1 grade so far in school. Its mean is 0.24, meaning that 24% of the fifth grade children in this sample have repeated at least one grade so far in school. The rest of the variables in the table are the exogenous variables in the model.

Table 1
Description of Variables

Variable	*Description*	*Mean*	*STDEV*	*OBS*
Reading score	Score on UNESCO languaje exam	16.300	5.137	80
Math Score	Score on UNESCO languaje exam	22.238	6.257	80
Repeater	Has child repeated a grade	0.2375	0.428	80
Ave Reading Grade	Average language grade (1-4)	3.390	0.923	70
Ave Math Grade	Average math grade (1-4)	3.306	0.914	70
Ability	Teacher's opinion of child's ability	2.888	1.191	80
TV and Radio	Daily minutes of TV or radio	155.225	117.225	80
Socio-economic Status	Index of income, education and poverty	-1.383	1.378	80
Parents Schooling	Most years of schooling, either parent	6.675	4.166	77
Social Security	Does the family get social security aid	0.475	0.503	80
Sib. Repeat Rate	Ratio of siblings that repeat	0.207	0.317	70
Eye exam	Has child had eye exam	0.325	0.471	80
PTA meeting	Yearly PTA meetings parent attends	1.603	1.323	78

Table 1 (*continued*)

Variable	*Description*	*Mean*	*STDEV*	*OBS*
Gender	0 = male; 1 = female	0.4375	0.499	80
Work for Pay	Does child work for pay outside the home	0.138	0.347	80
Helps Outside Home	Does child help parent outside of home	0.213	0.412	80
Time on Job	Father's time at current job	97.812	104.488	69
Books At Home	Number of books (not textbooks) in home	23.488	78.490	80
Siblings in School	Number of siblings currently in school	1.500	1.136	80
Disci-plinary Actions	Number of disciplinary action student received	0.288	1.093	80
Poor/non poor	Is the school poor (1)	0.750	0.436	80
Build. Cond.	Average condition of school plant	1.600	0.310	80
School size	Students in the school	340.750	163.167	80
Library Books	Number of books in school library	100.500	175.169	80

Table 1 (*continued*)

Variable	*Description*	*Mean*	*STDEV*	*OBS*
Class Library Books	Number of books in class library	196.000	206.724	80
Class Library	Does class library exist	0.500	0.503	80
Teacher Talk	Does teacher use lecture style of teaching	0.500	0.503	80
Class Style	Classroom climate: descriptive or substantive	1.500	0.503	80
Hrs Teaching	Time teacher spends on teaching and not administrative duties	15.25	2.966	80
Teacher Absence	Days absent for teacher	4.333	1.714	60
Teacher Train	Average inservice teacher training last year	45.000	23.057	80
Class Size	Fourth grade class size	39.500	9.264	80

4. Empirical Results

a) Factors Affecting Grade Repetition

For the equations measuring the likelihood that a child will repeat a grade (table 2), the dependent variable is equal to 1 if the child, now in the first semester of fifth grade, has repeated at least one grade since entering primary school. The equations are estimated, using binary logit estimation and the results of the two best fitting equations for child and family variables are shown as equations (1) and (2) in table 2. Since the dependent variable is transformed into a logistic function, the coefficients are interpreted as a change in the log of the odds of a child having repeated at least one grade.

The individual child variable which proved to be most significant in this equation (table 2) is the teacher's opinion of the child's ability, *Ability*, which is a proxy given that IQ scores are unavailable. The greater the teacher's opinion of the child's ability the lower the log odds of repeating a grade. While it is true that this variable is a subjective estimate by the teacher, the fact that it is closely correlated with the child's academic performance suggests that it is a reasonable proxy for ability. *TV and Radio*, the number of minutes that a child watches TV and/or listens to the radio per week, is weakly significant (at the 12% level) and negative in equation (1), meaning that more *TV and Radio* tends to reduce to log odds of grade repetition. However, the significance of this variable disappears when the socioeconomic status index is substituted for the *Time on Job* variable, as in equation (2), indicating some multicollinearity. Eye exam is positive and significant at the 1% level, suggesting that if the child has had an eye exam the log odds of repeating is increased. This is, of course, backwards from what one might expect. One explanation may be that causation is actually running in the other direction: children who are having trouble, i.e. failing a grade, are more likely to receive help in the form of eye exams.[1]

[1] Several factors expected to be important were consistently statistically insignificant in explaining the probability of repetition, including the gender of the child, his/her reading and math grade average, length of time in the same school, his/her work activities within and outside the home, time at home spent reading and at school, his/her absentee rate and the number of disciplinary actions. The years spent in preschool, which range from 0 to 3 years, is significant by itself at the 5% level of significance, decreasing the log odds of grade repetition by .8, but its effects are quickly overshadowed by other variables. In the sample, 55% of the children had 1 year of preschool and a quarter of them had none. These equations are not shown, but are available from the author upon request.

