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# Colombia
# Quality of Education in Colombia

## Achievements and Challenges Ahead: Analysis of the Results of TIMSS 1995–2007

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| COP$1.00 | = | US$0.00 |
| US$1 | = | COP$1,899.98 |

FISCAL YEAR
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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AAA | Advisory and Analytic Activities |
| CEIBAL | *Conectividad Educativa de Informática Básica para el Aprendizaje en Línea*<br>Basic Information Educational Program for Online Learning |
| CONPES | *Consejo Nacional de Política Económica y Social*<br>National Council of Economic and Social Policy |
| DHS | Demographic and Health Survey |
| DNP | *Departamento Nacional de Planeación*<br>National Planning Department |
| ECD | Early Childhood Development |
| EN | *Escuela Nueva* |
| GDP | Gross Domestic Product |
| GoC | Government of Colombia |
| HC | *Hogares Comunitarios de Bienestar Familiar*<br>Community Homes |
| IAEP | International Assessment of Educational Progress |
| ICFES | *Instituto Colombiano para la Evaluación de la Educación*<br>Colombian Institute for the Evaluation of Education |
| ICT | Information and Communication Technology |
| IEA | International Association for the Evaluation of Educational Achievement |
| LAC | Latin America and Caribbean |
| LLECE | *Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación*<br>Latin American Laboratory for the Quality of Education |
| MEN | *Ministerio de Educación Nacional*<br>National Ministry of Education |
| OECD | Organization for Economic Cooperation and Development |
| PACES | *Programa de Ampliación de la Coberatura de Educación Secundaria*<br>Program to Increase Secondary Education Coverage |
| PER | *Programa de Educación Rural*<br>Rural Education Program |
| PIRLS | Progress in International Reading Literacy Study |
| PISA | Program for International Student Assessment |
| PREM | Poverty Reduction and Economic Management Network |

| | |
|---|---|
| SERCE | *Segundo Estudio Regional Comparativo y Explicativo*<br>Second Regional Comparative and Explanatory Study |
| SIMCE | *Sistema de Medición de la Calidad de Educación*<br>Quality of Education Measuring System |
| TIMSS | Trends in International Mathematics and Science Study |

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**TABLE OF CONTENTS**

## FIGURES

## TABLES



## BOXES

**Acknowledgements**

This report was prepared by a team consisting of Raja Bentaouet Kattan (Task Team Leader), Emilio Porta, Mary Bend, Rachel Sorey, Antonella Novali, and Viviana Gonzalez with contributions from Elois Scott, Courtney Melissa Singh, and Kevin Macdonald. Peer reviews for this task were Harry Patrinos (Lead Education Economist, HDNED) and Halsey Rogers (Senior Economist, DECRG).

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# EXECUTIVE SUMMARY

The main objective of this report is to analyze the effect of time changes and factors associated with student achievement in Colombia in order to foster policies to improve education quality that are grounded in research and the Colombian context. In 2007, Colombia participated for the second time in the Trends in International Mathematics and Science Study (TIMSS),[1] providing a first-time opportunity to analyze the effects of time changes on student achievement over a period (1995-2007) during which a number of education reforms were made. Using the TIMSS 2007 results offers a chance to deepen the study on the factors associated with learning in Colombia and to benchmark Colombia's education system against that of other countries. This effort began during the first phase of the Colombia Programmatic Quality and Relevance of Education Analytic and Advisory Activities (AAA),[2] in which an analysis of Colombia's debut in the 2006 Program for International Student Assessment (PISA),[3] resulted in publication of "The Quality of Education in Colombia: An Analysis and Options for a Policy Agenda"[4] report (hereafter, "PISA Report"). The present report builds on this work through an analysis of Colombia's participation in TIMSS 2007 in relation to its performance on TIMSS 1995, and reaffirms the urgent need for improved student learning outcomes in Colombia, further confirming a number of the policy options put forward in the PISA Report to inform a future agenda for system design and reform.

**Colombia has made laudable improvements in educational access and internal efficiency**.[5]

As in many countries in the Latin America and Caribbean (LAC) region, Colombia has made great strides over the past two decades in improving educational access and internal efficiency. In 1985, just 65.5 percent of eligible students were enrolled in primary school; however, in 2008 this figure stood at 90 percent, just short of the regional average (93.5 percent). In addition to increased coverage, more students are surviving to the fifth grade (62.1 percent in 1990 vs. 87.8 percent in 2007) and dropout rates in primary school have decreased from 37 percent in 1998 to 12 percent in 2007. Similarly, primary repetition rates have fallen from 11 percent in 1990 to 3 percent in 2008. These improvements at the primary level have contributed to an upward trend in progression to secondary schooling, which moved from 60 percent in 1985 to 89.6 percent in 2000 before reaching 98.5 percent in 2007. In addition, secondary repetition rates have dropped dramatically from 19.7 percent in 1985 to just 3 percent in 2008. Furthermore, through innovative programs such as those providing ethno-education and flexible models for rural areas,

[1] TIMSS is an international assessment that evaluates the math and science abilities of nationally representative samples of students in the 4th and 8th grades, which is comparable across countries.
[2] The World Bank is currently involved in a multi-year Program of Analytic and Advisory Activities (AAA) to support the Government of Colombia (GoC) in improving the quality and relevance of its education programs and policies. Specifically, the Bank is providing technical expertise and policy advice – informed by analytical work and international experience – to contribute to consensus-building among key actors in Colombia on policy reforms and actions to improve the quality and relevance of education.
[3] PISA is an international assessment that provides a measure of reading, mathematics, and science achievement for a nationally representative sample, comparable across countries. PISA focuses on young people's ability to apply their knowledge and skills to real-life problems and situations, rather than on how much curriculum-based knowledge they possess.
[4] The Quality of Education in Colombia: An Analysis and Options for a Policy Agenda, World Bank 2008.
[5] Internal efficiency refers to survival rates, repetition rates, and dropout rates.

greater equity has been achieved in many underserved areas and the country has improved its internal efficiency.

**Despite these significant achievements, inequities remain and improvements in educational quality are an urgent challenge**.

Colombia's performance on international assessments,[6] an important measure of quality, indicates that improvements in educational quality and relevance are needed. Although many students advance to secondary school, the graduation rate is low. In addition to the high cost of education and the opportunity cost of not working, the low quality and relevance of learning has been cited as a reason for secondary students failing to graduate. Furthermore, pronounced differences in enrollment, attainment, and completion exist between poorer and wealthier departments and between rural and urban areas. Colombia is now tasked with improving educational quality and equity and increasing secondary completion rates. Improving educational quality, a critical step for human capital development and economic growth, will become even more important as secondary enrollment increases and more students who are less well-prepared enter the system.

***International Evidence***

Student factors such as income and parents' education are consistently shown to be correlated with student achievement. However, research on the factors associated with learning internationally shows that while student background plays an important role in student achievement, school and institutional factors are also correlated with student learning. Teacher quality is increasingly cited as the key ingredient to student performance, though the characteristics of good teachers are difficult to describe. At the school level, curriculum and pedagogy, sufficient resources, and time spent on learning and studying are also noted as important correlates of learning. Recent research has highlighted the importance of institutional factors for student achievement. Such factors include school autonomy over pedagogy, school resources and personnel decisions, centralized assessments and exit examinations, accountability systems that publicly disseminate performance data and enforce consequences, and competition from private institutions.

***Colombia Evidence***

Literature on the factors associated with learning in Colombia corroborates many findings internationally and sheds additional light on the Colombian context. Student characteristics, such as income and parents' education, are important to student learning in Colombia, and may be particularly influential in literacy development and in determining which schools students attend. Factors pertaining to student access to schooling, such as absenteeism, commuting distance, and child labor, as well as students' continuity at a school are also relevant to student achievement. At the school level, teacher quality, academic infrastructure and materials, and the length of the school day all have a positive impact on student learning. From an institutional standpoint, private schools and concession schools tend to outperform public schools, which some studies

[6] Colombia has participated in the 1995 and 2007 Trends in International Mathematics and Science Study (TIMSS); 1997 and 2006 *en el Primer y Segundo Estudio Regional Comparativo y Explicativo* (PERCE y SERCE); 2001 Progress in International Reading Literacy Study (PIRLS); and 2006 and 2009 Programme for International Student Assessment (PISA). (Source: World Bank 2008).

attribute to the differences in autonomy and incentives between public schools and private and concession schools, though it is also important to consider such unobservable factors as differences in student selection policies.

***PISA 2006 Analysis***

Colombia's debut participation in PISA 2006 provided the country with an important first-time opportunity to evaluate the quality of its education system through international benchmarking and to use the results to inform policy making. The PISA Report presented a comprehensive literature review and new analytical work within the conceptual framework of a recent World Bank study by Vegas and Petrow (2008)[7] on the factors associated with student learning,[8] and showed Colombia's performance to be low, falling short of its potential relative to its income level. The analysis of the distribution of Colombian test scores across PISA proficiency segments in mathematics, an important measure of general aptitude to solve problems, revealed that a majority of the country's students were not reaching the most basic proficiency levels.[9] These findings constitute an urgent call to action for Colombian policymakers.

***TIMSS 2007 Analysis***

Colombia's participation in TIMSS 1995 and 2007 provides a first-time opportunity for analysis of *time changes* in the factors associated with learning outcomes in Colombia. As such, the analysis presented in this report provides new analytical work on the predictors of student learning over time in Colombia, with a particular focus on mathematics achievement among eighth grade students in 2007. Furthermore, it offers an opportunity to build on the PISA Report by providing a broader set of student, school, and institutional variables through which to further analyze factors associated with academic achievement among students of roughly the same age (PISA studies 15 year-olds and TIMSS studies eighth grade students[10]).[11] The TIMSS analysis

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[7] Vegas, Emiliana and Jenny Petrow. 2008. *Raising Student Achievement in Latin America: The Challenge for the 21st Century*. Latin American Development Froum. Washington, D.C.: World Bank.

[8] In PISA 2006: Student factors including parents' attainment of university studies and the number of books and presence of computers in the home were found to be positively and significantly correlated with mathematics achievement. Student enrollment in grades 9, 10, and 11 was associated with a substantial, significant, positive effect that increased with each successive grade. Girls performed substantially and significantly worse than boys in mathematics. At the school level, the percentage of certified teachers was found to be strongly, significantly correlated with higher achievement, while the number of hours that students spent studying mathematics correlated moderately with higher math scores. Private schools performed considerably better than public schools, as did schools located in urban areas relative to their rural counterparts. The use of achievement data to evaluate teachers and school directors was the one institutional variable of the four variables studied with a significant (positive) correlation with achievement, albeit a modest one. The other institutional variables, which pertained to schools competing for students, determining pedagogy, and being authorized to fire teachers, showed no significant correlation with student achievement.

[9] While the average among OECD countries shows a roughly normal distribution across these segments with 10 percent performing Below Level 1 and 10 percent collectively performing at the highest levels, analysis demonstrated that Colombia's performance is heavily skewed toward the lower proficiency segments; nearly three quarters of Colombian students perform at Level 1 and Below Level 1 in mathematics, and less than one percent performs at Levels 5 and 6. Furthermore, an alarming proportion of Colombian students (45%) fall into the Below Level 1 segment, which calls into question their ability to perform effectively in the labor market or at upper education levels. [PISA defines six international benchmarks (Levels 1-6), as well as an additional proficiency segment - Below Level 1 – which represents an inability to answer even the most basic questions].

