Conferencia Interamericana de Seguridad Social

Centro Interamericano de Estudios de Seguridad Social

VOL. 3 NUM. 2 SECOND SEMESTER 2007

Well-being and Social Policy

Quality of Education II
Guest Editor
Harry Anthony Patrinos

CISS

UNIVERSIDAD IBEROAMERICANA

WELL-BEING AND SOCIAL POLICY
VOL 3, NUM. 2, pp. 41-66

ASSESSING ARGENTINA'S PREPAREDNESS FOR THE KNOWLEDGE ECONOMY: MEASURING STUDENT KNOWLEDGE AND SKILLS IN READING, MATHEMATICAL AND SCIENTIFIC LITERACY WITH EVIDENCE FROM PISA 2000

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Abstract

The results of 2000 study of the Programme for International Student Assessment (PISA) show that while Argentinean students performed similar to their peers in most other Latin American countries, they lagged behind all OECD and most of other participating countries. Attention needs to be given to further master the reading, math and science skills that are needed for a knowledge economy; and overcome the abnormal and high dispersion in performance among students. Comprehensive modeling and analysis of the education production function based on generalized least squares estimation and quantile regressions methods allow us to find that student's performance in Argentina is associated mostly with: school and learning climate; quality of teachers; and whether students are encouraged, guided and oriented to be effective learners. The findings show evidence of significant relationships that need future follow-ups to investigate how each indicator is affecting performance.

Key words: generalized least squares, quantile regression, PISA, outcome assessment, knowledge skills, school climate.
Classification JEL: I21.

Introduction

In order to compete in the current world global economy, countries must develop a high capacity and flexible workforce that can respond to changing demands. The knowledge economy is generating skill requirements such as problem solving and the capacity to understand and implement information and productivity-enhancing technologies. Employees need knowledge skills in order to raise productivity, competitiveness and living standards. Equipping people to deal with these

demands requires a new learning model that encompasses the entire life cycle: lifelong learning (World Bank, 2003a).

Argentina is emerging from one of the worst financial crises in its history. High levels of human capital are needed now more than ever to put the country back on a growth path. Their participation in the global economy will be predicated based on the strengths of its workforce. Naturally, the quality of workforce depends on the outcomes of the education and training system. International student assessments provide the opportunity to assess progress towards building a workforce that is capable of making a country competitive in the global knowledge economy. International assessments have been used in the past to rank countries' education systems, and increasingly for research on determinants of learning for generating policy recommendations to improve national learning system. While most international assessments are curriculum-based, the Programme for International Student Assessment (PISA) provides the opportunity to assess young people's readiness for the world of work. It provides a good test of the skills for the knowledge economy and for lifelong learning, issues that are of the utmost importance for middle-income countries. In this paper we document and analyze Argentina's performance in an international context, and assess the extent to which Argentina is prepared to meet the challenges of the knowledge economy. The specific questions that this paper attempts to answer are: (i) what is the achievement level of students in Argentina? Are students in Argentina able to analyze, reason, and communicate their ideas – essential for the knowledge economy – effectively? (ii) What are the factors that determine effective teaching and learning of the skills and competencies for the knowledge economy in Argentina, and how do the results compare to other countries? The intention is to find indicative evidence on the association between different variables and by no mean will show causality between the educational characteristics and performance.

1. The Literature on Determinants of Learning

Past research shows that in general, in developing countries education inputs are more important than socioeconomic origin in explaining academic outcomes, while in developed countries the contrary seems to be the case: family background and home factors are more important than the school and teacher characteristics in explaining achievement (Heyneman and Loxley, 1983; Fuller, 1987; Baker, Goesling and Letendre, 2002). Also these studies focused on inputs rather than institutional factors. Heneveld and Craig (1996), Patrinos and Psacharopoulos (1995) and Lockheed and Verspoor (1991) present several factors that are important for the development of effective schools in developing countries. Necessary basic inputs seem to include the following: (i) instructional materials such as textbooks, supplementary teachers' guides and materials and library books; (ii) a curriculum with appropriate scope and sequence, and content related to pupil experience; (iii) time for learning (the number and length of school days); and (iv) teaching practices (such as active student learning to include discussion and group work).

On the relative effectiveness and efficiency of secondary schools, Lockheed and Jimenez (1996), in a review of the empirical evidence from five developing countries, found that after controlling for socioeconomic factors private schools are more effective than public schools; and that the greater effectiveness and efficiency of private schools is due to differences in school-level management. In terms of efficiency, calculations based on school expenditure data indicate that,

on average, the unit costs for private schools are lower than for public schools. For the same unit cost, private schools provide as much as three times more learning, as do the public schools. Hanushek and Luque (2003) indicated that attention to the quality of human capital in different countries naturally leads to concerns about how school policies relate to student performance. Their results of their analyses of the educational production functions (using TIMSS data) within a range of developed and developing countries highlighted the value of efficient use of resource on performance. Woessmann (2003), using TIMSS, concluded that positive effects on student performance stem from centralized examinations and control mechanisms, school autonomy in personnel and process decisions, competition from private educational institutions, scrutiny of achievement, and teacher incentives and influence on teaching methods. A large influence of teacher unions on curriculum scope has negative effects on student performance.

Also, Hanushek and Kimko (2000) have shown that educational quality as measured by comparative tests in mathematics and science has a consistent, stable and strong influence on economic growth. Lee and Barro (1997), using TIMSS, investigated the determinants of educational quality in a panel data set that includes output and input measures for a broad number of countries. The results show that family inputs and school resources are closely related to school outcomes, as measured by internationally comparable test scores, repetition rates, and drop-out rates. In an important study, Lee & Barro (2001) found that the quantity of schooling, measured as the school attainment of males at secondary and higher levels, has a positive and statistically significant relationship with growth; on the quality of education, they found that science scores have a statistically significantly positive effect on growth. The implication is that a one-standard-deviation increase in scores (by 0.08) would raise growth rate on impact by 1.0 percent a year. By contrast, a one-standard-deviation increase in school attainment would increase growth rate by 0.2 percent a year. Thus, they conclude that quality and quantity of education matter, but quality matters much more.

At the national level, Fertig (2003) used OLS and quantile regressions, using PISA 2003 for Germany, found that negative factors include: schools without regular tests; too much regulation of schools – that is, schools did not have enough autonomy to decide upon important school relevant issues; poor school conditions; not enough access to modern information technology for the students; non-native students (especially in reading); and high student-teacher ratio and shortage of teachers. Fertig and Schmidt (2002) found, based on the country-level data of the PISA 2000 study, that reading test scores are associated with individual and family background information and with characteristics of the school and class of the 15 year old respondents to the survey. Their findings suggest that United States students, particularly those in the lower quantiles, are served relatively unsatisfactorily by their system of education. Overall, family background and school characteristics play a more important role for success in PISA 2000 than previously recognized in the debate. In particular, school conditions including teacher provision account for a sizeable fraction of student's individual success in PISA 2000. Thus, school quality apparently does matter. Wolter (2002), Using PISA 2000 for Switzerland, showed that besides the usual factors like education, wealth or the occupational status of parents, family configurations can play an important role in explaining differences between students. Abdul-Hamid (2003) investigated the factors that affected student performance in Jordan using TIMSS1999 data and also found advantages for the home, family, demographics, and school governance in determining student achievement. On the relationship between school climate and performance, Greenberg (2004) in her analysis of the

United States' National Assessment of Educational Progress (NAEP) 2000 data, has indicated that students in schools with the highest student behavior values had higher mean mathematics scores than students in schools in the middle or at the bottom of the student behavior distribution. A similar relationship existed between parental involvement and mathematics achievement and between school morale and mathematics achievement.