Table 2
Repetition Equation

Variable	*EQ*1	*EQ*2	*EQ*3
Ability	**-1.480**	**-1.630**	**-1.270**
	-2.669	-2.831	-1.970
TV and Radio	**-0.007**	**-0.004**	**-0.004**
	-1.532	-0.954	-1.009
Eye exam	**4.740**	**5.393**	**5.480**
	2.560	3.058	2.952
Time on Job	**-0.008**		
	-1.703		
Socioeconomic status		**-0.477**	**-0.493**
		-1.822	-1.784
Social security	**-2.224**	**-2.518**	**-2.569**
	-1.882	-2.022	-1.948
Parent's schooling	**-0.637**	**-0.448**	**-0.392**
	-2.638	-2.145	-1.839
Sib. repeat rate	**6.819**	**6.541**	**6.478**
	2.205	2.165	2.037
PTA meeting	**-1.125**	**-1.672**	**-1.823**
	-1.585	-2.031	-2.034
Poor/non poor			
Building condition			**2.019**
			1.068
Constant	**7.481**	**4.668**	**0.357**
	2.681	2.203	0.081
Log likelihood	-18.130	-17.893	-17.299
Schwarz criterion	1.106	0.995	1.037
McFadden R-squared	0.508	0.567	0.581
Sample size	67	75	75

The family variables that significantly affect the child's grade repetition include the socioeconomic status of the family, the level of parents schooling, *Time on Job*, and *Social Security*. The latter two variables are proxies for the father's job stability and formal sector status, both of which appear to be more important than the type of job (dummy variables for white collar and informal sector were not significant). *Time on Job* is the number of months the father has held his present job and *Social Security* is a dummy variable equal to 1 if the family is covered by the social security system.[2]

In equation (1), both of these are negative and significant at the 10% level, meaning that the log odds of grade repetition decreases as the length of time the father has held a job increases and/or if the family receives social security. Socioeconomic status is a normalized socioeconomic index that includes a the amount of weekly food expenditures, monthly family income, the quality of housing, and the number of people per room in the house. The higher the socioeconomic status, the lower the log odds of repeating. As mentioned, this variable replaces *Time on Job* in equation (2). With respect to parents' education, a variable, *Parents Schooling*, equal to the number of years of school of the parent that has the most schooling, is more significant than either the father's or mother's schooling separately and, as expected, the log odds of grade repetition significantly declines as the number of years of *Parents Schooling* increases. The school experience of the child's siblings also appears to be important. *Sib. Repeat Rate*, is the number of siblings who have repeated at least one grade, divided by the total number of siblings. As this rate increases the log odds of the child repeating a grade increases. Children whose parents attend school parent meetings, *PTA Meeting*, tend to have significantly lower odds of repeating a grade. This variable is viewed as a proxy for parents' interest in the child's schooling.

Overall, for equation (2), the best grade repetition equation has a McFadden R^2, which is roughly analogous to the coefficient of determination in a regression equation, of 0.57, indicating that child and family factors account for slightly more than half of the total variation in grade repetition. None of the school or classroom variables in this study significantly affect the child's chances of repeating a grade. Equation (3) adds the building condition variable which is a scalar equal to 1 if the building is in good condition and 3 if it is in poor condition. While not statistically significant, it does suggest that a

[2] Mother's employment is not significant, though in the sample 65% of the mothers are full time *amas de casa* (housewives).

building in worse condition increases the log odds of grade repetition. Evaluating all the independent variables at their means and solving equation (2), table 2 yields a 3 percent probability of repeating a grade for a child who is average in all the characteristics.

b) Factors Affecting Educational Attainment

Educational attainment is measured by the child's *Language Score* and *Math Score* results of a standardized UNESCO test, administered to the children in the sample in the second month of 5^{th} grade. The results of regressions on language and math scores are presented in tables 3 and 4, respectively.

Child and Family Factors

The child variables statistically significant for both language and math scores are the average of past grades (reading grades in the language equation and math grades in the math equation), gender, time spent watching TV and listening to the radio, and whether or not the child has repeated a grade. In addition, in the language equations, (1) and (3), the child working for pay, the parents schooling and the number of other siblings in school are significant. In the math equation, the teacher's opinion of the child's ability, the socioeconomic status of the family and number of disciplinary actions against the child in school are also significant.

In order to interpret the effects of specific variables more specifically, equations (1) of tables 3 and 4 are used. *Ave Reading Grade*, used as a proxy for ability, is significant at the 1% level and positive, increasing language score by approximately 2 points for each grade point on a 5-point scale. *Ave Math Grade* is likewise positive and significant at the 1% level, raising math scores by about 2 and three quarters points for each grade point. *Gender* indicates that all else equal, being female on average increases language scores by three and a half points and math scores by two and a half points. These estimates for gender differences are very close to those of Fuller, *et al* (1999). The coefficient *TV and Radio* is negative for both language and math scores. Each additional 100 minutes spent watching *TV* or listening the radio lowers the reading score by 0.8 of a point and math by 1.7 points. If a student has repeated a grade previously, *Repeater*, on average his/her language score will be lower by more than 2 points