[10] While TIMSS also evaluates 4th grade students, Colombia's 4th graders did not participate in TIMSS 1995. Accordingly, and because this report seeks to further analysis conducted in the PISA Report, only 8th grade math results are evaluated.

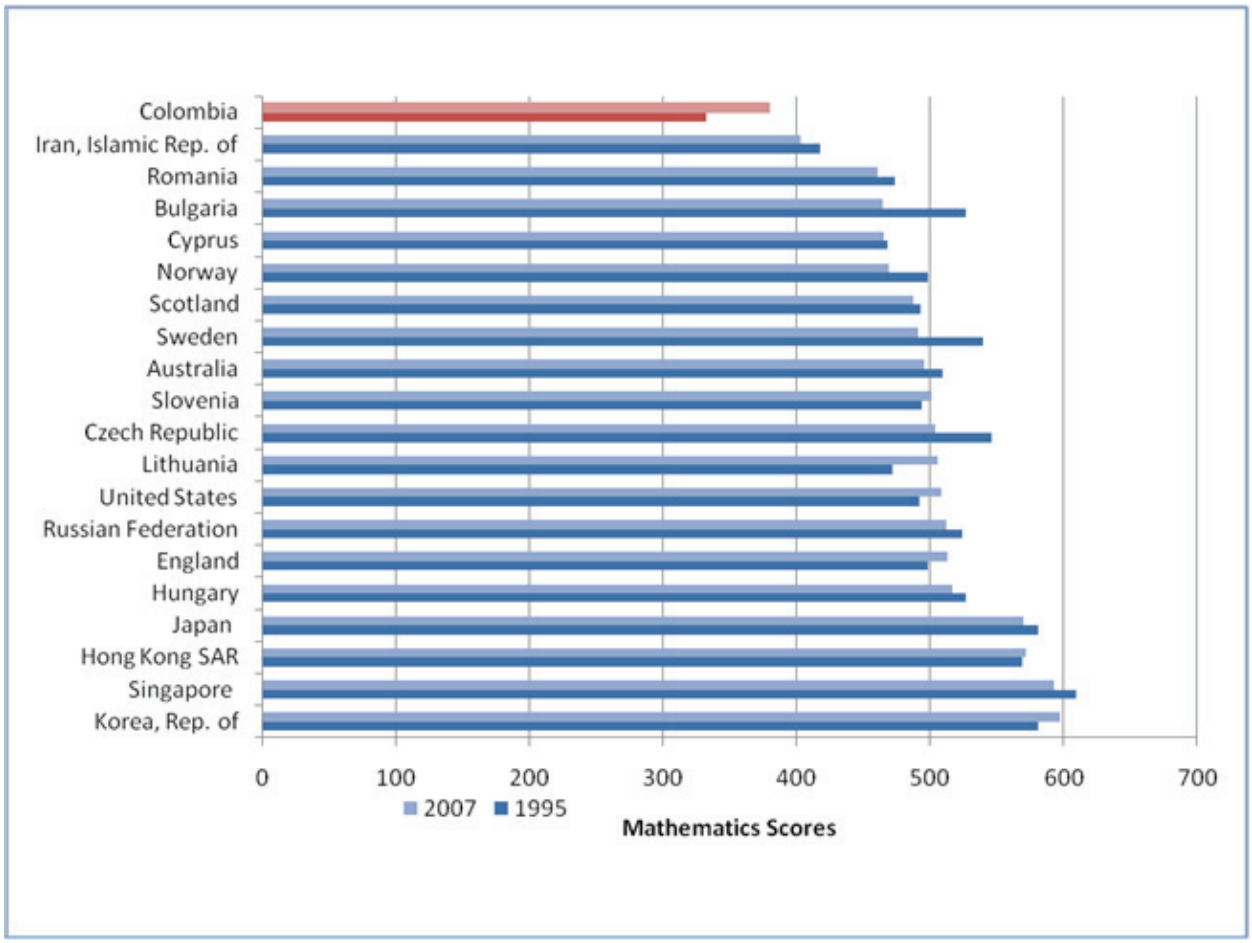
confirms the results of the PISA Report, thus adding to the current knowledge base and advancing new research on the factors associated with learning in Colombia.

**Over the 1995-2007 period, Colombia made greater gains in eighth grade mathematics than any other country participating in TIMSS.**

Between 1995 and 2007, Colombia made greater gains (47 scale score points)[12] on the mathematics portion of TIMSS than any other country participating at the eighth grade level. These gains appear to be the result of Colombia's success in decreasing repetition and dropout rates, while at the same time expanding educational access to lower income families.[13] In total, only six countries,[14] approximately one fourth of those taking the TIMSS in both years, showed improvement in their scores.

[11] While the analysis conducted in both reports is not causal, the estimation method applied allows for a close approximation of the degree and direction of association between two variables.
[12] This improvement was significantly better than their 1995 score.
[13] These findings align with those of recent PREM work presented by Marcelo Guigale in September 2009 on the occasion of Colombia Education Minister Cecilia Valdez White's visit to World Bank headquarters in Washington, D.C. to discuss reform efforts and achievement during her 8-year tenure.
[14] In order according to change in score between 1995 and 2007: Colombia (47 points), Lithuania (34 points), Korea (17 points), United States (16 points), England (16 points), and Slovenia (7 points).

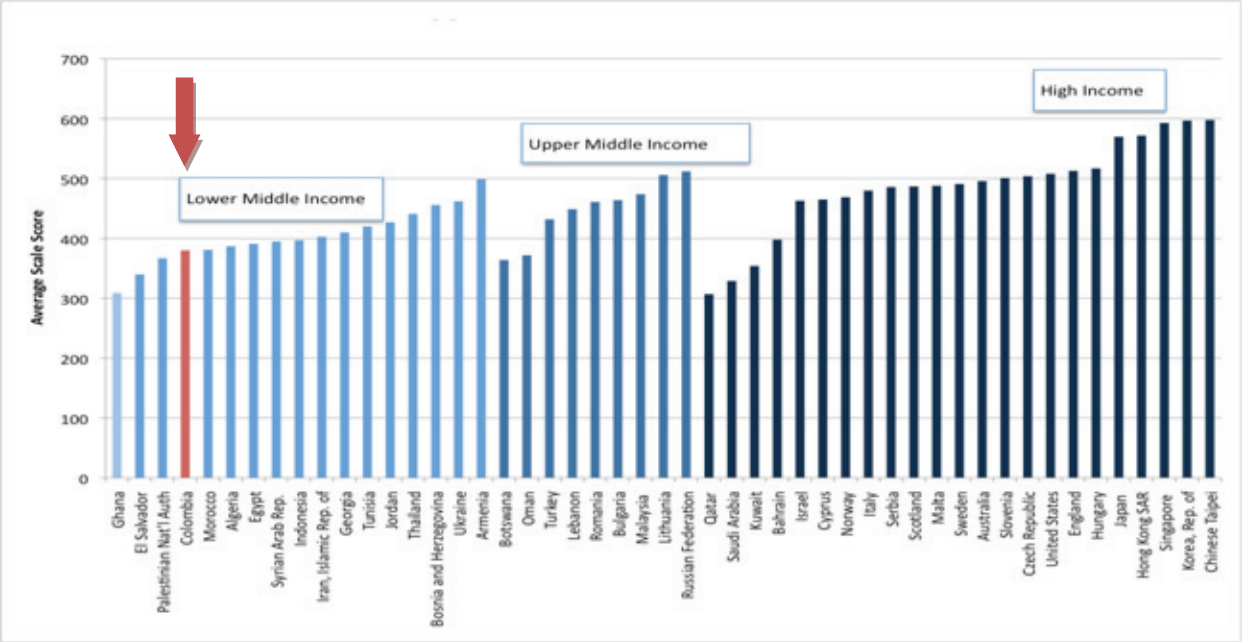
**Figure 1: TIMSS Mathematics Scores 1995 vs. 2007**




**However, analysis of the country's TIMSS 2007 performance shows Colombian student achievement to be low and fall short of its potential relative to its income level**.

Colombia's performance was lower than 37 and higher than 7 participating countries, with its average scale score (380) placing it 120 points below the mean and 218 below that of the top performing country (Chinese Taipei).

**Figure 2: Mean Mathematics Scores, TIMSS 2007, all countries**



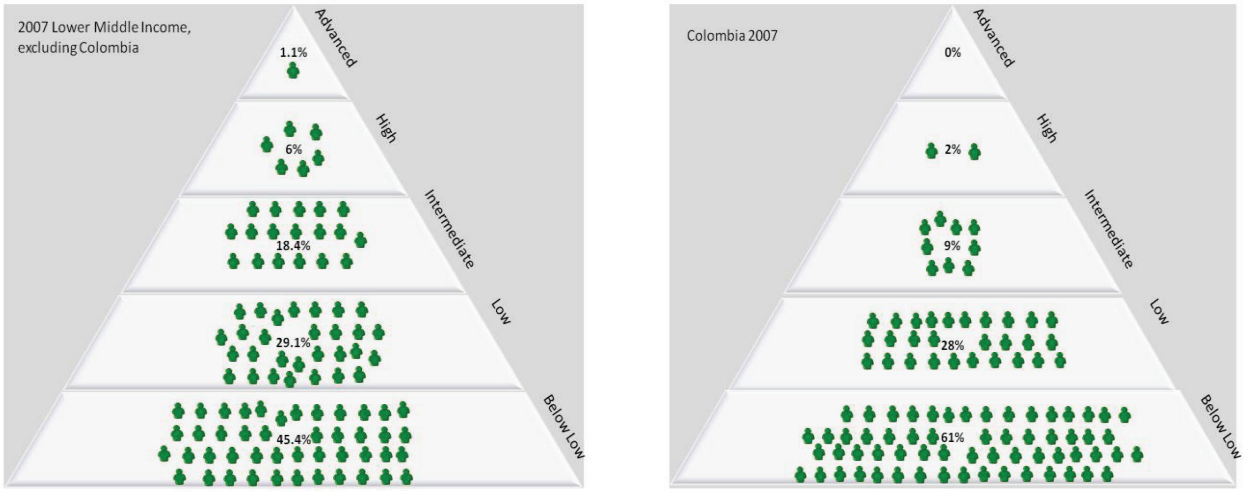

Given that national income per capita tends to correlate with performance and that Colombia was one of fifteen lower middle-income countries[15] to participate in TIMSS 2007 (and only one of two countries in LAC, both of which are lower-middle income), that Colombia had the third-lowest average score[16] among its economic peers is particularly surprising.

[15] A total of 15 Lower Middle-Income Countries (as defined by the World Bank in 2007) participated in the TIMSS 2007 eighth grade Math assessment: Algeria, Armenia, Bosnia and Herzegovina, Colombia, Egypt, El Salvador, Georgia, Indonesia, Iran (Islamic Rep.), Jordan, Palestinian Nat'l Authority (also known as: West Bank and Gaza), Syrian Arab Republic, Thailand, Tunisia, and Ukraine. [In current World Bank development practice, economies are divided according to 2008 GNI per capita, calculated using the World Bank Atlas method.] The groups are: low income, $975 or less; lower middle income, $976 - $3,855; upper middle income, $3,856 - $11,905; and high income, $11,906 or more.

[16] El Salvador, the only other LAC country to participate in TIMSS 2007, had the lowest score (340). Palestinian National Authority (also known as: West Bank and Gaza) had the second-lowest score (367).