2. Background on Pisa

PISA, an initiative of the Organization for Economic Cooperation and Development (OECD), is part of an ongoing program of reporting on indicators in education. PISA gathers reliable information on educational outcomes across countries, especially measures of students' skills, and aims to monitor trends in performance over time and give countries the opportunity to assess their systems against other countries. The PISA study includes countries at different levels of economic development (OECD and non-OECD developing countries). Among the general findings (OECD, 2001) of PISA 2000 in relation to Argentina and Latin American countries are:

- While, on average, 10 percent of 15-year-olds in the world's most developed countries have top-level[1] reading skills, in Latin American countries it was less than 2 percent (with Argentina 1.7 percent).
- At the other end of the scale, an average of 6 percent of 15-year-olds fall below Level 1, PISA's lowest level of reading proficiency. In Argentina, Brazil, and Mexico, 23 percent, 23 percent and 16 percent, respectively, fall below level 1. Young people in these categories show serious gaps in the foundation of literacy skills needed for further learning, impairing their ability to benefit from further educational opportunities at school or beyond.
- Japan and Korea are the top performers in mathematical and scientific literacy while Peru, Brazil, Chile, Argentina and Mexico were among the worst performers.
- Finland, Japan and Korea maintained a comparatively narrow gap between the highest and poorest performers while still attaining high average levels. On the other hand, Argentina has one of the largest gap among Latin American countries and PISA countries.
- In all PISA countries girls were, on average, better readers than boys. In Latin American countries, for example in Argentina, Brazil and Mexico, females also scored higher than boys but the difference between boys and girls was smaller than in all other countries except Korea.
- Results vary widely across schools, but there are countries in which the large majority of schools achieve high standards. In countries where differences among schools are widest (such as in Argentina), a significant part of these differences tends to be associated with the socio-economic composition of schools.

[1] Being able to understand complex texts, evaluate information and build hypotheses, and draw on specialized knowledge.

3. Past Research on Assessing Achievement in Argentina

Assessing readiness for the knowledge economy has been confined to macroeconomic indicators (see, for example, Dahlman and Aubert, 2001), and quality of education research has relied on national assessments based on the curriculum (World Bank, 2002). The use of international assessments is more limited (World Bank, 2003b), and so far has been based on curriculum-based tests. Argentina participated in the 1997 UNESCO comparative study of language and mathematics skills in primary school throughout the region and was clearly one of the better performers. Yet, achievement in Argentina varied across socio-economic and geographical lines: students in large cities and urban areas score consistently higher than those in rural areas. Argentina's education system succeeded in creating a stock of human capital. But the system has not succeeded in creating the human capital which will enable Argentina to develop into a knowledge-based economy. While participation in secondary and tertiary education is high, completion rates are unacceptably low. Curriculum at all levels is too heavily focused on rote learning and repetition and the quality of instruction is poor.

With the enactment of the Federal Law of Education in 1993, Argentina established for the first time a system for monitoring the quality of education: The National Learning Assessment System (in Spanish), targeted towards pupils in the 3rd, 6th and 9th grade (primary) as well as 3rd polimodal (secondary). The system consists of various tests grouped by areas, such as mathematics and language. The language tests have been designed to approximate the students' conceptual understanding and reading comprehension. The mathematics tests have been constructed to estimate students' ability to solve problems, conduct mathematical operations and read graphs and tables. Still, the actual contents of the tests changed on a yearly basis, which in turn makes comparison over time difficult. While scores were higher in 2000 than 1996 levels, the data indicates an overall decline in performance after 1998 in both language and mathematics. In addition, while Argentina performs relatively well in the region, performance tends to be better in areas of more rote learning, and worse in analysis and interpretation (Naronzini, 2001).

Several quantitative studies of the determinants of learning in Argentina have taken place. McEwan (2001) looks at 7th grade Spanish and math achievement. Catholic schools are somewhat more effective than public schools in producing student outcomes, but the differences are not as pronounced as in Chile. Llach, Montoya and Roldán (1999) added 12th grade achievement to their analysis. They found, controlling for socioeconomic status, that private school attendance is positively associated with achievement, but at the middle school level there are no significant differences. However, private school attendance is positively associated with lower dropout and repetition, and promotion rates. With respect to mathematics, Eskeland and Filmer (2002) found that school autonomy is significantly correlated to the test scores in urban areas. Although parent participation has no significant impact by itself, it does have a positive correlation when present together with autonomy. Neither autonomy, participation, nor their interaction is significantly associated with language test scores. Recently, Argentina participated in the Progress in International Reading Literacy Study (PIRLS), along with 34 other countries. With 150,000 students at the fourth grade (9- and 10-year-olds) tested, PIRLS 2001 is the first in a planned 5-year cycle of international trend studies in reading literacy. PIRLS shows that Argentinean fourth-grade students read poorly, coming in 31st out of 35 countries in reading, trailing several developing countries, including Colombia, Turkey and Slovenia.

4. Analytic Design and Methodology

It is hypothesized that there is no single but several different factors that affect basic education quality in Argentina. Using a thorough econometric and statistical investigation all factors related to institutions, schools, students, parents and teachers were investigated. Mixed-methods approach is used. The approach included distributional analysis of performance, factors affecting achievement using ordinary and generalized least squares, and conditional relationships among subgroups using quantile regressions. Factors affecting achievement are analyzed and compared. Initially Ordinary Least Squares (OLS) methods were used to analyze the determinants of learning. The following linear regression model was estimated:

$$\mathbf{Y} = b_1 \mathbf{X}_1 + b_2 \mathbf{X}_2 + \mathbf{e} \qquad (1)$$

where $\boldsymbol{Y}$ is the test score and $\mathbf{X}_1$ is a vector of student variables that include household characteristics such as socioeconomic indicators, $\mathbf{X}_2$ is a vector of school indicators such as school resources, school and institutional features. However, because of the non-spherical error term, the OLS estimation was not highly dependable. In order to accommodate for schools fixed effects we then used the Generalized Least Squares (GLS) estimation methodology. To accommodate the school factors and cover for the between schools and within schools dimensions we estimated a combined model:

$$\mathbf{Y} = b\,\mathbf{X} + \mathbf{u}\,\mathbf{S} + \mathbf{r} \qquad (2)$$

where **X** is the predictors' matrix that also includes the school variables - which are fixed for each student at the same school. **S** is the predictors' matrix that includes student variables only. **u** is a random element associated with school disturbances (as a second level random variables), which we assume to have covariance matrix **T**. We use the GLS estimate for $\boldsymbol{b}$ as $\boldsymbol{b^* = (X' V^{-1} X)^{-1} X' V^{-1} Y}$. Where **V** is the variance matrix and is equal to $\boldsymbol{ZT^dZ' + \sigma^2 I}$, $\mathbf{T}^d$ is the diagonal matrix for the variance of **u**. The GLS variables are then used in a quantile regression model as a segmentation strategy to estimate the conditional relationships among subgroups especially between best and worst performing groups. The basic quantile regression model specifies the conditional quantile as a linear function of covariates. For the qth quantile, a common way to write the model (see, e.g. Buchinsky, 1998) is:

$$y_i = x_i'\beta_q + u_{q_i}, \mathrm{Quant}_q(y_i \mid x_i) = x_i'\beta_q, \; q \varepsilon (0,1) \qquad (3)$$

where $\mathbf{Quant}_q(\mathbf{y_i}|\mathbf{x_i})$ denotes the quantile of y_i, conditional on the regressor vector $\mathbf{x_i}$. It is only assumed that $\mathbf{u}_{qi}$ satisfies the quantile restriction $\mathbf{Quant}_q(\mathbf{u}_{qi} \mid \mathbf{x}_i) = \mathbf{0}$. The $\mathbf{q}^{th}$ regression quantile ($\mathbf{0 < q < 1}$) of **y** is the solution to the minimization of the sum of absolute deviations residuals:

$$\min_{\beta} \frac{1}{n} \left\{ \sum_{i:y_i \geq x_i'\beta} q \,|\, y_i - x_i'\beta \,| + \sum_{i:y_i < x_i'\beta} (1-q) \,|\, y_i - x_i'\beta \,| \right\} \qquad (4)$$

Based on quantile regressions, we interpreted the national performance scores conditional on observable characteristics, as the reflection of different education systems.

The student population chosen for PISA, 15 year olds, were assessed as they approach the end of their compulsory schooling.[2] In Argentina a national random sample of 3,983 (weighted to represent 505,404) 15-year-old students was chosen from about 200 schools. The learning domains of reading, mathematical and scientific literacy, together with some other areas such as students' familiarity with computers, learning strategies students use, and students' attitudes towards their schools, have been chosen to be the foci of PISA. The variables used in this analysis of data for Argentina are listed in Table 1.

Table 1
Variables used in the Analyses and the Descriptive Statistics

Variable	Mean	Std.
Number of Siblings	2.57	1.57
Mother's education above Secondary	44%	0.5
Mother is working	49%	0.5
Home educational resources (index variable) This was created based on the availability, in the home, of dictionary, quiet place to study, desk for study, books, and calculators.	-0.8	1.29
School is in a large city	13%	0.33
Number of students in the school	672	446
Proportion of teachers fully certified by designated authorities	85%	0.23
Percentage of girls at the school	53%	0.18
Time spent on homework (index variable) Derived from time student devote to homework per week	0.09	0.97
Enjoyment of reading (index variable), derived from students' level of agreement with following statements: I read only if I have to; reading is one of my favorite hobbies; I like talking about books with other people; I find it hard to finish books; I feel happy if I receive a book as a present; for me, reading is a waste of time; I enjoy going to a bookstore or a library; I read only to get information that I need; and, I cannot sit still and read for more than a few minutes	0.26	0.75
Sense of belonging (index variable), derived from students' reports on their level of agreement with the following statements concerning their school: I feel like an outsider (or left out of things); I make friends easily; I feel like I belong; I feel awkward and out of place; other students seem to like me; and, I feel lonely	0.08	0.97

[2] For more information about the design, development and implementation of PISA, see http://www.pisa.oecd.org.

Table 1 (continued)

Variable	Mean	Std.
Teacher behaviors (index variable), derived from principals' reports on the extent to which the learning by 15-year-olds was hindered by: low expectations of teachers; poor student-teacher relations; teachers not meeting individual students' needs; teacher absenteeism; staff resisting change; teachers being too strict with students; and students not being encouraged to achieve their full potential	0.1	1.01
Teacher morale (index variable), derived from the extent to which school principals agreed with the following statements: the morale of the teachers in this school is high; teachers work with enthusiasm; teachers take pride in this school; and, teachers value academic achievement	-0.11	1.11
Student uses computers at school, dummy that measures whether a student uses computer at school several time a week or several times a month	33%	0.47
Student uses calculator at school, dummy that measures whether a student uses the calculator at school several time a week or several times a month	68%	0.47
Student uses the Internet at school, dummy that measures whether a student uses Internet several time a week or several times a month	9%	0.28
School is public	85%	0.35
Student uses labs at school (dummy)	38%	0.49

5. Results and Findings

General overall performance of Argentina

Overall, Argentinean students outperformed, on average, Latin American countries in Math but were behind Mexico in reading and science. Table 4 shows the performance across participating countries in the three subjects. In comparison to other participating countries, Argentina outperformed only three countries: Indonesia, Macedonia (in reading and math) and Albania. In reading, Argentina has 22 percent of students below level 1,[3] which is 16% higher than the OECD average. Students at level 1, according to the OECD, may be able to read, but have not acquired the skills to use reading for learning. Only 2 percent of students in Argentina (although higher than other LAC countries, it is very low in comparison to the OECD average at 10 percent) are at level 5, at which they are able to evaluate information, build hypotheses, draw on specialized knowledge, and accommodate concepts contrary to expectations (Table 2, Figure 1).

[3] See http://www.pisa.oecd.org for level definition.

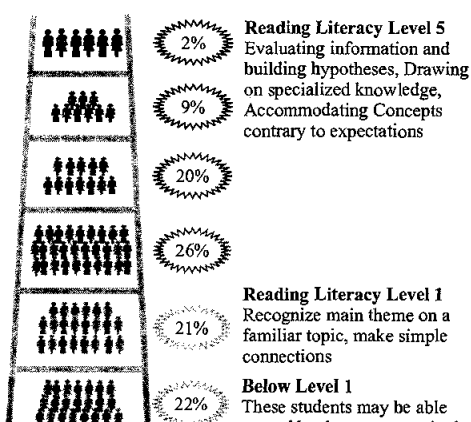
Table 2
Students in each of Six Levels of Reading, Selected Countries
(percent)

Country	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5
Brazil	23.3	32.5	27.7	12.9	3.1	0.6
Argentina	***22.6***	***21.3***	***25.5***	***20.3***	***8.6***	***1.7***
Chile	19.9	28.3	30.0	16.6	4.8	0.5
Mexico	16.1	28.1	30.3	18.8	6.0	0.9
US	6.4	11.5	21.0	27.4	21.5	12.2
Italy	5.4	13.5	25.6	30.6	19.5	5.3
Spain	4.1	12.2	25.7	32.8	21.1	4.2
Korea	0.9	4.8	18.6	38.8	31.1	5.7
OECD average	6.0	11.9	21.7	28.7	22.3	9.5