Table 3

Language Score Equation

Variable	*EQ*1	*EQ*2	*EQ*3	*EQ*4	*EQ*5	*EQ*6	*EQ*7	*EQ*8
Ave Reading Grade	**2.037**	**2.268**	**1.961**	**2.242**	**2.278**	**2.247**	**2.289**	**2.249**
(num)	4.769	5.494	4.705	5.423	5.677	5.438	5.173	5.393
Gender	**3.591**	**3.020**	**3.577**	**3.020**	**2.989**	**3.051**	**2.608**	**3.027**
(binary)	4.280	3.676	4.388	3.729	3.742	3.782	3.053	3.708
TV and Radio	**-0.008**	**-0.008**	**-0.008**	**-0.007**	**-0.007**	**-0.007**	**-0.007**	**-0.007**
(Minutes/day)	-2.014	-2.111	-2.174	-2.035	-1.929	-1.915	-1.927	-1.931
Repeater	**-2.306**	**-1.765**	**-1.581**	**-1.554**	**-1.734**	**-1.736**	**-1.861**	**-1.645**
(binary)	-2.421	-1.913	-1.589	-1.674	-1.932	-1.898	-1.586	-1.727
Work for Pay	**-2.453**	**-1.472**	**-2.240**	**-0.917**	**0.708**	**-0.716**	**0.293**	**-0.773**
(binary)	-1.970	-1.193	-1.844	-0.733	-0.561	-0.562	0.218	-0.598
Socioecon Status	**0.392**	**0.252**	**0.336**	**0.225**	**0.228**	**0.237**	**-0.144**	**0.229**
(index)	1.229	0.824	1.081	0.756	0.767	0.799	-0.482	0.763
Parents Schooling	**0.202**	**0.110**	**0.194**	**0.134**	**0.141**	**0.155**	**0.198**	**0.145**
(years)	1.780	0.976	1.757	1.223	1.278	1.435	1.818	1.289
Time on Job	**0.005**	**0.003**	**0.005**	**0.004**	**0.004**	**0.005**	**0.008**	**0.004**
(num)	1.217	0.741	1.286	1.017	1.068	1.185	1.912	1.080
Books At Home	**0.009**	**0.006**	**0.008**	**0.006**	**0.006**	**0.007**	**0.007**	**0.006**

Table 3 (*continued*)

Variable	*EQ*1	*EQ*2	*EQ*3	*EQ*4	*EQ*5	*EQ*6	*EQ*7	*EQ*8
(num)	1.388	1.020	1.275	1.055	1.093	1.144	1.322	1.083
Siblings in School	**-1.010**	**-0.772**	**-0.790**	**-0.717**	**-0.771**	**-0.781**	**-0.46**	**-0.748**
(num)	-3.010	-2.343	-2.294	-2.217	-2.406	-2.455	-1.215	-2.256
Poor/non poor		**-2.668**						
(binary)		-2.632						
Build. Cond.			**-2.791**					
(index)			-1.985					
School size				**-0.026**				
(num)				-1.162				
School Size^2				**0.000**				
(num)				1.502				
Library Books					**0.010**			
(num)					3.337			
Class Library Books					**0.004**			
(num)					1.952			
Teacher Talk						-2.444		
(binary)						-3.062		
Class Style						1.420		

Table 3 (*continued*)

Variable	*EQ*1	*EQ*2	*EQ*3	*EQ*4	*EQ*5	*EQ*6	*EQ*7	*EQ*8
(index)						1.712		
Hrs Teaching							**0.558**	
(hr/day)							3.898	
Teacher Absense							**-0.401**	
(num)							-1.626	
Teacher Train								**0.119**
(num)								3.117
Class Size								**2.263**
(num)								2.644
Class Size^2								**-0.035**
(num)								-2.716
Constant	**22.437**	**25.204**	**26.116**	**24.348**	**20.701**	**21.438**	**14.358**	**-14.864**
	11.692	12.029	9.934	5.949	10.365	11.433	5.326	-1.079
R-squared	**0.717**	**0.753**	**0.739**	**0.771**	**0.772**	**0.771**	**0.801**	**0.772**
Adj. *R* Squared	**0.660**	**0.696**	**0.679**	**0.712**	**0.713**	**0.713**	**0.729**	**0.708**
Schwarz	**5.460**	**5.393**	**5.449**	**5.387**	**5.383**	**5.385**	**5.320**	**5.449**
Sample size	**60**	**60**	**60**	**60**	**60**	**60**	**46**	**60**