Furthermore, no Colombian eighth graders performed at the Advanced Benchmark,[17] only 2 percent performed at the High Intermediate Benchmark and, cumulatively, 39 percent performed at least at the Low Benchmark. Furthermore, an alarming proportion (61 percent) of eighth graders did not reach the Low Benchmark, which calls into question their ability to perform effectively at upper education levels and/or in the labor market. (See Figure 3 below.)

**Figure 3: Comparative Distribution of test scores in 8th Grade Math by Proficiency level, Colombia (Right) and all TIMSS 2007 lower-middle income participants (Left)**




**Based on analysis of Colombia's TIMSS 2007 mathematics, it appears that a number of factors are related to student performance in Colombia**.

At the student level, gender (female) and age[18] are significantly negatively correlated with test scores; and mother's level of education and the availability of learning materials at home are significantly positively related to student achievement. At the school level, lack of school safety[19] is significantly negatively correlated with test scores; and having a female math teacher and a teacher with high expectations are significantly positively related to student achievement. Also, while having a teacher whose major area of study was math showed a significantly positive relationship with student performance; the interaction between this and other variables[20] reveals that the relationship is no longer significant. Finally, parental support for student achievement and parental participation in school activities were two of the three institutional variables studied with a significantly positive correlation with achievement; however, after accounting for interaction with other variables, the relationship is not found to be significant.

[17] TIMSS defines five international benchmarks, from lowest to highest: Advanced (625 points), High (550 points), Intermediate (475 points), Low (400 points) and Below Low – meaning that students are unable to answer even the most basic questions – (< 400 points).
[18] The older a student is, the less likely he/she is to perform well.
[19] As measured by bullying incidences during the last month.
[20] A production function is constructed for Colombia using those student, school and institutional variables found to have a significant correlation (either negative or positive) with 8th grade scores on TIMSS 2007.

In order to validate these findings, a similar analysis applied to four economic peers of Colombia confirmed that the only variables that show the same outcome for Colombia and the group analyzed are: lack of school safety (significantly negative), age of student (significantly negative), 26-200 books at home (significantly positive), and computer available at home (significantly positive).[21] When the analysis is applied to another comparator group of three higher scoring countries, Korea - chosen for its outstanding performance and relatively higher GDP, Hungary - chosen for its higher than expected score given its level of GDP, and Jordan – chosen because it has a similar GDP to Colombia and yet scores higher than Colombia, the greater presence of learning materials (books and computers) at home, and higher average education levels among mothers in the higher scoring comparator group appear to be the most important factors in explaining the difference in average scores on TIMSS.[22]

These TIMSS findings further confirm a number of the results presented in the PISA Report including the importance of students having materials at home for learning (books and computers) and a mother with a university-level education. Both analyses also show that Colombian girls score lower on international assessments than do boys. Finally, in TIMSS 2007 the proportion of teachers having math as a major area of study was related with higher achievement, which is similar to PISA 2006 findings that the percentage of certified teachers was strongly, significantly correlated with higher achievement. In addition, factors not studied in PISA (teacher expectations of students, teacher gender, teacher's level of job satisfaction, professional development opportunities for teachers, the presence of computers, textbooks, and calculators in school, class time spent in lectures and learning math, socioeconomic make up of schools' student populations, and presence – or lack of - school safety[23]) are analyzed within this report, thus broadening current research on the factors associated with learning in Colombia based on analysis of the country's participation in international assessments.

**Colombia has rightly prioritized education quality in its national reforms and planning efforts. Its culture of educational innovation and evaluation provides a strong foundation for improvement**.

***National Reforms and Planning Efforts***. Colombia has recognized the need to improve educational quality and has put it at the center of its education policy. The four strategies that comprise this policy include: (i) strengthening the education quality assurance system at all levels; (ii) providing professional development for teachers and school directors; (iii) implementing programs to develop competencies; and (iv) fostering policy and program evaluation. These strategies feature prominently in Colombia's national education planning. Its National Development Plan aims to undertake comparable multi-year academic assessments and use the results to improve the performance of students, teachers, and schools. The National

[21] A production function equivalent to that applied to Colombia - with one exception: public vs. private schooling was not considered due to country context differences - is applied to the four comparator lower middle income countries (El Salvador, Bosnia and Herzegovina, Tunisia, and Jordan).

[22] A production function equivalent to that applied to Colombia - with one exception: public vs. private schooling was not considered due to country context differences - is applied to the three higher scoring comparator countries (Korea, Hungary and Jordan).

[23] Presence – or lack of – school safety is measured qualitatively through teacher perceptions and quantitatively through the number of bullying incidents taking place between students over the past month (prior to administration of TIMSS).

Education Plan further develops the national strategy for improving the quality of education by: (i) establishing standards for basic competency in language, mathematics, social and natural sciences, and citizenship; (ii) evaluating students, teachers, and administrators and disseminating the results; and (iii) improving school quality, including the establishment of a process for quality certification. Colombia has engaged the public in the development of a ten-year plan to address these and other issues critical to education through its most recent *Plan Nacional Decenal de Educación.*

***Innovative Policies and Programs***. Colombia has a demonstrated track record of educational innovation and evaluation, especially targeted to disadvantaged students, upon which it has built successive education reforms. At the student level, an early childhood development program, *Hogares Comunitarios de Bienestar Familiar* (HC), has been shown to improve enrollment and promotion in later grades, and a conditional cash transfer program, *Familias en Acción*, has also been shown to improve enrollment. HC is part of a larger national early childhood policy, which by law seeks to foster integrated care, education, nutrition, and health services for children under five years old. Furthermore, Colombia has recently instituted important reforms in its teacher policy, which require new teachers to demonstrate adequate performance in order to advance and continue in the profession. At the school level, Colombia's world-renowned and internationally replicated *Escuela Nueva* (EN) program has improved student achievement in rural areas by enabling students to progress through a flexible curriculum, by engaging them with active pedagogy supported by teacher training, and by adapting to local needs through democratic decision-making and community engagement. EN now comprises one of nine flexible education models that rural schools can choose to implement under the *Programa de Educación Rural* (PER I and PER II). In addition, based on the successful *Programa de Ampliación de la Cobertura de Educación Secundaria* (PACES) program, which enabled low-income students to attend private schools through vouchers and improved student achievement, Colombia has implemented a strategy of subsidizing private schools to serve low-income students. The country has moved progressively toward the decentralization of education service provision, in particular by endowing sub-national governments with the responsibility for ensuring enrollment and funding them accordingly. It has also enabled sub-national governments to grant schools more autonomy while instilling accountability for performance through contracting arrangements, the most well-known example of which is the Bogotá *Concesiones* Program, a strategy that has spread to other parts of the country.

Given the large time span between assessments, it would be difficult to attribute gains to specific policies. More regular and frequent participation in international assessments would allow Colombia to better understand not only the factors associated with learning in the country, but also the impact that innovative policy reforms have had.

**Colombia would benefit from adopting policies to improve student learning by setting ambitious standards for all actors, strengthening the overall system, and targeting critical gaps**.

International research has increasingly shown that educational quality, more than quantity, has a causal impact on economic growth. While Colombia's economic growth has improved in recent

years, Colombia needs to increase educational quality and equity for that growth to be sustainable and to benefit the population broadly.

***Reducing the proportion of students at the bottom proficiency levels of international assessments has to be the number one priority of education policymakers in Colombia***. In order for Colombia to achieve sustainable and equitable economic growth, it needs to improve learning outcomes among all students, but particularly among the significant proportion of its population that does not achieve minimum levels of performance. Based on the analysis of TIMSS results presented in this report, which confirms and further supplements that provided in the PISA Report, analysis of Colombia's participation in international assessments reaffirms the importance of (i) continuing participation in and learning from international and national assessments; (ii) enabling disadvantaged populations to achieve high standards; and (iii) systematically enhancing the quality and accountability assurance system.

***Continue participation in and learning from assessments***. The regular and systemic use of accurate assessment data provides a strong foundation for educational quality by enabling system benchmarking, informing decision-making at all levels, and galvanizing public involvement and support. Colombia could use its participation in international assessments (including TIMSS and PISA) to benchmark the performance of its education system against international standards and to adapt policies so as to progress toward the achievement of those standards. In particular, it might consider setting performance targets for future rounds of assessments as part of its National Education Plan. By participating in each future application of TIMSS and PISA, Colombia could build a data set that allows for closer evaluation of the effect of time changes on student learning. In addition, by ensuring that key programs (such as *Escuela Nueva* and other innovative education programs) are included in Colombia's country-specific background questionnaires for the TIMSS and PISA, data could be gathered and used to analyze the effects of particular policies and/or programs. Colombia can learn from the experience of high performing middle income countries that have used international assessments and other benchmarking tools to achieve impressive gains.

In addition, assessment data could be broadly and consistently disseminated publicly and used at all levels to enable participants to contribute more fully in the school improvement process. Information from assessments can be used to identify where schools and regions are failing and to target policies and programs that improve teaching and administrative practices and support low achieving students. Parents can use assessment data to monitor their children's learning and help their local schools improve. Colombia could also consider using assessment results to engage the public and mobilize support for education, as it has done with the *Plan Decenal*. These policy options rest on the strength of the national assessment system itself, which Colombia has taken important steps to develop and improve, and should continue to advance.[24]

[24] In 2009, Colombia's Congress passed Law 1324 which supports the institutional transformation of its national assessment institute (ICFES) from a public entity focused primarily on assessment and the reporting of results, into an *empresa estatal de carácter social.* As such, ICFES will play a larger role in evaluating primary and secondary schooling to improve education quality in Colombia, while at the same time gaining administrative autonomy from MEN and gaining the ability to conduct work on a commercial basis at the local and international levels. This transformation, which is taking place within the sector's ongoing decentralization, provides an excellent opportunity for ICFES to improve its ability to design, conduct, analyze, and disseminate the results of national assessments and other forms of evaluation, and to promote a culture of evaluation and results-based learning throughout the sector. In

***Enable disadvantaged populations to achieve high standards***. Colombia faces a systemic problem in providing a quality education to certain populations, which the country must rectify through carefully targeted and continuously evaluated policies and programs. It is important that Colombia continue to implement, evaluate, refine, and expand programs proven to improve school readiness through improvements in the coordinated delivery of high-quality early childhood development (ECD) services (which Colombia has recently taken important steps towards with The National Policy for Early Childhood Development, "*Colombia por la Primera Infancia,*" presented in CONPES 109 and the 2009 ECD policy "*Política Educativa para la Primera Infancia*") and to increase enrollment, advancement, and achievement among poor, rural, and ethnic minority students, as well as those affected by violence (as it is doing in programs such as EN, *Concesiones*, PER I and PER II, PACES, and *Familias en Acción*). In relation to this, Colombia should seek to provide increased opportunities for all students to access ICT and other learning materials. It is also important that Colombia identify the source(s) of academic disparities between girls and boys and expand appropriate and effective strategies to reduce performance gaps between genders. Colombia could learn from the experience of other countries in addressing the needs of disadvantaged students and the teachers and schools that serve them.