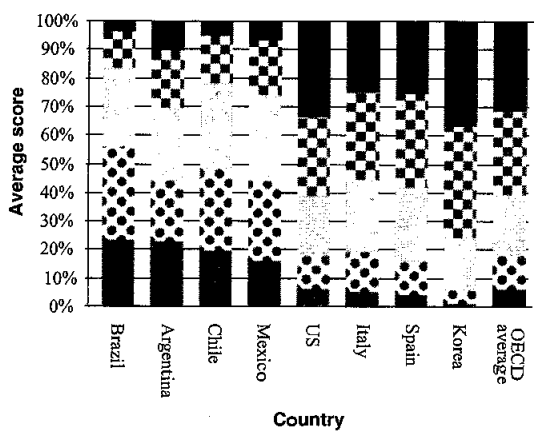
Only 31 percent of Argentinean students are either at or above Level 3 proficiency, as compared to 61 percent of students in OECD countries. OECD has identified Level-3 proficiency as the least acceptable. In contrast, Finland and Korea has 79 percent and 75 percent respectively of students at or above Level 3. However, among the Latin American countries, Argentina and Mexico has the smallest percentage of students below Level 3.

Figure 1
Reading Performance Levels

(a) Reading Performance of Argentina by Reading Level



(b) Percentage of students in the different levels of Reading, PISA 2000



Comparisons based on GDP, enrollment and expenditures on education

Argentina under-performed in comparison to other countries (other than those in Latin America) when controlling for GDP per capita as a proxy for wealth, or public expenditure on education per student. Countries such as Thailand, Russia, Latvia and Bulgaria, with GDP per capita lower than Argentina, performed significantly better. In comparison, Mexico has a lower net enrollment ratio in secondary than the other LAC countries (which participated in PISA), and performance is still better.

Performance and equity

The overall variation in performances among Argentinean students is large compared to the rest of participating countries and is the opposite, for example, of Mexico. The gap between the top 5 percent and the bottom 5 percent in Argentina is one of the highest and only smaller than Israel. Top achievers such as Korea and Finland had the smallest gap. When comparing countries on performance controlling for level of dispersion, one sees that Argentina is close to Peru but different from Mexico, Chile and Brazil. It is similar to other LAC countries as it belongs to the under-performing group in terms of test scores; but Mexico, on the other hand, is in the same quadrant as Portugal, Italy and Thailand because of its low gap (see Figure 4).

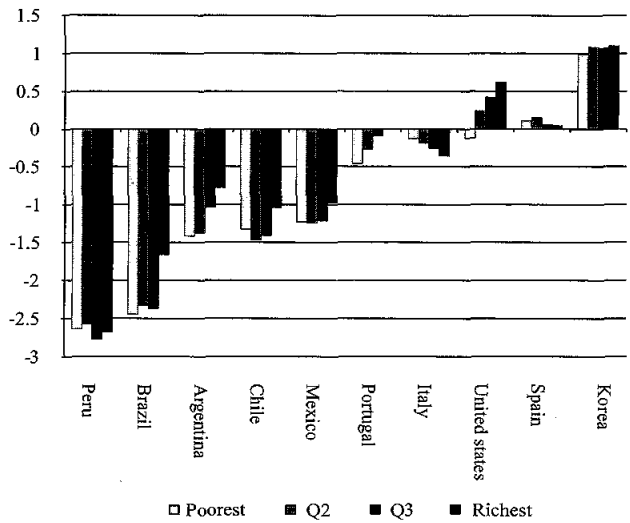
In terms of socioeconomic status, Argentina has a complicated inequity pattern as it shows high and uniform variation among the four socioeconomic groups. This is different for example from the pattern in Mexico, Portugal, Spain and Italy. In Brazil, on the other hand, there are significant differences between means and variances between each pair of the socioeconomic groups, and this is also the case for the United States. One country among the top achievers with high equity is Korea, with a difference in means between the lowest socioeconomic group and the rest, and small variation in scores and no significant difference among SES groups. Looking at SES effect further, another level of analysis was conducted to compare performance of each socioeconomic group (SES) in Argentina to a similar group in other countries. This relative comparison of performance of peers across countries consists of constructing z-scores for each socioeconomic group and comparing these standardized scores across countries (Figure 2). The z-score is a normalization of values by subtracting the overall mean and dividing by the standard deviation. Hence it is a measure of how far is the actual value relative to the average score in standard deviation units. The z-score for SES level *l* in country *c* is:

$$Z_{lc} = \frac{(\bar{x}_{cl} - \bar{x}_{l})}{\sigma_{l}}$$

where $\bar{x}_{cl}$ is the mean score for students in SES level *l* in country *c;* $\bar{x}_{l}$ is the mean for all students in SES level *l* in all countries; and $\bar{\sigma}_{l}$ is the standard deviation for all students in SES level *l* in all countries. Based on these comparisons we find the following:

- Students from all four SES groups scored below the international average in their group.
- Students who come from highest SES group in Argentina performed better than their peers from LAC countries but worse than peers in majority of other countries.
- Relative to their SES groups, the richest two groups performed better than their peers in LAC countries but poorest two groups performed lower than their peers in Mexico.
- There was a significant difference between the tops two and the lowest two SES groups in Argentina but no difference in Mexico, for example.

Figure 2
Overall Performance Relative to Socioeconomic Levels -Standardized Scores