Table 4
Math Score Equation

Variable	*EQ*1	*EQ*2	*EQ*3	*EQ*4	*EQ*5	*EQ*6	*EQ*7	*EQ*8
Ave Math Grade	**2.748**	**2.866**	**2.952**	**2.942**	**2.903**	**2.906**	**2.483**	**2.916**
(num)	3.933	4.254	4.253	4.411	4.409	4.382	3.123	4.342
Gender	**2.474**	**1.947**	**2.363**	**1.819**	**1.785**	**1.804**	**1.521**	**1.799**
(binary)	2.093	1.680	2.035	1.590	1.572	1.582	1.054	1.563
TV and Radio	**-0.017**	**-0.015**	**-0.016**	**-0.014**	**-0.013**	**-0.013**	**-0.010**	**-0.013**
(Minutes/day)	-3.294	-3.015	-3.191	-2.801	-2.726	-2.724	-1.534	-2.705
Repeater	**-3.242**	**-2.306**	**-2.326**	**-2.067**	**-2.288**	**-2.307**	**-1.751**	**-2.244**
(binary)	-2.331	-1.653	-1.600	-1.494	-1.678	-1.702	-0.838	-1.586
Helps Outside Home	**2.220**	**2.053**	**2.060**	**2.032**	**2.081**	**2.087**	**3.302**	**2.073**
(binary)	1.540	1.478	1.454	1.492	1.534	1.539	1.945	1.513
Socioeconomic	**1.099**	**0.737**	**0.976**	**0.649**	**0.644**	**0.656**	**0.277**	**0.649**
(index)	2.451	1.610	2.193	1.433	1.433	1.460	0.520	1.426
Parents Schooling	**0.003**	**-0.117**	**-0.046**	**-0.123**	**-0.108**	**-0.103**	**0.019**	**-0.108**
(years)	0.018	-0.725	-0.291	-0.783	-0.687	-0.665	0.107	-0.680
Ability	**1.254**	**1.353**	**0.874**	**1.288**	**1.408**	**1.390**	**1.836**	**1.370**
(1-5)	2.254	2.520	1.496	2.186	2.681	2.363	2.734	2.265

Table 4 (*continued*)

Variable	*EQ*1	*EQ*2	*EQ*3	*EQ*4	*EQ*5	*EQ*6	*EQ*7	*EQ*8
Disciplinary Actions	**-1.397**	**-1.108**	**-1.260**	**-0.889**	**-0.819**	**-0.815**	**-0.973**	**-0.823**
(num)	-2.545	-2.045	-2.318	-1.631	-1.488	-1.484	-1.615	-1.480
Poor/non poor		**-3.296**						
(binary)		-2.367						
Build. Cond.			**-3.704**					
(index)			-1.812					
School size				**-0.034**				
(num)				-1.008				
School Size^2				**0.000**				
(num)				1.305				
Library Books					**0.013**			
(num)					3.084			
Class Library Books					**0.006**			
(num)					1.918			
Teacher Talk						**-3.141**		
(binary)						-2.746		
Class Style						**1.910**		
(index)						1.544		

Table 4 (*continued*)

Variable	*EQ*1	*EQ*2	*EQ*3	*EQ*4	*EQ*5	*EQ*6	*EQ*7	*EQ*8
Hrs Teaching							**0.645**	
(hr/day)							2.840	
Teacher Absense							**-0.486**	
(num)							-1.268	
Teacher Train								**0.157**
(num)								2.931
Class Size								**2.829**
(num)								2.386
Class Size^2								**-0.044**
(num)								-2.459
Constant	**13.858**	**15.454**	**20.009**	**15.065**	**9.718**	**10.927**	**17.317**	**-34.155**
	4.958	5.576	4.587	3.065	3.238	3.009	2.798	-1.727
R-squared	**0.620**	**0.654**	**0.641**	**0.674**	**0.676**	**0.676**	**0.660**	**0.676**
Adjusted R-squared	**0.560**	**0.593**	**0.577**	**0.608**	**0.611**	**0.611**	**0.562**	**0.604**
Schwartz criterion	**6.193**	**6.160**	**6.198**	**6.166**	**6.158**	**6.159**	**6.358**	**6.221**
Sample Size	**67**	**67**	**67**	**67**	**67**	**67**	**50**	**67**

and math by more than 3. If a child is working for pay, on average his/her language score is almost two and a half points lower.

The coefficient of socioeconomic status index is positive for both language and math and statistically significant for the math equation. Closely correlated with socioeconomic status are *Parent Schooling*; a measure of job security, *Time on Job*; and the number of books in the home, *Books in Home*. These all improve educational attainment. When either the mother's years of school or father's are regressed against language and math scores their coefficients are positive and significant, father's years of schooling being slightly more significant than mother's. This study found that for educational attainment the combined variable *Parent Schooling*, which is the years of schooling of whichever parent has the most, was more significant than the educational level of either parent separately. Adding parent education, books and father's job stability to the language equation increases the adjusted R^2 and reduces the Schwarz criterion, though multicollinearity between the variables is apparent, causing insignificant t-statistics and unstable coefficients. Testing these three variables plus the socioeconomic index as a group gives results that are statistically significantly different from zero at the 1% level. This suggests that job stability and family education along with socioeconomic status contribute to language attainment. In contrast, the mathematics equation shows little response to either the work security or the number of books in the home, though socioeconomic status is significant at the 5% level.