***Systematically enhance the quality and accountability assurance system***. While Colombia possesses elements of an accountability system, it needs to strengthen them by aligning authority and capacity with responsibility for performance at each level of the system. Using results from assessments to set targets could be a helpful component of these systems. At the student level, Colombia might consider establishing "high stakes" examinations (such as exit exams) and evaluate their impact on student learning. At the school level, Colombia could establish and enforce standards for school performance, for example, through a quality certification process as outlined in the National Education Plan. School improvement programs providing support for teachers and disadvantaged or low-achieving schools could be highly beneficial as well. Furthermore, while a teacher evaluation system has already been established, the system could be further strengthened. Finally, parents and community members might be granted a greater voice and degree of authority in the school improvement process.

response, ICFES has clarified its organizational mission as being that of an evaluation agency that not only administers tests but also has overall responsibility for education quality evaluation. ICFES has requested the World Bank's technical and financial assistance on activities related to its institutional strengthening, and the World Bank through the AAA has been providing Technical Assistance in this regard.

# CHAPTER 1: BACKGROUND

## *Section 1: Sector Trends*

1.1 Until the current global economic downturn, Colombia's economy grew at its fastest pace in over a decade. In 2007, real GDP-growth reached a solid 8 percent, outperforming the regional average of 6 percent. In the face of the current crisis, Colombia is proving itself to be one of the region's most resilient economies; its GDP growth during the first half of 2009 was third only to that of Argentina and Peru.[25]

1.2 As in many countries in the Latin America and Caribbean (LAC) region, Colombia has made great strides over the past two decades in improving educational access and internal efficiency. These improvements contributed to narrowing the gap between its net primary enrollment and the Latin America and Caribbean average, and helped the country progress from a low base of primary school completion in 1989 to surpassing the regional average in 2005. By 2007, Colombian children were 10 percentage points more likely to complete primary school than the average Latin American child.[26]

1.3 Despite these significant achievements, pronounced disparities between Colombia's regions persist, with poorer departments exhibiting lower average enrollment rates than wealthier departments. In addition, as evidenced by Colombia's participation in several regional and international assessments[27] and subsequent low results, improving the quality of education is an urgent challenge.

1.4 Over the past two decades, Colombia has taken important steps toward assessing student performance by participating in a series of international studies in order to benchmark the quality and equity of its education system against that of other countries and to assess the strengths and weaknesses of its system. Colombia has participated in TIMSS (1995 and 2007), the *Primero Estudio Internacional Comparativo* (1997), Progress in International Reading Literacy Study – PIRLS (2001), the *Segundo Estudio Regional Comparativo y Explicativo* - SERCE (2004), and PISA (2006). With the exception of the regional assessments,[28] Colombia has performed well below the participant mean in all international assessments. (See Annex 1 for a Table outlining Colombia's results on international assessments).

[25] Source: DNP September 24, 2009.
[26] Source: EdStats, World Bank. Accessed on September 30, 2009.
[27] Colombia has participated in the: 1995 and 2007 Trends in International Mathematics and Science Study (TIMSS); *1997 Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación (LLECE);* 2001 Progress in International Reading Literacy Study (PIRLS); *2004 Segundo Estudio Regional Comparativo y Explicativo* (SERCE); and 2006 Programme for International Student Assessment (PISA). (Source: World Bank 2008).
[28] In SERCE: Colombia scored at the regional mean for 3rd and 6th grade Math, and above the regional mean for 3rd and 6th grade Language. In the *Primero Estudio Internacional Comparativo:* Colombia scored below the 3rd grade regional mean and above the 4th grade regional mean in all subjects tested.

***Section 2: Planning and reform efforts***

1.5 Colombia's current planning efforts at the national level are strongly focused on educational quality and the strategies that contribute to it. The National Development Plan aims to undertake comparable multi-year academic assessments and use the results to improve the quality of teaching, student learning, and schools. The National Education Plan establishes the key goals of universal coverage, increased efficiency, and improved quality and articulates a national strategy for improving educational quality by: (i) establishing standards for basic competency in language, mathematics, social and natural sciences, and citizenship; (ii) evaluating students, teachers, and administrators and disseminating the results; and (iii) improving school quality. To galvanize support for its reforms, the MEN has used the *Plan Nacional Decenal de Educación* as a means of engaging the public in setting the nation's education priorities for the ten-year periods of 1996-2005 and 2006-2015. (See Annex 2 for a detailed description of the latest *Plan Decenal*).

1.6 Through these plans, Colombia has been working to address a number of priorities by establishing an overarching framework for quality assurance, increasing the relevance of and access to education, and implementing improvement efforts at all levels through: programs targeting students and families to enhance student competencies and improve student outcomes, professional development for teachers and school directors, school-based instructional and organizational interventions, and system reform efforts aimed at creating an environment conducive to student and school improvement. Since 2002, Colombia has been developing basic competency standards, monitoring, analyzing and using evaluation data for student and teacher performance, fostering school quality through the use of self-evaluation, improvement plans and a certification process, and strengthening sub-national agencies to support schools' improvement efforts, especially schools that are performing below expectations.

1.7 Furthermore, the MEN has engaged in specific efforts to increase enrollment and retention among students who have been forcibly displaced by violence. The recent increase in enrollment among these students is partly attributable to their participation in flexible education models, such as *Aceleración de Aprendizaje* and *Círculos de Aprendizaje*, which respond to specific needs and characteristics such as being over-age for their grade. Strategies aimed at improving retention among these students include: (i) education and nutrition subsidies delivered in coordination with the *Familias en Acción* program; (ii) preferential access among displaced families to social protection through *Juntos*, the Network for Overcoming Extreme Poverty; (iii) orienting local education entities in the use of resources allocated to school feeding programs; (iv) promotion and approval of projects that are investing resources from cooperatives and mutual associations in programs aimed at improving access and retention among displaced students; and (v) since 2008, the provision of resources to local education entities to offer displaced students a free education at state educational institutions.

1.8 Colombia has also implemented school-based programs, particularly in rural areas, which aim to improve schools' capacities and outcomes through relevant curriculum, engaging pedagogy, and professional development to support classroom teaching. Most notably, its *Programa de Educación Rural* (PER I and PER II) has provided rural schools with an

opportunity to choose from among nine flexible educational models[29] aimed at improving academic access, relevance, and achievement in rural areas. One of these interventions includes the internationally-renowned *Escuela Nueva*, created in the mid 1970s and greatly expanded in the 1990s.

1.9 Important efforts to improve teacher quality through evaluation and professional development have also been carried out in recent years. In June 2002, the government approved a new rating system and salary scale for teachers, which accounts for teachers' responsibilities and performance and evaluates teachers through three basic examinations at different stages of the teaching career. Furthermore, it established a system of professional development that: (i) develops teachers' basic competencies and establishes plans for their improvement; (ii) fosters their use of information and communication technologies; (iii) establishes a cadre of ethno-educators; and (iv) assures the quality of the higher education institutions that provide teacher training. In addition, teachers working with students displaced by violence are given pedagogical tools that enable them to adapt their teaching to the challenges that such students face. Furthermore, Colombia has engaged in important system-level reforms over the last few decades to devolve authority and responsibility for education provision to the local level and to foster accountability for student and school performance.

1.10 Finally, Colombia has also taken important steps toward assessing student performance through standardized testing as a tool to improve education at the school, regional, and national levels. In 1991, the MEN began administering national achievement tests, known as SABER. Tests were administered in 1991, 1992, 1993, 1994, 1997, 1998, and 1999 to nationally representative samples of students in grades 3, 5, 7, and 9, which comprise two grades in primary and two in lower secondary. In 2002 and 2003, the MEN began administering SABER to all students in grades 5 and 9, corresponding to the end of primary and lower secondary and thus complementing the *Examen de Estado para el Ingreso a la Educación Superior* (*Examen de Estado*) administered at the end of upper secondary. The SABER tests have assessed language and mathematics since 1991; natural sciences and citizenship competencies were added in 2002 and 2003, and social sciences in 2005. SABER is not "high stakes," but rather is intended to generate performance data to inform decision-making and educational policy. The *Instituto Colombiano para la Evaluación de la Educación* (ICFES), which administers these tests, also produces statistical reports on the *Examen de Estado* for all departments, results of which are posted for public access on its website, and disseminates test results for SABER via the MEN's publically available website. ICFES' recent transformation will foster semi-autonomous operational capacity, increased financing, and the ability to provide improved educational assessment services.[30]

***Section 3: Overview of TIMSS***

1.11 The Trends in International Mathematics and Science Study (TIMSS) is a cross-national comparative study developed through the auspices of the International Association for the

[29] This includes *Escuela Nueva* and other flexible curriculum models for rural education and indigenous communities.
[30] ICFES and the Colombian government are receiving World Bank support in this effort.

Evaluation of Educational Achievement[31] (IEA) to assess the mathematics and science knowledge and skills of fourth- and eighth-graders. TIMSS is designed to align broadly with mathematics and science curricula in the participating countries. The results, therefore, suggest the degree to which students have learned mathematics and science concepts and skills likely to be taught in school. TIMSS also collects background information on students, teachers, and schools to allow cross-national comparison of educational contexts that may be related to student achievement.

1.12 More than 60 countries, including Colombia, participated in TIMSS 2007, which was the fourth application of TIMSS carried out since 1995. The TIMSS math assessment is designed along two dimensions: the mathematical topics or content (*Content Domains*) that students are expected to learn and the cognitive skills (*Cognitive Domains*) students are expected to have developed. For TIMSS 2007, the eighth grade Content Domains[32] were *Number, Algebra,* and *Geometry* and the Cognitive Domains were *Knowing*, *Applying*, and *Reasoning*. The proportion of items devoted to a domain reflects the contribution of the domain to the overall mathematics scale score of each country. In scoring TIMSS 2007, more than half the eighth grade math items (117) were multiple-choice and the remainder (98) were constructed response; however, more than half (51 percent) of the score points came from constructed response items. Also, while most questions received 1-point for a correct response, some questions requiring more elaborate responses were scored as 2-points, with partial credit being given for partly correct answers.

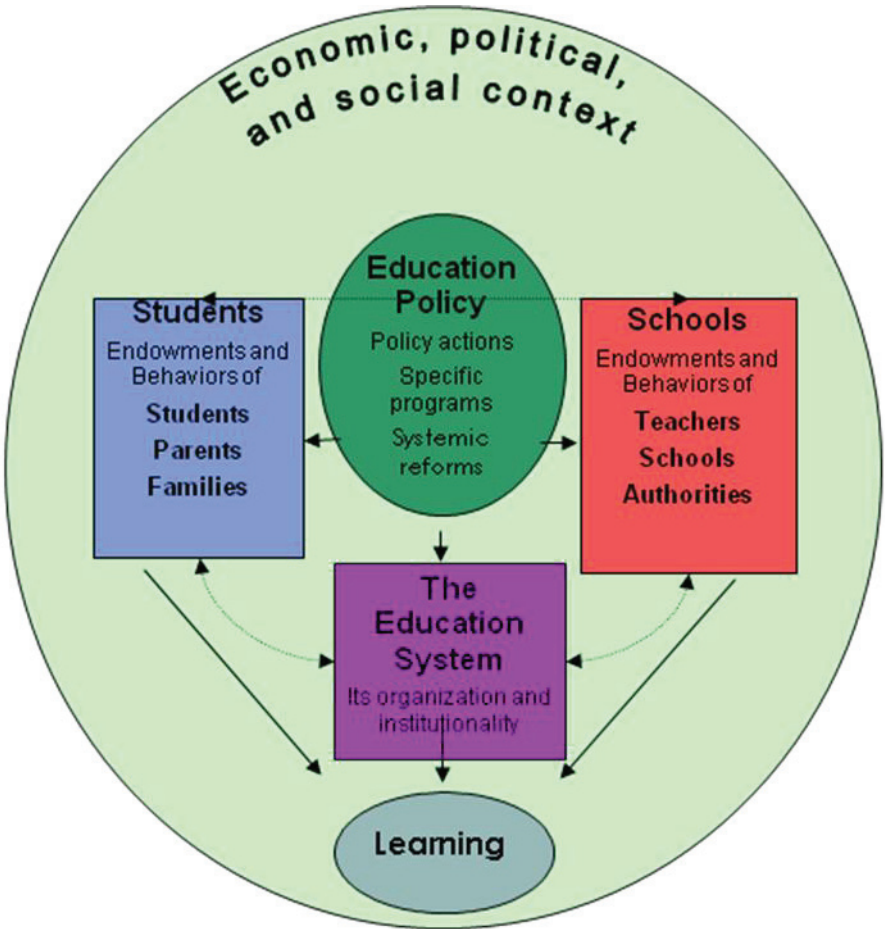
1.13 In addition to the math assessment, TIMSS 2007 applied a background questionnaire to teachers for the first time in order to gather information about their education, experience, training, hours of class time, perceptions on tutoring, and their students' past performance (including time spent on homework). This background questionnaire, in addition to others,[33] provides valuable information that can be used to gain further insight on factors related to student learning in Colombia. (See Annex 3 for a list of the countries participating in the TIMSS math assessment between 1995 and 2007, Annex 4 for more detailed information on TIMSS 2007, and Annex 8 for more information on student, family, school, and institutional factors).