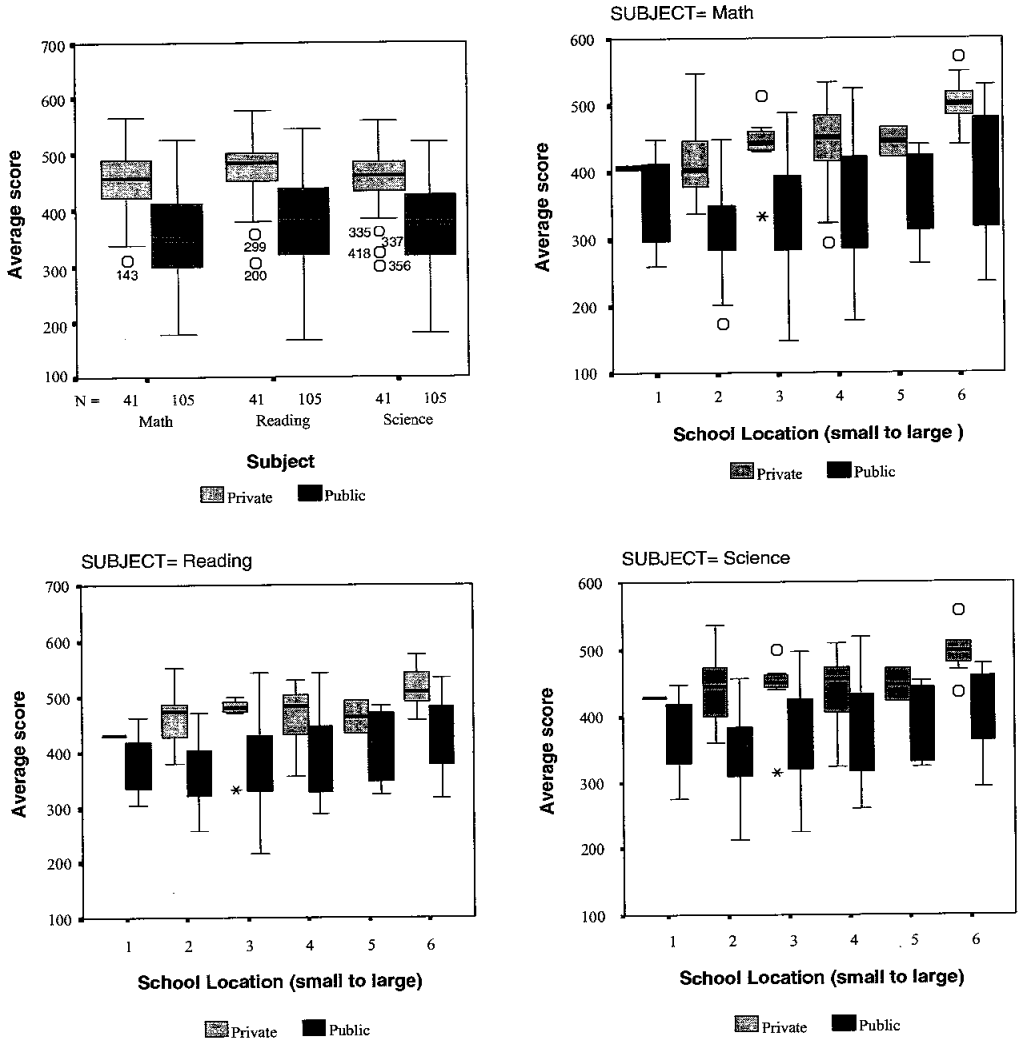


Schools comparison

Type and location of schools affect performance. There is a significant difference in performance between private and public schools. On average, private schools achieved better and had lower dispersion than public schools; at the same time, some public schools' performance was similar, and sometimes better, to some private schools. There is a significant difference in school average score and school dispersion based on location of the school; schools in large cities had higher average scores than the rest of schools; schools in villages and small towns had higher dispersion in comparison to schools in cities; top achieving schools were from large and medium sized cities. Similar to most of PISA countries a considerable proportion of the variation in student performance lies between schools. In LAC countries and Argentina, specifically, performance is closely related

to the learning environment offered by the respective schools and learning climate. The significance of school type and location has been also confirmed. (Table 5, Figure 3).

Figure 3
Distribution of Test Scores by School Type and Geographic Location



School educational resources were carefully investigated and only those that have direct connection to the curriculum are found important. In science only laboratory equipments were found to be significantly associated with performance and the value increased by level of performance as shown by the quantile regression estimates (Table 6).

School educational resources

Overall, the marginal effect of an increase in the quality of educational resources tends to be highest in countries where deficiencies reported by principals are particularly pronounced. This negative relationship may suggest diminishing returns to investment in educational resources. However, the value of coefficients varies widely across countries. In Argentina, Mexico and Peru, but also in Germany, a one unit change of the index is associated with difference in scores by 25 points or more, corresponding to an improvement of more than a third of a proficiency level on the combined reading literacy scale. See Figure 5.

Quality of teachers

In an effort to assess the qualities of teachers that are associated with high performance of students, we looked at teacher's morale, behavior and attitude, and certification and qualifications. High teacher morale, as perceived by the school principal, is associated with better performance. Confirming with the substantial evidence that teacher's quality is highly correlated with student test scores (Rockoff, 2004; Murnane, 1975; Armor et al., 1976). For schools where teachers work with enthusiasm, the math and reading scores seem to be higher. When teachers take pride, it is observed that students in that school achieve more. When teachers value academic achievement, then students significantly achieve higher in math and reading. Moreover, teacher morale is the most significant factor associated with math performance for top achievers as shown by results from the quantile regression.

Teacher behavior and teacher-related factors affecting school climate were associated with performance. In schools where teachers had high expectations, students are observed to perform better; and when principals feel that there is a strong relationship between students and teachers, students perform better. Moreover, students going to schools with high levels of teacher absenteeism, and when students are not encouraged to achieve to their full potential, they achieve less, especially in mathematics and reading.

Teacher certification did not show a significant positive impact, although about 85 percent of students were taught by teachers that are fully certified by the designated authorities, it does not a significant positive impact on performance (math and reading are affected, most especially among low achievers) (see Figure 5).

Technology: quality and not quantity

The international experience of the effects of computers at schools on students' achievement and learning shows mixed results (see Krueger and Rouse, 2003; Angrist and Lavy, 2002; Boozer, Krueger and Wolkon, 1992; Goolsbee and Guryan, 2002; Kirkpatrick and Cuban, 1998; Wenglisky, 1998). The research of Rouse and Krueger (2003) in the United States suggests that while the use of computers may improve some aspects of students' language skills, it does not appear that these gains translate into a broader measure of language acquisition or into actual readings skills. On teachers readiness or preparedness to use technology, Rowand (2000) reported that only one-third of teachers felt well or very well prepared to use computers an the Internet. For the Netherlands, Leuven, Lindahl, Oosterbeek and Webbink (2003) showed that extra funding for computers and for language materials did not improve test scores in languages, arithmetic or information processing. Angrist and Lavy (2001) showed that the influx of new computers increased teachers' use of computer-aided instruction but it did not appear to have had educational benefits that translated into higher test scores. In Argentina mixed results have also been observed. The existence of computers and the computer to student ratio at the school did not make a difference, but in schools where the use of computers was significant, students achieved significantly higher than other students in reading, math and science (while controlling for other factors, see Figure 5).The analysis highlights two major findings for Argentina in this regard:

a. Although using computers at school was associated with positive achievement, we notice that in mathematics using calculators at school, as reported by students, also played an important factor. Hence low threshold technology can also be helpful. When controlling for achievement levels as revealed by the estimates from the quantile regressions we see that calculators showed higher contribution to achievement than computers among low achieving students but computers played this role for high achievers.

b. Moreover, giving the opportunity to students to use computers at school has contributed most to achievement in reading than to science and mathematics. This may have been due to availability of software and learning modules related to reading than in science and mathematics.

Student-related factors

Instrumental motivation as measured by students perception and understanding of education as a mean to increase their job opportunities; to insure that their future will be financially secure; and to get a good job was seen to be significant in the GLS models for science and mathematics. When students are aware of the importance of studying mathematics and science in the labor market and their future careers, they tend to achieve better in these areas. The level of association also varies between the different achievement-quantiles. This was more significant for high achieving students than low achievers in science and was only significant for the top two achieving quantiles (75^{th} and 90^{th}) in mathematics. The awareness and enjoyment levels of the subject matter were important in reading performance and among the different achievement groups. Also, allocating time and working out class assignments and homework was associated with better performance. Noticeable importance of this factor was observed among low achievers in mathematics and top achievers in science.