With respect to siblings, each additional sibling in school decreases the child's reading score by 1 point. Maybe too many siblings needing help with school reduces the help that the child receives at home. This variable was not significant in the math equation and was thus omitted from it. However, the teacher's opinion of the child's ability was highly significant and robust in the math equation. Whether this is due to the confidence provided by the high opinion of a teacher, or whether teachers are more likely to recognize the ability of high math achievers is not clear. Also significantly affecting the math score is the number of disciplinary actions the child receives. It lowers math scores by over a point for each additional sanction.[3]

[3] Several other variables originally included in the regressions proved not to have significant effects on language and math scores. Personal variables that appear not to be important for language achievement are the home duties variables, suggesting that giving children responsibility at home does not detract from their school achievement. Though children who held paying jobs outside the home suffered a statistically significant 2.5 point decline in language scores, math scores

Overall, the set of personal and family variables in equation (1) explains 72% of the total variation in language scores and 62% in math scores. A Chow test on equation 1, in tables 2 and 3, is used to test the hypothesis that the variables affect the learning of children in the non-poor strata differently than the children in the poor strata.[4]

It yields an F statistic of 1.28 for reading, 1.33 for math, meaning that one cannot reject the hypothesis that the effect of these child and family variables on math and reading scores on the poor and non-poor populations are essentially the same.

School Level Variables

The study gathered a large number of school and classroom variables. However, in this sample, a pretest to a larger survey, only four schools were involved: one poor school without programs, two poor schools with programs and one non-poor school without special programs.[5] Special programs are those instituted locally or nationally to enhance the quality of learning, such as special teacher training, special textbooks, financing for school libraries, etc. The small size of the sample limits the ability to generalize the results. It also means that in any

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increase from the parent's report that the child helped outside the house, **Helps Outside Home** (t = 1.5), though only marginally. This variable is not significant in the language equation. Number of absences and extracurricular time spent reading were not significant in either equation. Among the family variables the number of siblings repeating a grade and total number of siblings are not important, just the number concurrently in school. Dummies for the father's job being white collar or in the informal sector, whether or not the child has had eye or ear exams or the mother's employment were not statistically significant in either the math or language equations. Though the number of years of preschool is significant by itself, its effect is almost completely masked by the other personal variables. In contrast with the language equation, no sibling information or parental employment information affected mathematics scores for this sample of children. There was little difference whether or not the father or mother were unemployed (though mother's employment did matter by itself), or whether the father was a blue collar or white collar worker. Similarly, whether or not other siblings were currently in school or had repeated grades did not contribute to the explanatory value of the model.

[4] Work for pay is omitted for the language equation for the Chow test because it does not vary in the non-poor sub-sample.

[5] The second poor school with program was originally selected to be a non-poor school, but was later reclassified based on the socioeconomic status of the children. It is less poor than the other two.

equation only a few school and classroom variables can be included at any one time before problems of near perfect multicollinearity arise. Nonetheless, some insights into school and classroom factors can be gained by adding these variables to the basic child/family model.

Equation 2 of tables 3 and 4 show that even after controlling for personal and family variables including the family's socioeconomic status and the education of parents, simply being in a school in a poor neighborhood lowers language aptitude scores by over 2.5 points and math scores by 3. The explanatory value of the language equation rises to 75% and the math equation to 65% of the total variation. An important question to ask is what characteristics of a "poor" school are negatively affecting learning. Looking at specific factors, much of the poor/nonpoor is accounted for by condition of the building, *Build. Cond.* (tables 3 and 4, equation 3). Data for this variable is from the researcher observation survey that ranked 1 as good, 2 as average and 3 as poor. The variable is calculated by averaging together the rankings of the conditions of walls, floors, windows and doors, roofs and bathrooms. The rankings ranged from a high of 1.6 (the non-poor school) to a low of 2.7. The coefficient is negative and significant in both the language and math equations. A simulation shown in figure 1 graphically demonstrates the effects of building conditions on language and math scores, as well as on grade repetition. For the simulation the assumed ranks go from the extremes of 3 to 1 (worst possible to best possible). The strong effect of building conditions on the dependent variable may be because school condition is interpreted as reflecting school quality, by both teachers and students. If the school is in poor physical condition, it conveys to the children that school is not important. A better physical plant may attract or retain better teachers and encourage students to study harder.

Another factor associated with poor/non - poor is school size, which is much larger in the borderline and non-poor schools (tables 3 and 4, equation 4). School size is entered as a quadratic. In the language equation, school size and school size squared have an F of 5.99, and in the math equation of 7, both statistically significant at the 1% level. Solving the quadratic equation shows that the minimum school size is 263 students in the language equation and 265 students in the math equation. Thus, language scores decline until the school has 263 and begin to rise after that, suggesting that larger schools are better. In this sample the 3 poor schools had 149, 218 and 454 students. The non-poor school had 542 students. Larger schools often mean more facilities. Each of the two smallest schools had 1 VCR and the 2 larger schools had 2 $VCRs$. One of the poor schools had