***Section 4: Conceptual Framework***

1.14 This report applies the conceptual framework developed in a recent World Bank study on education quality in Latin America (Vegas and Petrow, 2008) to the Colombian context. Vegas and Petrow summarize the factors and policies that affect student learning in the region and approach the problem of raising student achievement by examining the student, school, and institutional variables that jointly interact to produce student learning. In addition, the authors recognize that the economic, political, and social contexts provide the backdrop for these interactions. Their framework, which describes these relationships, is reproduced below in Figure 4.

[31] IEA is an international organization of national research institutions and governmental research agencies.
[32] Each content domain has several topic areas (i.e., number at eighth grade is further categorized by whole numbers; fractions and decimals; integers; and ratio, proportion, and percent).
[33] Four types of background questionnaires—curriculum, school, teacher, and student—organized around the TIMSS curriculum model were used in TIMSS 2007.

**Figure 4: Conceptual Framework (Vegas & Petrow, 2008)**




1.15 In reviewing the research literature on the factors associated with learning, Vegas & Petrow (2008) identify a number of student, school, and institutional variables that affect student learning, which are summarized below in Table 1. (See Annex 8 for more information on factors associated with learning outcomes.)

**Table 1: Student, School, and Institutional Variables that Affect Student Learning**

| **Student** | |
|---|---|
| What do students bring with them to school?<br>• Gender<br>• Age<br>• Language<br>• Cognitive development<br>• Pre-primary schooling<br>• Natural ability | What kind of support do they receive in the home?<br>• Values<br>• Socioeconomic status<br>• Parents' education<br>• Income<br>• Books in the home<br>• Time for homework |
| **School** | |
| How effective are teachers?<br>• Motivation<br>• Knowledge<br>• Pedagogy<br>• Time in the profession<br>• Rotation and turnover<br>• Professional calling | What are the characteristics of schools?<br>• Infrastructure<br>• Materials and textbooks<br>• Class size<br>• Peer group and school climate<br>• Time spent in the classroom |
| **Institutional** | |
| How are school systems administered?<br>• Level of administration<br>• Management capacity<br>• Parental / community participation<br>• Public / private provision<br>• Curriculum and standards<br>• Assessments and exit examinations | |

1.16 The current study applies the Vegas & Petrow conceptual framework to the Colombian context, within which the TIMSS 2007 questionnaires are reviewed and the details of the predictors of test scores as a result of the interaction of different student, school, and institutional characteristics in Colombia are presented. An econometric model was used to estimate the size and direction of the variables' effect on determining overall test scores. While the analysis is not causal, the estimation method applied allows for a close approximation of the degree and direction of association between two variables, a significant piece of information for policy makers designing interventions aimed to improve educational outcomes.

***Section 5: Methodology***

1.17 The methodological approach is as follows: The change in Colombia's TIMSS scores between 1995 and 2007 is compared to that of the other participating countries and

decomposition, using the Oaxaca-Blinder method[34] of a production function incorporating students' background characteristics, is conducted for Colombia's results over the period in an effort to determine what factors may have contributed to this change. (See Annex 6 for more information on the Oaxaca-Blinder Method). Analysis of TIMSS 2007 scores follows, in which:

i) Mean test score comparisons (overall scale score and scores in the content and cognitive domains) are used to understand Colombia's mathematics performance relative to other countries and to expectations given its Gross Domestic Product (GDP) and the country's socioeconomic characteristics. In this section, countries are grouped by income level to facilitate comparison of their performance, given the strong correlation between GDP and education outcomes (Hanushek and Woessmann 2007).

ii) Comparisons in equity scores and proficiency distributions among all participants (overall test score dispersion,[35] distribution of test scores by proficiency level – here the Logit model is applied in an effort to determine which factors might contribute to a Colombian student scoring above the Below Low Benchmark – and distribution of test scores by percentile) are carried out to highlight comparative quality and equity issues.

iii) The Vegas and Petrow model is applied to Colombia's eighth grade TIMSS 2007 math results in which student, school, and institutional characteristics are correlated with student achievement. Correlations are compared with those found in the PISA 2006 analysis.

iv) A production function using variables with significant results from the TIMSS 2007 correlations for Colombia is analyzed, taking into consideration student characteristics and interactions between a larger set of variables, to further determine the factors associated with learning in Colombia.

v) The same production function used for Colombia, with one exception (the variable on public vs. private schooling is removed[36]), is then applied to a select peer comparison group of four other lower middle income countries, (El Salvador, Jordan, Tunisia, and Bosnia and Herzegovina) in an effort to determine which factors are similar across this group.

vi) Decomposition of test scores between Colombia and four higher scoring comparator countries, which have made important advances in educational results (Jordan, Hungary and Korea[37]), is carried out in an effort to identify what factors may be contributing to the difference in scores between Colombia and these more successful countries. From these many vantage points, the analysis presented in this report seeks to spark and deepen a dialogue on factors associated with learning and education quality in Colombia.

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[34] Presents the differences in scores between two groups into two additive elements: one attributed to the existence of differences in observable characteristics between the two groups and the other attributed to differences in the rewards to those characteristics.

[35] Overall test score dispersion is an indicator of how compressed the test score distribution is around the mean, with a low dispersion indicating a high level of equity.

[36] Public vs. private schooling was not considered due to differences in country context and varying definitions.

[37] Korea is a high performing and high income country, Hungary is a good performing upper middle income country, and Jordan is a strong performer within the lower middle income countries.

1.18 Several limitations of the TIMSS data and the efforts of this analysis to mitigate them deserve mention. First, small variations in the TIMSS 2007 Math scores among eighth grade Colombian students and in a number of questions on the background questionnaires are important. The approach of this analysis is to explain and attempt to maximize the use of variables that have a relationship with learning as demonstrated on the TIMMS 2007. Second, some variables are constructed using questions about perceptions, and clearly perceptions can be erroneous. This analysis computes the sample statistics of several variables and uses the ones that, based on our knowledge, appear to reflect reality. Third, the data may contain questions that are interpreted differently in different contexts. An effort was made to report means and deviations of the most important variables in the text, choosing those that made sense according to data from other sources. Finally, it is important to note that correlation between any two or a set of variables (as in the production function analysis) does not necessarily indicate causation; in other words, while this report establishes that a number of variables may be positively related to student learning in Colombia, it does not claim that they are the cause of learning.

1.19 Mathematics was targeted specifically in this study due to the fact that it measures general aptitude to solve problems, one of the most important attributes in learning. Similarly mathematics plays a critical role in overall learning outcomes, life skills, and ability to attain higher education. Colombia participated in the TIMSS math assessment in 1995 only at the eighth grade level (and not at the fourth grade level); hence the analysis presented herein focuses exclusively on the performance of eighth grade Colombian students in mathematics relative to their peers in other countries.

# CHAPTER 2: INTERNATIONAL COMPARISONS OF TIMSS RESULTS OVER TIME (1995 AND 2007)

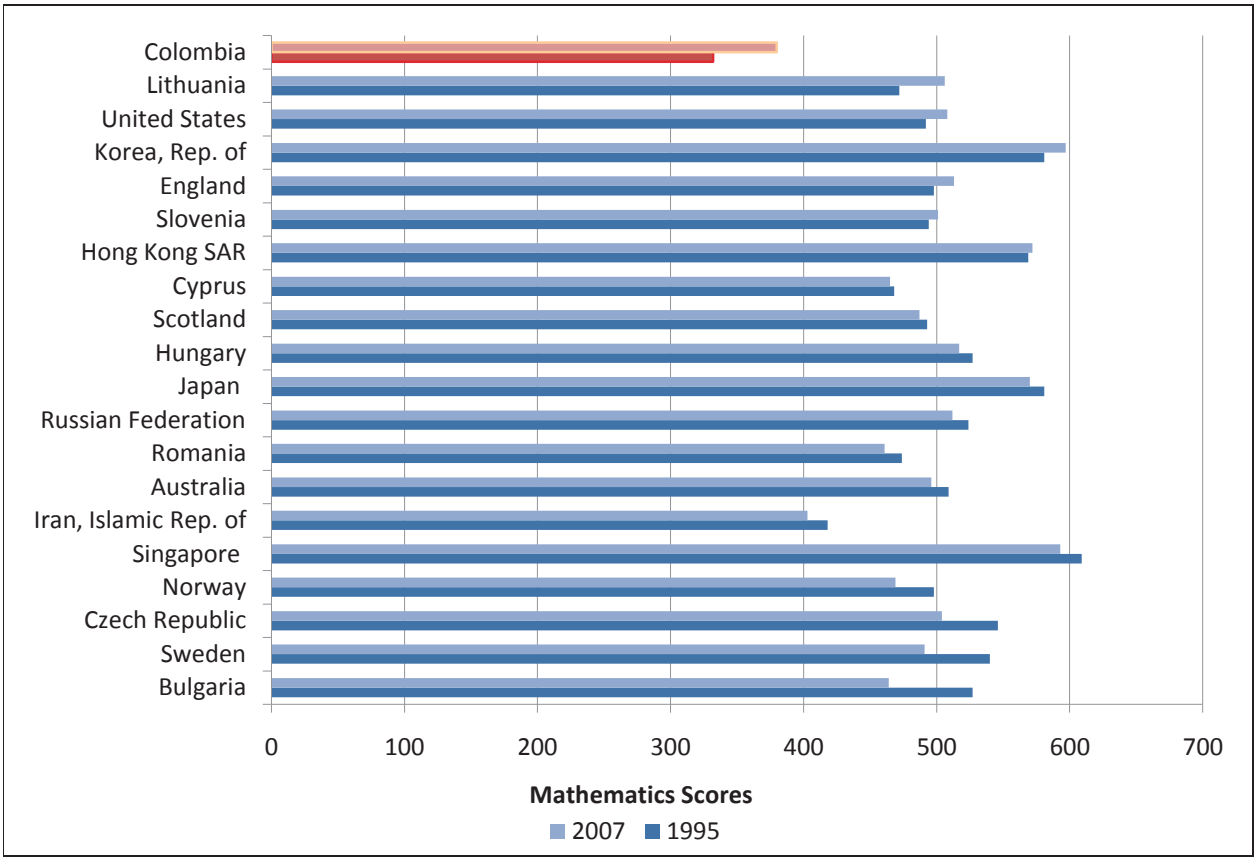
2.1 The analysis presented in this chapter supplements and furthers the existing literature and research, and allows for deeper analysis of the Colombian case using TIMSS data to, for the first time, study the changes over time (1995-2007) on factors associated with student learning in Colombia. Along with 20 other countries, Colombia participated in the eighth-grade TIMSS math assessment in both 1995 and 2007. A major strength of international assessments, including TIMSS, is that they allow for tracking of progress over time for those countries that have continued to participate.[38]

***Section 1: Overall Results (scale score points)***

2.2 **Between 1995 and 2007, Colombia showed greater improvement (47 scale score points)[39] than all other participating countries in the eighth grade TIMSS math assessment** (see Figure 5 below). Lithuania made the second greatest improvement (34 scale score points). In total only six countries,[40] approximately one fourth of those taking the TIMSS in both years, showed improvement in their scores. (See Annex 5 for a Table comparing TIMSS participant results in 1995 and 2007.)