Family factors

Most important were mother's education level and availability of educational resources in the home of the child. Mother's education level makes the most significant effect in science especially among the top achievers. Mother's work negatively affected the performance in mathematics but not in the other fields. This may be due to the fact that reasonable amount of practice, assistance and guidance at the home may help in understanding and mastering mathematical concepts. Educational resources at home affect reading performance the most and its effect increases by the achievement level; its effect on the performance of top achievers was twice as much as for bottom achievers. Educational resources include books and a computer in the house.

6. Conclusion and Policy Implication

Although Argentinean students performed similar to their peers in most other Latin American countries, more could be done to bring them to a comparable level with other OECD and PISA participating countries. Attention needs to be given to further master the reading, math and science skills that are needed for a knowledge economy; and overcome the abnormal and high dispersion in performance among students. Based on the above comprehensive modeling and analysis of the education production functions we find that student's performance in Argentina is associated mostly with: school and learning climate; quality of teachers; and whether students are encouraged, guided and oriented to be effective learners. The findings show evidence of significant relationships that need future follow-ups to investigate how each indicator is affecting performance.

What is working? Positive school climate, learning environments, and school setups (as measured by teacher morale; relationship between students and teachers; sense of belonging; guiding and encouraging students to use learning aides; private school environment; and proportion of girls at school).

What is not clear? Existence of computers, calculators and labs for science. The effective use of such resources was associated with performance and not its existence and its numbers. Rethink the resources issues.

What is not working? Teacher certification, whether a degree is obtained in the subject matter, and student-teacher ratio.

In conclusion, Argentina's overall performance is below the OECD level. Given that the PISA tests on basic knowledge needed for a knowledge economy we can say that Argentina needs to start implementation of strategic plans to identify gaps and implement remedial interventions to catch up and improve their overall performance in reading, math and science. The data indicates that there are relatively successful institutions and students and seem to be capable to do better. The gap in students' performances is alarming as it is bigger than in most countries. While this phenomenon could delay the country's efforts to adapt to rapid change associated with a knowledge economy, at the same time it shows that some students and schools have done reasonably well. The analyses also seem to provide tips on where the investigation needs to start:

- How could the school climate be improved and what are the components of the successful teaching environment?

- What instructional material needs to be added and how to be used effectively to improve teaching and learning in the core skills?
- How can the family and community get involved to help their children achieve better and how to reduce the influence of socioeconomic disadvantages of some groups, students and communities?

Table 3 summarizes the results and Figure 6 shows simulated results under several scenarios for improvements targeting low achievers.

Table 3
Summary of Performance Factors

School Factors

Positive Factors	Mixed Effects	Negative Factors
➡ **Private** school over public in all subjects	**School educational resources**: ➡ Students who used computers (effectively) at school achieved better in all subjects ➡ Using calculators at school has positive effect on math achievement	High **student-teacher ratio** associated with low score
➡ More **girls** in school is associated with better performance	➡ Total number of computers available to teachers does not have significant positive impact	High percentage of **certified teachers** has negative effect
➡ Location of school (**cities specially large ones**) has positive influence (villages and small towns disadvantaged)	➡ Computer-Student ratio at school does not have a clear impact	Existence of the Internet at school was not associated with good performance
➡ Longer school hours associated with better performance.	➡ Availability of science equipments and laboratories	

Teacher related factors

Positive Factors	Negative Factors
➡ High level of **relationship** between teachers and students (perceived by school principal) ➡ High teacher **morale is** associated with higher scores (perceived by principal) ➡ Teacher behavior and related factors affecting school climate associated with high scores Degree in the subject matter, especially in science, was associated with positive performance	Certification didn't seem to be associated with performance.

Table 3 (continued)

Student and learning factors Positive Factors	
➡ **Interest** in subject has positive effect	
➡ Student perception of **relationship** with teacher (get along, interest in student, listen, extra help, treat fairly)	
➡ Improving students sense of belonging at school was associated with better performance	
➡ Time on **homework** associated with better performance	
General Characteristics **Positive Factors**	**Negative Factors**
➡ Boys achieved better than girls in math and science but girls perform better (but big difference) in reading	Mother's employment associated with low performance
➡ Mother's education (above secondary) associated with better performance	Number of sihlings
➡ **Home educational resources** associated with high performance in math and reading	

Figure 4
Math Score and Dispersion across Countries

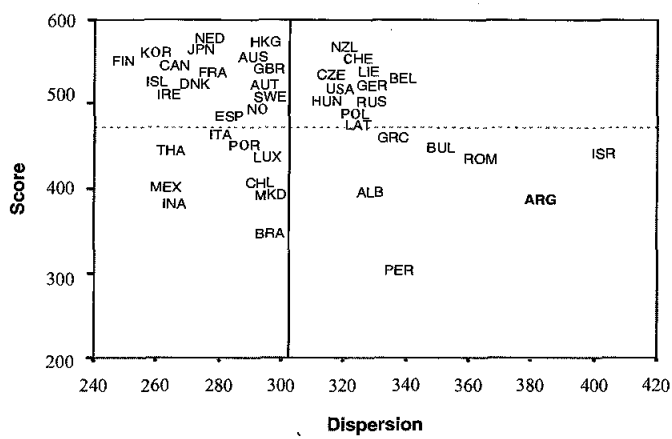


Table 4
Student Performance on Reading, Scientific and Mathematical Literacy Scales

Country	Performance in reading literacy			Performance in math literacy			Performance in science literacy	
	Mean	S.E.		Mean	S.E.		Mean	S.E.
Finland	546	(2.6)	Hong Kong-China	560	(3.3)	Korea	552	(2.7)
Canada	534	(1.6)	Japan	557	(5.5)	Japan	550	(5.5)
New Zealand	529	(2.8)	Korea	547	(2.8)	Hong Kong-China	541	(3.0)
Australia	528	(3.5)	New Zealand	537	(3.1)	Finland	538	(2.5)
Ireland	527	(3.2)	Finland	536	(2.2)	United Kingdom	532	(2.7)
Hong Kong-China	525	(2.9)	Australia	533	(3.5)	Canada	529	(1.6)
Korea	525	(2.4)	Canada	533	(1.4)	Australia	528	(3.5)
United Kingdom	523	(2.6)	Switzerland	529	(4.4)	New Zealand	528	(2.4)
Japan	522	(5.2)	United Kingdom	529	(2.5)	Austria	519	(2.6)
Sweden	516	(2.2)	Belgium	520	(3.9)	Ireland	513	(3.2)
Austria	507	(2.4)	France	517	(2.7)	Sweden	512	(2.5)
Belgium	507	(3.6)	Austria	515	(2.5)	Czech Republic	511	(2.4)
Iceland	507	(1.5)	Denmark	514	(2.4)	France	500	(3.2)
France	505	(2.7)	Iceland	514	(2.3)	Norway	500	(2.8)
Norway	505	(2.8)	Liechtenstein	514	(7.0)	United States	499	(7.3)
United States	504	(7.1)	Sweden	510	(2.5)	Belgium	496	(4.3)
Denmark	497	(2.4)	Ireland	503	(2.7)	Hungary	496	(4.2)
Switzerland	494	(4.3)	Norway	499	(2.8)	Iceland	496	(2.2)
Spain	493	(2.7)	Czech Republic	498	(2.8)	Switzerland	496	(4.4)
Czech Republic	492	(2.4)	United States	493	(7.6)	Spain	491	(3.0)
Italy	487	(2.9)	Germany	490	(2.5)	Germany	487	(2.4)
Germany	484	(2.5)	Hungary	488	(4.0)	Poland	483	(5.1)
Liechtenstein	483	(4.1)	Russian Federation	478	(5.5)	Denmark	481	(2.8)
Hungary	480	(4.0)	Spain	476	(3.1)	Italy	478	(3.1)
Poland	479	(4.5)	Poland	470	(5.5)	Liechtenstein	476	(7.1)
Greece	474	(5.0)	Latvia	463	(4.5)	Greece	461	(4.9)
Portugal	470	(4.5)	Italy	457	(2.9)	Latvia	460	(5.6)
Russian Federation	462	(4.2)	Portugal	454	(4.1)	Russian Federation	460	(4.7)
Latvia	458	(5.3)	Greece	447	(5.6)	Portugal	459	(4.0)
Israel	452	(8.5)	Luxembourg	446	(2.0)	Bulgaria	448	(4.6)
Luxembourg	441	(1.6)	Israel	433	(9.3)	Luxembourg	443	(2.3)
Thailand	431	(3.2)	Thailand	432	(3.6)	Thailand	436	(3.1)