Figure 1
Condition of the Building

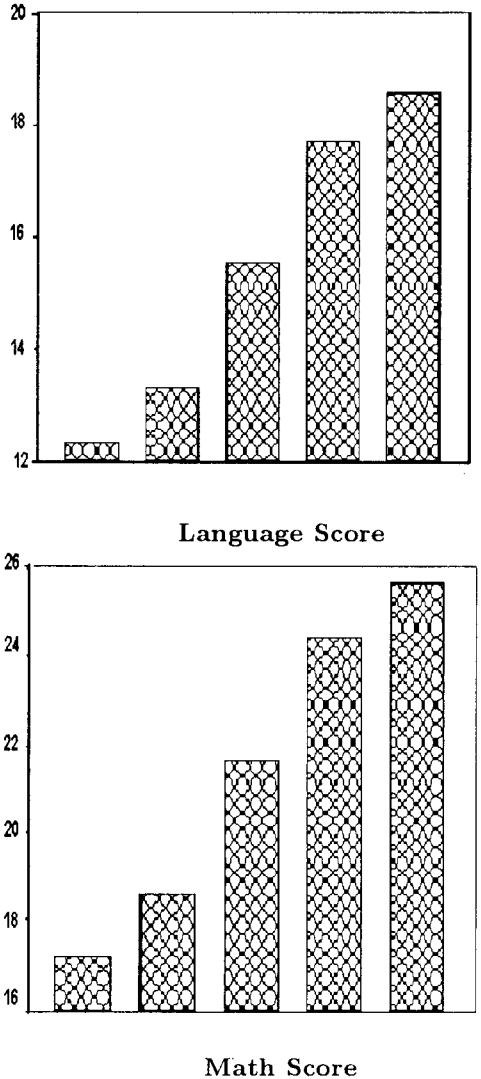
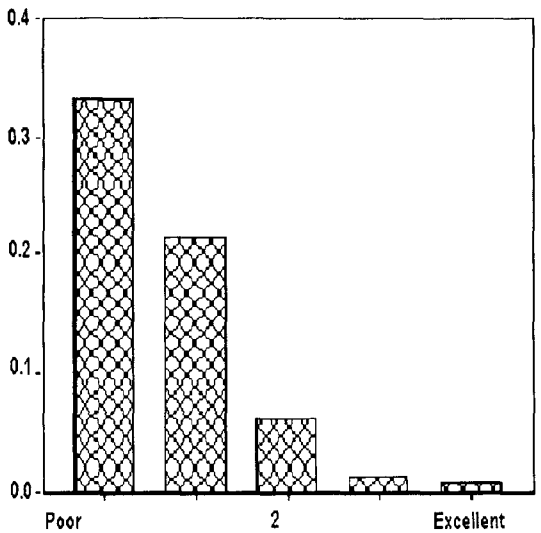


Figure 1
(*continued*)



in tables 3 and 4 shows the positive, significant effects of the size (in numbers of books) of the school library and the classroom libraries on language and math scores. The schools in the sample either had libraries in the classroom or a central school library, but not both. One school in the sample had neither. A simulation on the effect of the number of books on math and language scores is shown in figure 2 where first it is assumed that there are no library books, then progressions of central school library books from 100 to 200 to 400 with no classroom library books are assumed and finally a progression of 200 and 400 classroom library books with no central library. According to these results the same number of books in a central library adds more to reading and math than those books allocated within classroom libraries, but either significantly increase language and math scores. These results reinforce the proposition that inadequate resources in the smaller, poorer schools are detrimental to student achievement. Overall the combination of child, family and school variables explain 77% of the total variation in language scores of the children and 68% of the total variation in math scores of the children.

Classroom Variables

Effects of teaching style, teacher qualifications, teaching time and class size are investigated in equations 6, 7 and 8, tables 3 and 4. Two variables are used to measure classroom style, both of which came from researchers' classroom observations. The first, *Class Style*, is an index combining an observer's estimation of whether the teacher is using a transactions or transmission style of teaching and the type of questions used on reading and math exams (mechanical vs. problem solving) (Barnes, 1999). In addition, a dummy variable equal to 1 when the predominant time teaching is spent with the teacher talking to (or at) the students, *Teacher Talk*, is included (tables 3 and 4, equation 6).

The more interactive the classroom climate, and the less time the teacher spends talking, the higher the language score, both statistically significant. Teacher time talking was even more ineffective with respect to mathematics, reducing the average score by more than 3 points. The *Class Style* variable, though positive, is not statistically significant in the math equation. Thus equation 6 supports the assertion that the talking/lecture, transmission style of teaching is less effective for fostering learning in 5^{th} graders.

Figure 3 shows a simulation of increasingly interactive teaching styles with and without teachers predominantly relying on lecture/talking for teaching. Bar 5 where the transaction style is at a maximum and teachers use techniques other than talking predominantly to teach, shows maximum language and math scores. Because

lecturing style was prevalent in two of the three poor schools, and not used at the non-poor school, the results are highly correlated with the building condition ($r = 0.81$).[7]

Several authors (including Lockheed and Verspoor, 1991) have stressed the importance of the amount of actual teaching time received or "time on task". Equation 7, in tables 3 and 4, attempts to measure the effect of increased teaching time by including a variable for the number of days the teacher is absent and the hours spent actually teaching. This variable, *Hrs Teaching*, came from a question which asked teachers specifically how much time they spent on actual teaching, not including administrative tasks, grading, disciplining, etc. In the sample the teachers' estimates of the hours per week varied from 12 to 20. This variable is subjective in that it is based on the teachers' estimate. The number of days absent, teacher absence, is taken from school records and averages 4.33 days per year. A simulation shown in figure 4 shows the effects of increased hours of teaching with absences at their mean and then almost doubled to 8 days. As the teacher's estimate of time on task increases, both math and language scores increase. Scores decrease with increased teacher absence. Absences are missing for school 3 so there are only 46 observations in the reading and 50 in the mathematics regression when this variable is present.