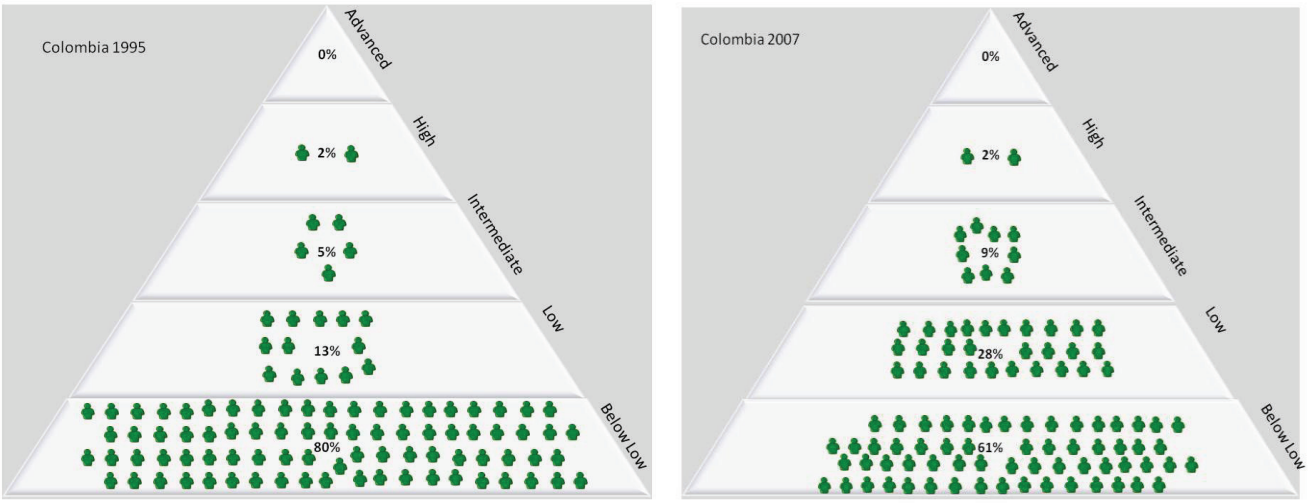
[38] In 1995, 41 countries participated in the TIMSS assessment, in 2007 the number increased to 60 countries. See Annex 4 for a detailed overview of scaling changes.
[39] This improvement was significantly better than their 1995 score.
[40] Colombia, Lithuania, Korea, United States, England and Slovenia.

**Figure 5: Mathematics Scores 1995 and 2007**




2.3 Figure 6 below shows that in comparison to 1995, in 2007 more Colombian eighth grade students were able to reach the Low and Intermediate international benchmarks for mathematics achievement. The number of students reaching at least the Low Benchmark increased from 20 to 39 percent, and the number reaching at least the Intermediate Benchmark increased from 7 to 11 percent. However in 2007, as in 1995, the majority of Colombian students were still unable to reach even the lowest proficiency level indicating that substantial room for quality improvements still exists.

**Figure 6: Percentage of Colombian students reaching TIMSS international benchmarks in mathematics achievement in 1995 (Left) and 2007 (Right)**




***Factors associated with learning improvements*[41]**

2.4 Analysis of Colombia's improvement in learning achievements based on TIMSS performance in 2007 and 1995 suggests that around one-fifth of the increase in achievement (8 points) is explained by changes in the household and personal characteristics of the student population (including the number of books and availability of a computer in the home, student age at the time of taking TIMSS, and student's mother having a tertiary education - or higher).

More than four-fifths (38 points) is not explained by these changes, but rather by changes in the relationship between characteristics and their learning.[42] In other words, the Colombian education system is now better able to transform its students' background characteristics into learning than before. To fully understand how Colombia made improvements in mathematics achievements over the 1995-2007 period, further research and analysis into other unobserved factors is necessary.

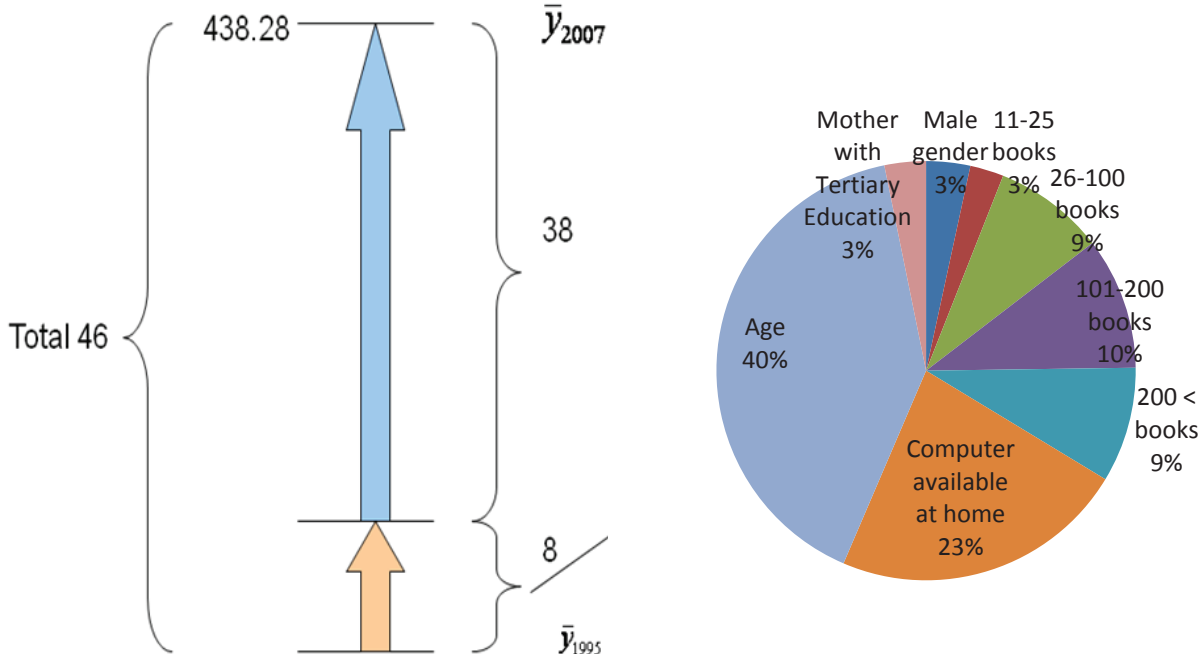
2.5 Of the 8 point increase explained by student characteristics, the largest explanatory factor contributing to improvements in test scores is a reduction in students' age upon entering eighth grade, which according to the analysis accounts for 40 percent of Colombia's improvement on

[41] To explore the possible factors that explain Colombia's noteworthy improvement between 1995 and 2007, the decomposition method Oaxaca - Blinder (1973) is applied. This method has been widely used in academia for determining the extent of pay discrimination to which women are subjected in some labor markets and recently its use has been extended to the analysis of achievement tests, among other areas. (See Annex 7 for a detailed description of the Oaxaca-Blinder method).

[42] Here it is important to note that it is difficult to locate these factors for a number of reasons: a) Colombia did not participate in TIMSS 1999 and 2003 so the precise path of its improvement between 1995 and 2007 is unclear and it is therefore impossible to determine if the change occurred in recent years or as a result of constant improvement over the period; and b) due to changes on the background questionnaires from one application to the next, it is difficult to construct a model to decompose the changes in the score over time.

TIMSS over the 1995-2007 period.[43] (See Figure 7 below). This could be a potential result of reduced repetition and improved intake rates over the period. The other important factors include the presence of learning materials (books and computers) in the home; however this is likely a proxy for family income. Mothers' education also had a small relationship with improving test scores, indicating that this may also be an area that could be targeted to improve educational attainment of children. (See Annex 7).

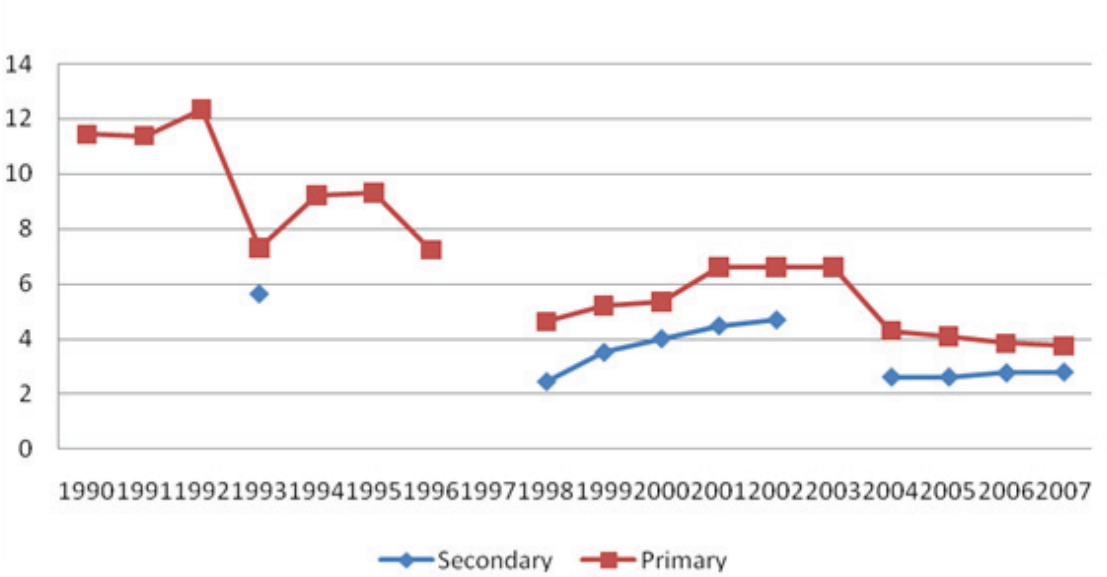
**Figure 7: Decomposition of Colombia's 1995-2007 TIMSS results**




2.6 A decrease in the age of students entering eighth grade and increased math scores presents a potentially valuable relationship. Over the observation period (1995-2007), the mean age of eighth grade students in Colombia dropped from 14.9 to 14.4 years, which may be the result of efficiency gains (reduced repetition and increased completion rates) in the school system. Indeed, during this time Colombia was able to systematically decrease repetition rates, with the 2007 levels just one-third of what they were in 1995 (dropping by 5 percentage points between 1995 and 2007 at the primary level, and by 3 percentage points between 1993[44] and 2007 at the secondary level) and improve completion rates (by 18.6 percentage points).[45] Figure 8 below shows the significant reductions that have been made in repetition rates since 1990, by education level.