Table 4 (continued)

Country	Performance in reading literacy		Performance in math literacy			Performance in science literacy	
	Mean	S.E.	Mean	S.E.		Mean	S.E.
Bulgaria	430	(4.9)	Bulgaria	430	(5.7)	Israel	434	(9.0)
Mexico	422	(3.3)	Argentina	388	(9.4)	Mexico	422	(3.2)
Argentina	418	(9.9)	Mexico	387	(3.4)	Chile	415	(3.4)
Chile	410	(3.6)	Chile	384	(3.7)	FYR Macedonia	401	(2.1)
Brazil	396	(3.1)	Albania	381	(3.1)	Argentina	396	(8.6)
FYR Macedonia	373	(1.9)	FYR Macedonia	381	(2.7)	Indonesia	393	(3.9)
Indonesia	371	(4.0)	Indonesia	367	(4.5)	Albania	376	(2.9)
Albania	349	(3.3)	Brazil	334	(3.7)	Brazil	375	(3.3)
Peru	327	(4.4)	Peru	292	(4.4)	Peru	333	(4.0)

Table 5
Education Production Function
(From the GLS)

	Reading	Math	Science
	503.48	462.32	438.01
Intercept	37.74	(26.52)	(28.3)
	19.89	-12.57*	7.32**
Student is female	4.56	(-2.4)	(1.56)
	7.35	-11.96	-4.33
Number of sibling in the family	5.48	(-6.93)	(-2.76)
	23.10	27.75	32.31
Mother education level above secondary	5.28	(5.05)	(6.72)
	11.84	9.01	12.72
Home educational resources	6.53	(4.09)	(6.25)
	-40.74	-47.62	-15.82
School is private	-8.09	(-7.39)	(-2.85)
	29.72*	13.01**	17.48**
Percentage of girls at school	2.28	(0.76)	(1.23)
	35.84	38.0	33.86
School is in a large city	6.33	(5.05)	(5.04)
	-1.22**	-0.19**	-0.12**
Student teacher ratio	(-1.82)	(-0.2)	(-0.15)
	6.09**	12.61*	2.87**
Frequent use of computers at school	(1.35)	(2.24)	(0.6)
		32.99	
Frequent use of calculators at school		(5.76)	
	-18.55	-16.85	-18.82
Frequent use of the Internet at school	(-3.16)	(-2.34)	(-3.09)
	9.35	13.05	4.54
Index of teacher morale at school	(3.83)	(4.09)	(1.46)
	12.78	8.33	12.20

Table 5 (continued)

	Reading	Math	Science
Index of student's sense of belonging	(6.62)	(3.56)	(5.91)
	-59.86	-43.74	-39.69
Proportion of certified teachers at school	(-5.92)	(-3.39)	(-3.33)
Proportion of teacher with degree in the subject matter		30.48	23.19
		(3.63)	(3.26)
	-0.62**	0.95**	-0.60**
Time spent on doing homework	(-0.29)	(0.37)	(-0.25)
			14.27
Frequent use of labs			(2.75)
	24.03		
Enjoy reading	(10.44)		

Notes: All coefficients are significant at the 0.01 level except: * Significant at 0.05 level. ** Not statistically significant.

Table 6
Quantiles Model

(a) Reading	Q10	Q25	Q50	Q75	Q90
Student is female	35.01	31.31	21.15	11.20**	6.45**
Number of sibling in the family	-12.17	-11.04	-12.31	-11.53	-7.51
Mother education level above secondary	13.43**	24.09	27.30	28.46	33.04
Home educational resources	15.29	15.39	13.32	8.31	10.31
School is private	49.93	32.67*	46.00	41.95	48.95
Percentage of girls at school	106.95	65.21	61.84	43.39	43.11*
School is in a large city	35.99	39.63	37.09	37.19	25.09
Student teacher ratio	-3.86	-3.29	-2.35	-1.84	-1.30**
Frequent use of computers at school	17.13*	16.39*	12.79	12.8	7.83**
Frequent use of the Internet at school	-30.70	-16.66*	-17.33	-15.4	-17.87*
Index of teacher morale at school	7.21**	5.47**	10.96	9.33	6.19**
Index of student's sense of bel onging	17.54	12.82	11.46	14.38	10.45
Enjoy reading	13.67	16.79	22.20	24.74	25.96
Constant	310.47	371.99	428.18	484.29	518.92
Pseudo R-square	0.25	0.28	0.31	0.32	0.30
(b) Math	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**
Number of sibling in the family	-14.55	-10.12	-11.12	-8.27	-7.88
Mother education level above secondary	21.80*	25.84	27.79	37.75	42.28
Home educational resources	8.29*	10.37	10.26	8.14	6.34*
School is private	36.97**	60.75	48.31	40.44	20.97**
Percentage of girls at school	51.43**	42.59*	35.46	22.97**	2.98 **

Table 6 (continued)