With respect to teacher qualifications, all four teachers in the sample had normal school credentials so the effect of teacher preparation could not be tested. However, teacher training received during the year does positively affect language and math outcomes.[8]. Class size, estimated as a quadratic functional form, increases language scores and math scores, as shown in equation 8, of tables 3 and 4. Solving for the maximum effective size, both equations yield a maximum of 32 students. Learning increases with class size until that point and then declines as the size becomes greater than 32.

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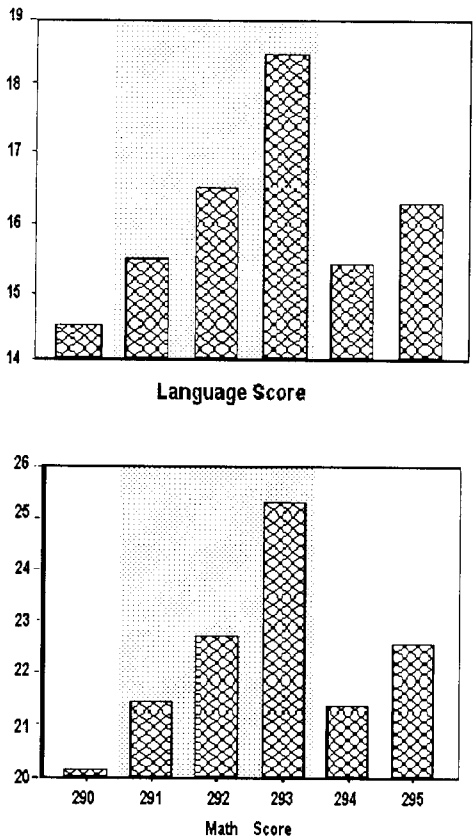
[7] The existence of a library in the classroom is perfectly collinear with classroom style in this sample. It may be that teachers who engage in interactive teaching styles insist on and find ways to provide classroom libraries. In all of these classrooms, desks were arranged in straight lines so that we could not test the effects of grouped furniture. Use of diverse materials, study guides, educational games etc. did not prove to be statistically significant in this sample. Predominant use of blackboards had a negative effect, but is masked by other variables.

[8] Neither training received by school directors or teacher salaries are statistically significant. This may be due to the small amount of variation of these variables within the sample.

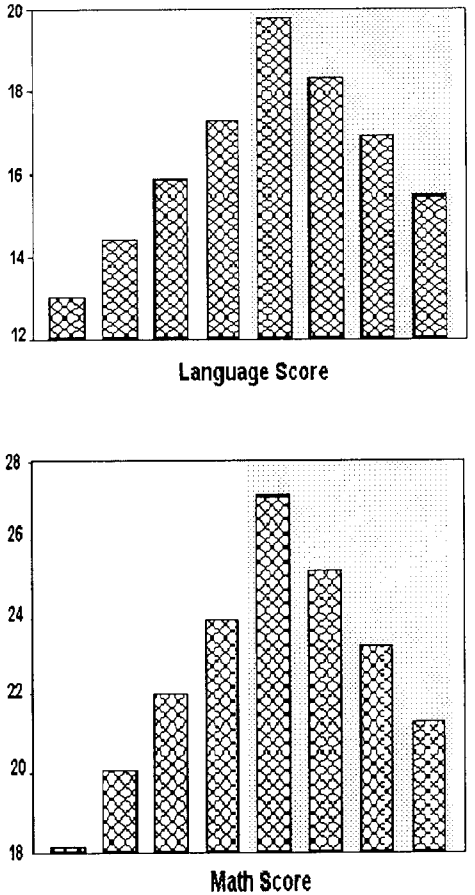
Figure 2
Number of Library Books



In School Library: shaded
In Classroom Library: unshaded

	School	*Library*	*Classroom*	*Library*
1:	0	–	0	–
Bar 2:	–	100	–	0
Bar 3:	–	200	–	0
Bar 4:	–	400	–	0
Bar 5:	–	0	–	200
Bar 6:	–	0	–	400

Figure 3
Teaching Style

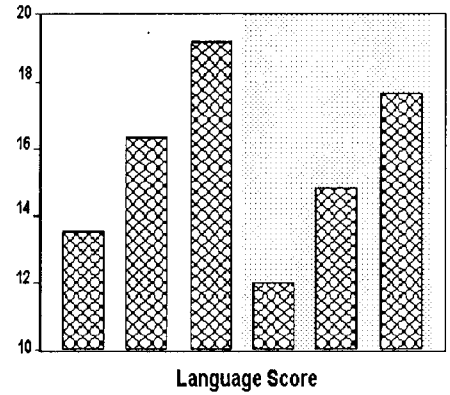


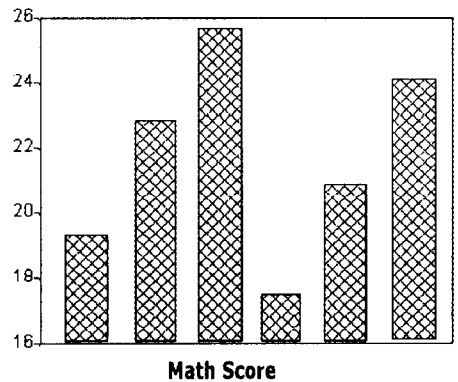
Classroom Climate Index: 0 = transmission to 3 = transaction
Talking Predominant Teaching Style: not unshaded