[43] While the reported score improvement is 47 points, there are some missing values in the data set. Based on the available data, decomposition analysis has been done for a change of 46 points.
[44] Figures for 1995 are not available.
[45] Source: EdStats ADePT using 1995-2005 Demographic and Health Survey (DHS).

**Figure 8: Repetition rates in Colombia 1990-2007, by grade level (% of students)**




Source: UNESCO Institute for Statistics in EdStats

2.7 In sum, this evidence suggests that policy efforts implemented by Colombia during this period to reduce repetition and improve completion through introduction of flexible education models like *Escuela Nueva*, improvements in teacher quality through introduction of evaluation and professional development strategies, and increased support to families in the form of conditional cash transfers through programs such as *Familias en Acción* and *Red Juntos*, in addition to school-based programs - particularly in rural areas, may have resulted in lowering repetition and improving learning outcomes, as measured by eighth grade math achievement on TIMSS.

2.8 When analyzing the improvement in Colombia's TIMSS scores between 1995 and 2007, it is important to highlight that these improvements took place while the country was expanding educational coverage, especially among the poorest families and those located in rural areas. Table 2 below shows that while eighth grade completion rates were improving in general between 1995 and 2005, particularly noticeable increases took place among the poorest 40 percent of the population (23.9 percent) and those located in rural areas (20.8 percent). Given the large time span between assessments, it would be difficult to attribute gains to specific policies. More regular and frequent participation in international assessments would allow Colombia to better understand not only the factors associated with learning in the country, but also the role that innovative policy reforms have had.

**Table 2: Proportion of 15-19 year olds completing 8th grade in a given year**

| | 1995 | 2005 | Change |
|---|---|---|---|
| Total | 47.9 | 66.4 | 18.6 |
| Boys | 43.9 | 61.3 | 17.4 |
| Girls | 51.6 | 71.4 | **19.8** |
| Urban | 60.8 | 76.1 | 15.3 |
| Rural | 19.3 | 40.1 | **20.8** |
| Poorest 40% | 20.5 | 44.4 | **23.9** |
| Middle 40% | 57.1 | 77.1 | **20.0** |
| Richest 20% | 80.2 | 91.2 | 11.0 |

Source: EdStats ADePT using 1995-2005 DHS

2.9 Empirical international evidence[46] suggests that, in general, the students that come from disadvantaged socioeconomic backgrounds tend to underperform relative to their peers from advantaged socioeconomic backgrounds. Given this context, it is particularly noteworthy that Colombia was able to improve its TIMSS scores while at the same time expanding coverage to populations whose inclusion in the system typically leads to an overall reduction in test results.

[46] See for example: 1) Clarke, M., Madaus, G., & Shre, A.R. (2005). "Testing and diversity in college admissions," in J. Ptrovich & A.S. Wells (eds.), *Bringing Equity Back: Research for a New Era in American Educational Policy* New York: Teachers College Press, pp.103-135; 2) Porta, E., Laguana, J., "Equidad de la Educación en Guatemala," Proyecto Diálogo para la Inversión Social en Guatemala, AED/USAID-Guatemala, 2007; 3) Porta, E., Arcia, G,. Laguana, J., "Análisis de los Factores Asociados con el Rendimiento Académico en 3º y 6º Grados de Primaria," *PREAL*, UNICEF, CARE Nicaragua and MECD: Managua, 2004; 4) North Carolina Department of Public Instruction. "Movement in the Village: Variables Affecting Student Achievement," Raleigh, USA, 2004; 5) Velez, Eduardo, Ernesto Schiefelbein and Jorge Valenzuela. "Factors Affecting Achievement in Primary Education," HRO Working Paper No. 2, World Bank: Washington, DC., 1993; 6) Mizala, Alejandra, Pilar Romaguera and Teresa Reinaga, n.d., "Factores que inciden en el rendimiento escolar en Bolivia," Ministerio de Educación, La Paz, Bolivia; 7) Chávez Cuentas, José Carlos. "Determinación de los factores explicativos de los resultados escolares de la educación primaria en el Perú," Estudio de Caso No 69, Departamento de Ingeniería Industrial, Universidad de Chile: Santiago, Chile, 2002; 8) Fertig, M. 2003. "Who is to Blame? The Determinants of German Students' Achievement in the PISA 2000 study," IZA Discussion Paper no. 739; 9) Fertig, M. and C. M. Schmidt, "The role of background factors for reading literacy: Straight national scores in the PISA 2000 study." IZA Discussion Paper no. 545, 2002; 10) Fryer, R. and S. Levitt. "Understanding the Black-White test-score gap in the first two years of school." NBER Working Paper no. 8975, 2002; 11) Glewwe, P. 2002. "Schools and Skills in Developing Countries: Education policies and socioeconomic outcomes," *Journal of Economic Literature* 40(2): 436-82, 2002; and 12) Hernandez-Zavala, M., H. Patrinos, C. Sakellariou and J. Shapiro." Quality of schooling and quality of schools for indigenous students in Guatemala, Mexico and Peru." Policy Research Working Paper no. 3982, World Bank: Washington, D.C., 2006.

As such, the evidence reveals that Colombia has made gains in helping all students, regardless of their background, access schooling.

***Section 2: International Comparisons (TIMSS 2007)***

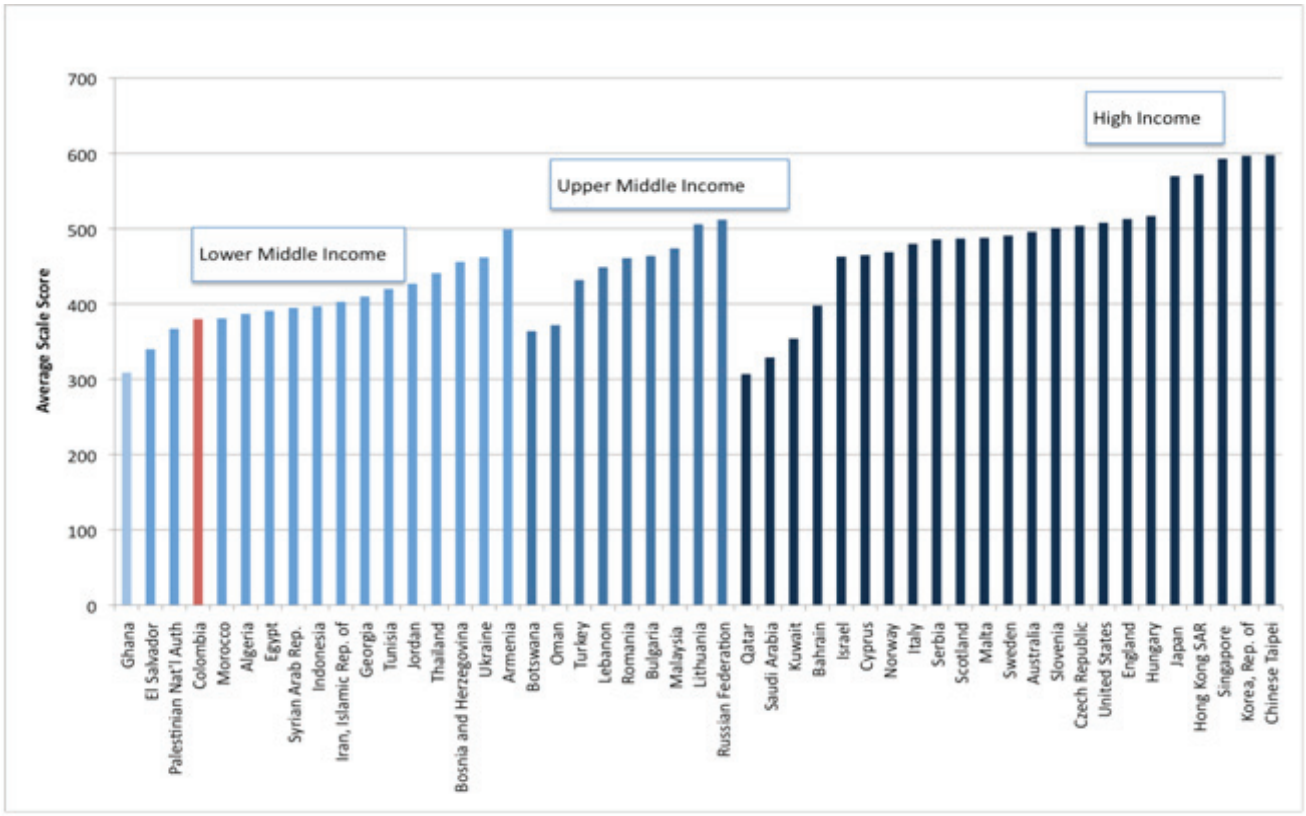
***Overall performance***

2.10 Although Colombia made greater gains in math than any other TIMSS participant between 1995 and 2007, students from Colombia scored lower than the majority of countries in both years. Colombia's overall performance on eighth grade TIMSS 2007 math is as follows:

- In eighth grade math, the international mean TIMSS score was 500 points (with a standard deviation of 100), which is 98 points below that of Chinese Taipei, the best math performer.
- The average Colombian eighth grader participating in TIMSS 2007 math scored 380, which is 120 points below the international mean and 218 points below that of the top performing country.
- Colombia's average TIMSS 2007 eighth grade math score was lower than that of 37 countries and higher than that of 7 countries.

2.11 The average overall scale scores among all TIMSS 2007 eighth grade math participants are shown in Figure 9 below. (See Annex 9 for a Table showing the average overall scale scores among all TIMSS 2007 eighth grade math participants).

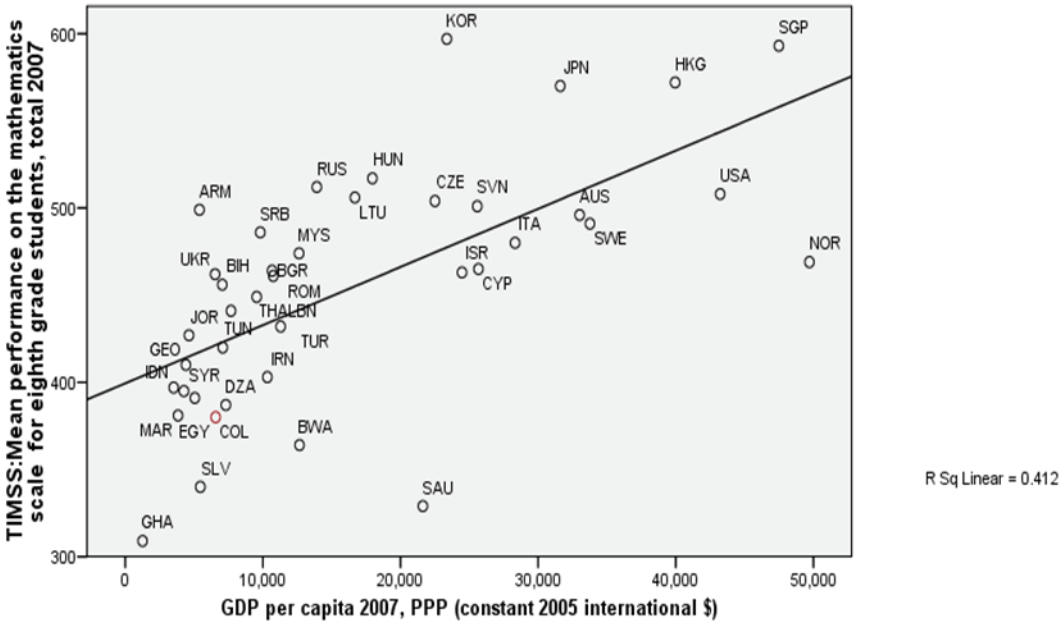
**Figure 9: TIMSS 2007 Math Scores, all countries**




***Overall performance of all participants – including lower middle-income countries, by predicted results based on GDP per capita***

2.12 Given that countries tend to perform according to their level of income, it is useful to observe how well countries perform relative to expectations based on their specific income levels. As illustrated by Figure 10, which shows the distribution of average country scores in relation to expected results as determined by each country's per capita GDP level, Colombia scores below the predicted line.