(b) Math	Q10	Q25	Q50	Q75	Q90
School is in a large city	51.66	39.44	43.76	36.13	23.30
Student teacher ratio	-3.00**	-2.13**	-2.80	-2.19*	-1.65**
Frequent use of computers at school	27.17*	19.65*	11.25**	6.09**	-0.57**
Frequent use of calculators at school	25.56*	30.77	38.54	33.03	37.07
Frequent use of the Internet at school	-13.31**	-10.09**	-18.34**	-6.25**	4.45**
Index of teacher morale at school	15.83	14.01	17.63	14.14	15.59
Index of student's sense of belonging	6.46**	7.66*	9.53	9.32	4.83**
Constant	283.40	331.18	406.42	457.89	508.63
Pseudo R-square	0.22	0.24	0.23	0.23	0.22
(c) Science	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**
Mother education level above secondary	30.10	29.07	28.37	37.03	28.21
Home educational resources	6.74**	10.55	15.45	12.65	11.81
School is private	41.40	31.30	28.94	17.34*	20.02*
School is in a large city	13.49**	26.78	20.25*	19.62	8.50**
Proportion of certified teachers at school	-31.05**	-9.85**	-39.99*	-45.17	-44.67*
Proportion of teacher with degree in Science	17.32**	12.98**	11.41**	19.11**	21.85**
Frequent use of labs	12.83**	4.64**	14.14*	22.40	27.59
Index of teacher morale at school	1.82**	10.01	2.85**	4.02**	0.01**
Frequent use of computers at school	6.29**	- 0.44**	15.07*	6.45**	5.40**
Frequent use of the Internet at school	-3.24**	-8.57**	-15.42**	-8.83**	-4.92**
Index of student's sense of belonging	13.89	12.84	12.86	11.45	12.45
Constant	345.82	379.37	453.12	497.01	547.56
Pseudo R-square	0.19	0.21	0.23	0.27	0.27

Figure 5
Effects of Different Inputs and School Characteristics on Achievement by Performance Quantiles
(Science)

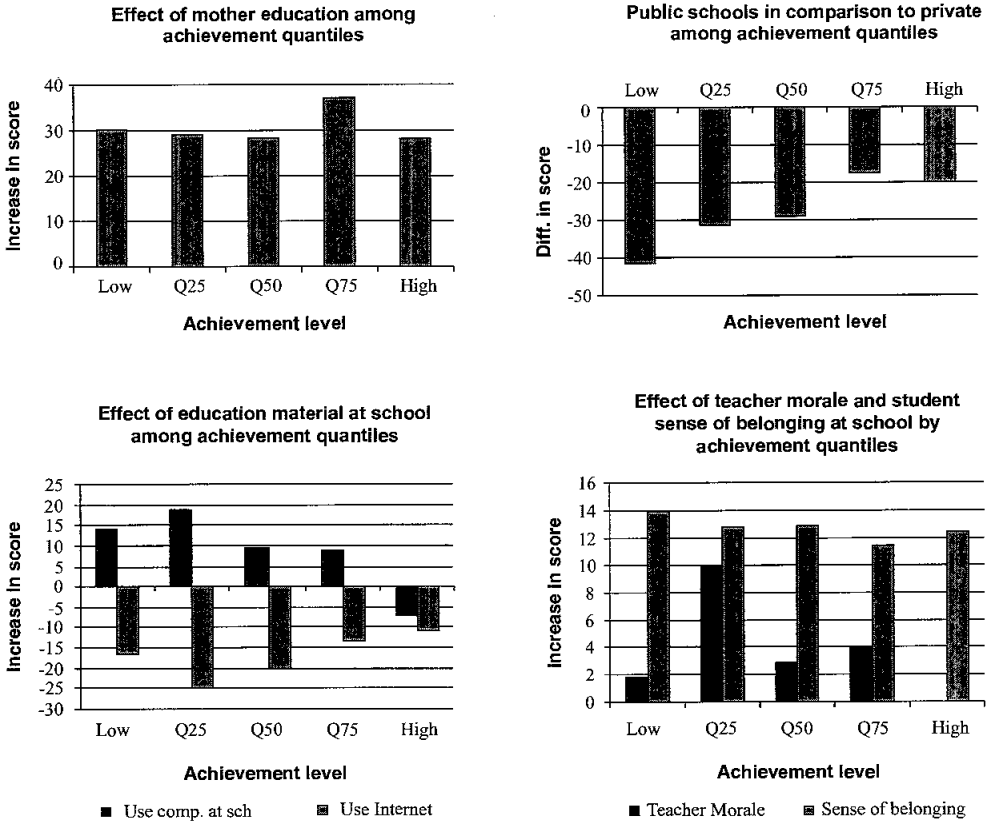
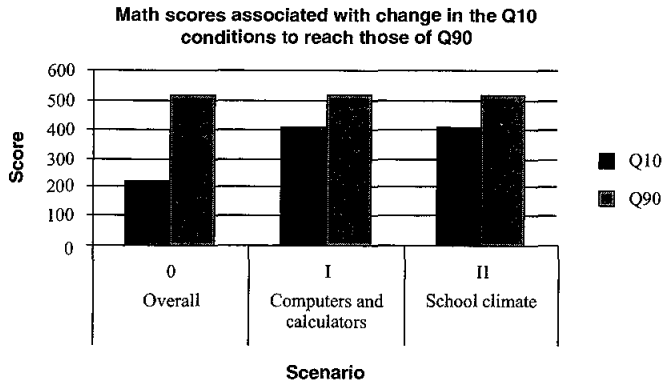
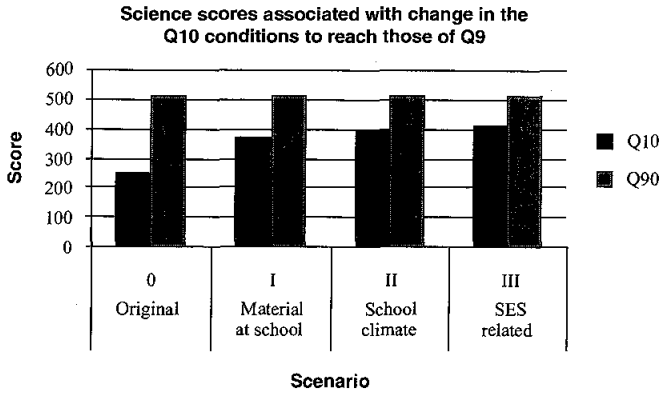


Figure 6
Simulating the Magnitude of Expected Improvement as a Result of Improving Conditions of Low Achiever

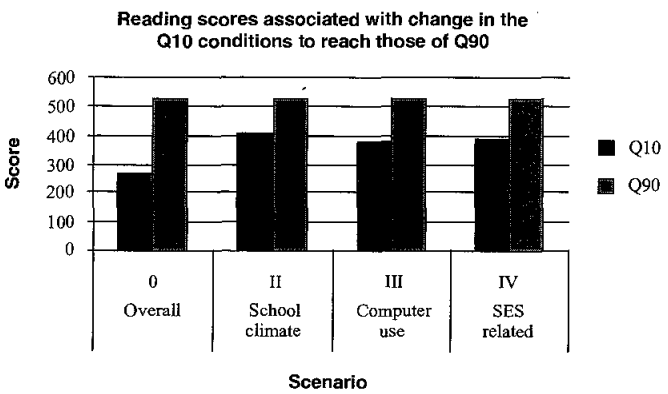


SES related items:
Home educational resources
mother education
location of school



School climate includes:
Proportion of teachers with degree in science
improving teacher morale
Develop students sense of belonging at school

SES related items:
Home educational resources
mother education
location of school



School climate includes:
Student teacher ratio
Developing the joy of reading
Improving teacher morale
Improving the sense of belonging at school

SES related includes:
Home educational resources
Mother education
Number of sibling

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