	Class Climate	*Talking Style*		*Class Climate*	*Talking Style*
Bar 1	0	1	Bar 5:	3	0*
Bar 2:	1	1	Bar 6:	2	0
Bar 3:	2	1	Bar 7:	1	0
Bar 4:	3	1	Bar 8:	0	0

* most interactive

Figure 4
Time Spent Teaching





Hours per week actually spent teaching
Number of teacher absenses at sample mean and shaded, double sample mean

	Hours Teaching	*Days Absent*
Bar 1:	10	4.33
Bar 2:	15	4.33
Bar 3:	20	4.33
Bar 4:	10	8
Bar 5:	15	8
Bar 6:	20	8

5. Concluding Remarks and Policy Implications

This econometric production function analysis of grade repetition, language and mathematics scores underscores the importance of personal and family variables in scholastic achievement. Specifically, the coefficients associated with gender, parental education levels, socioeconomic variables and past history of grade repetition were all significant determinants of repetition, language and math scores. The teacher's opinion of the child's ability level improved both the odds of not repeating a grade as well as mathematics scores. Grade repetition was adversely affected by having siblings who have repeated, and was improved if the family was in a social security program and if the level of parent involvement in the school was high. Reading scores suffered as the number of other siblings in school increased, or if the child held a paying job outside of home. Scores improved significantly with job stability and the number of books in the house besides textbooks. Math scores dropped with the number of disciplinary actions the child received, but increased if the child helped the family outside the home.

With respect to school level variables, a poor condition of the physical plant decreases reading and math scores, and increases the likelihood of repetition. The effect is greater on math scores than language. A larger quantity of classroom and library books improves math and reading scores. Minimum school size for effective learning is around 250 students.

With respect to classroom variables, in both standardized test equations, time that the teacher spends actually teaching as opposed to time spent on administrative task, disciplining students etc. was highly important. Results indicate that an interactive approach to teaching is more effective in increasing standardized test scores than a flat 'banking style' lecture approach. In-service teacher training also improves both language and math scores.

The results presented have several policy implications. At the family level, the importance of parents' schooling underlines the multi-generational effect of an investment in education. The more highly educated the parents and the more books in the home, the better children perform in school. Since today's children are tomorrow's parents, investing in ways that improve their educational output will not only benefit them (and the country's output as they enter the labor force), but will also improve the educational performance of their children. Given that the average number of years of schooling for the mother in the survey was 5.5, and for the fathers only slightly over 6, there is a lot of room for improvement. This multi-generational effect suggests that there is an extremely high, long run return on the investment in education.

The results also indicate that economic policies that provide stable, formal sector jobs, especially those that provide social security

for low income, unskilled workers have a side benefit of improving children's school performance.

Sample size limitations prevent definitive analysis with respect to school and classroom variables, but these results are suggestive of some educational policies that could be fruitful. First, investing in repairing buildings and upkeep may be important. Teacher and student perceptions of school quality maybe related to the level of plant repair, so that building conditions to directly affect achievement scores and repetition rates. Second, consolidating small poor schools into larger schools saves money on administration that could be spent on more equipment and better upkeep of the school.

Specifically estimated in this model were the effects of classroom and school libraries. Consolidations could create larger libraries with a much broader variety of books and other resources that are more easily able to cater to diverse student interests and better encourage reading and learning. Larger schools are also more likely to be able to create and support expanded facilities such as science laboratories, computer laboratories and music rooms. The maintenance of equipment and supplies make it nearly impossible for each small school to have such facilities. However, they could be fully utilized in a larger school, where a variety of these resources can be successfully shared by several classes. These efficiencies of scale should be recognized and capitalized on. This sample suggests a minimum recommended school size is in the neighborhood of arround 250 students. The results also suggest an optimal class size for 5^{th} grade of between 30 and 35 students.

Third, increasing teacher training during the school year for active teachers and helping teachers move toward more interactive teaching styles also appear to be fruitful avenues to pursue. Fourth, a reduction in the administrative load on the teachers as a percent of time that could be spent teaching, either with expanded staff (aides) or perhaps even an expansion of the school day, may lead to an increase in time actually spent teaching, increasing student learning and reducing grade repetition. Fifth, investing in teaching materials, including library books also has a significant payoff. The results indicate that books collected in a central library may have a greater impact than the same number of books in individual classroom libraries, but both are beneficial. While the preschool variable was not significant when combined with other variables, it is important and at least within this sample fairly widespread with 75% of the children having at least one year of preschool. Our results suggest the continued investment in preschool.

Improving educational quality does require added investment. It is not a free good. However, this investment has an extremely high long run payoff whose effects spread into future generations. This investment in human capital is a necessary ingredient for economic

development.

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