**Figure 10: Math proficiency and per capita income**




2.13 Although one would expect Colombia, a lower middle-income country,[47] to perform worse than 27[48] participants, all of which are upper middle-income and high income countries, it is somewhat surprising that Colombia does not perform better among its economic peers. In 2007, a total of 15 lower middle-income countries[49] (as defined by the World Bank in 2007) participated in the TIMSS 2007 eighth grade math assessment; among these countries Colombia's performance is as follows:

- The mean lower-middle income score was 411.66, which is 87.34 points below that of Armenia (499), the best lower-middle income performer. Colombia's score was 31.66 points below the lower middle-income mean and 119 points below Armenia's score.
- With 380 points, Colombia scored lower than 12 and higher than two (El Salvador[50]– 340, and Palestinian National Authority[51] – 367) of the 15 lower-middle income participant countries.

[47] In current World Bank development practice, economies are divided according to 2008 GNI per capita, calculated using the World Bank Atlas method. The groups are: low income, $975 or less; lower middle income, $976 - $3,855; upper middle income, $3,856 - $11,905; and high income, $11,906 or more. In 2007 countries with GNI per capita (Atlas Method) between US$875 and US$ 3,465 were classified by the World Bank as lower-middle income.

[48] A total of 27 upper middle-income and high-income countries (according to 2007 World Bank classification) participated in the TIMSS 2007 eighth grade math assessment: Australia, Bahrain, Botswana, Bulgaria, Cyprus, Czech Republic, Hong Kong (China), Hungary, Israel, Japan, Kuwait, Lebanon, Lithuania, Malaysia, Malta, Norway, Oman, Qatar, Romania, Russian Federation, Serbia, Saudi Arabia, Singapore, Slovenia, Sweden, Turkey, and the United States.

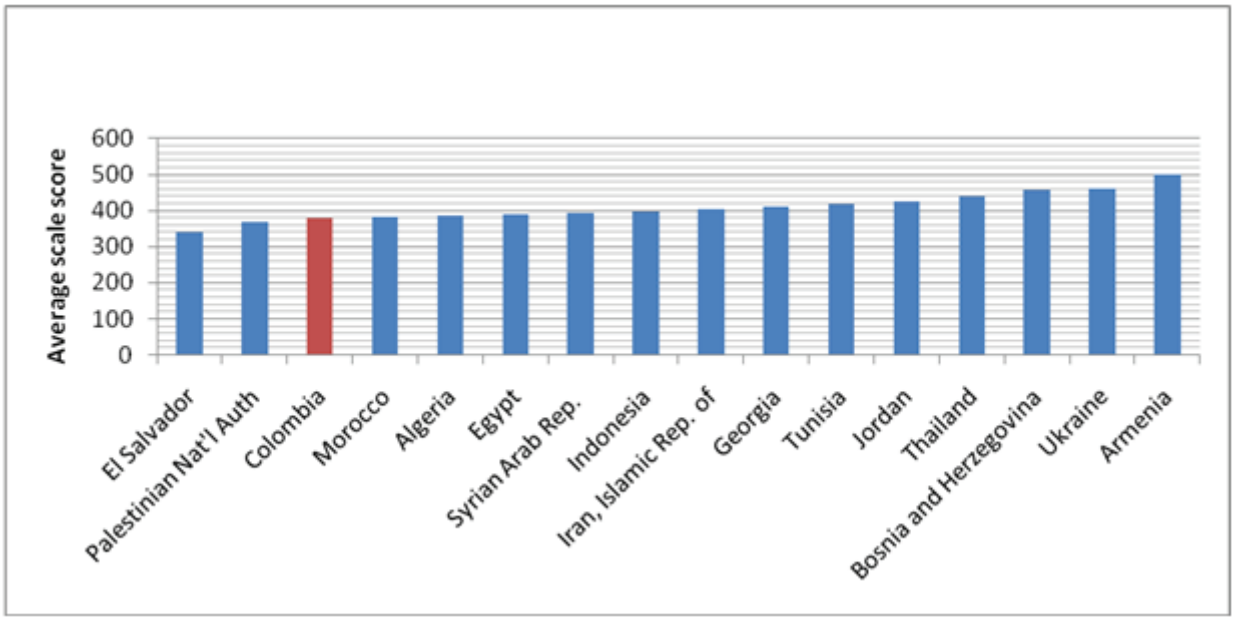
[49] A total of 15 Lower Middle Income Countries participated in the TIMSS 2007 eighth grade math assessment: Algeria, Armenia, Bosnia and Herzegovina, Colombia, Egypt, El Salvador, Georgia, Indonesia, Iran (Islamic Rep.), Jordan, Palestinian National Authority (also known as: West Bank and Gaza), Syrian Arab Republic, Thailand, Tunisia, and Ukraine.

[50] El Salvador was the only other LAC country to participate in TIMSS 2007.

[51] Also known as: West Bank and Gaza.

2.14 Tunisia and Bosnia and Herzegovina, also lower middle income-countries with GDP per capita levels very similar to that of Colombia in 2007 (as evident in Figure 10 above), present interesting points of comparison. Like Colombia, Tunisia performs below its estimated score line, though by a lesser margin than Colombia. (See Annex 10 for a Table of average scale scores among lower-middle income TIMSS 2007 eighth grade math participants). In contrast, Bosnia and Herzegovina outperforms both Colombia and Tunisia and scores above the predicted line. Especially noteworthy are the cases of Armenia and Jordan, also middle income-countries but with even lower GDP per capita levels (as evident in Figure 10 above), which outperform Colombia and achieve better than expected results in mathematics. This finding is also consistent with Jordan's performance relative to Colombia's on PISA 2006.[52] (See Box 1 for more information about the gains made by Jordan). Figure 11 below provides a visual depiction of where Colombia scores among its economic peers.

**Figure 11: Average scale scores among lower middle-income TIMSS Mathematics 2007 participants**




***Performance in the Content and Cognitive domains***

2.15 In addition to reporting overall scale scores for participating countries, TIMSS also reports on content and cognitive domains. As described in Chapter 1, the mathematics assessment is organized around two dimensions, a "content domain" specifying the subject matter to be assessed in mathematics and a "cognitive domain" specifying the thinking processes that students are likely to use as they engage with the content. In eighth grade, the countries scoring highest on the overall TIMSS 2007 math assessment were also more likely to be the highest-scoring countries in each of the content and cognitive domains and the countries with the lowest overall scores tended to be those with the lowest scores in the content and cognitive

[52] Armenia did not participate in PISA 2006, so no comparison can be drawn between its performance on both assessments relative to Colombia's.

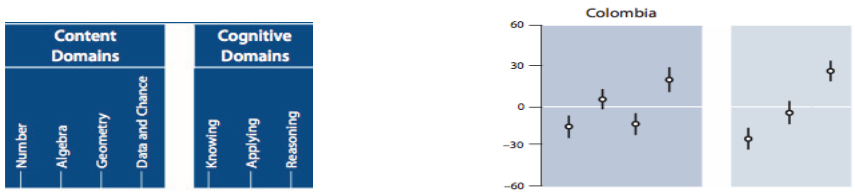
domains.[53] Colombia's 2007 performance in the content and cognitive domains of TIMSS 2007 eighth grade math is as follows:

- In all of the content domain areas, Colombia's performance was significantly lower than the TIMSS scale score average of 500: *Number* (369), *Algebra* (390), *Geometry* (371), and *Data and Chance* (405).
- In all of the cognitive domain areas, Colombia's performance was significantly lower than the TIMSS scale score average of 500: *Knowing* (384), *Applying* (364), and *Reasoning* (416).

2.16 Within the content domain, Colombia's eighth graders performed strongest on *Data and Chance*; this difference in comparison to the other four areas, though marginal, was statistically significant. Based on this, one might infer that Colombia is doing a relatively better job of teaching students to organize data and display it in graphs and charts and to understand issues related to misinterpretation of data.[54] Within the cognitive domain areas, Colombia's eighth graders did best in the area of *Reasoning*; this difference was statistically significant though marginal in comparison to the other three areas. Therefore it is possible that Colombia is doing a relatively better job of teaching students to go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems, than building their knowledge base of mathematics facts, concepts, tools, and procedures and strengthening their ability to apply knowledge and conceptual understanding in a problem situation.[55]

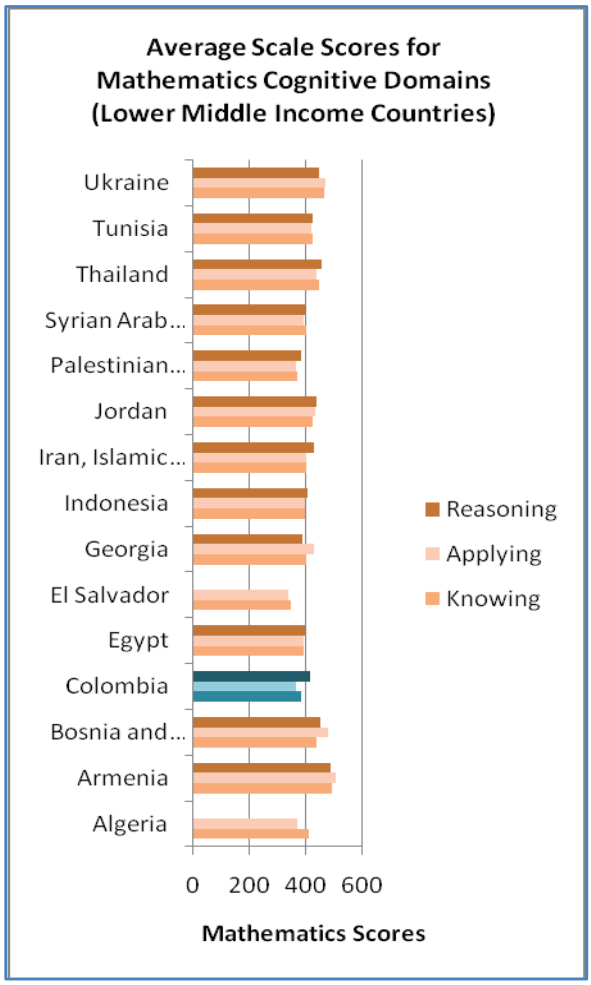
2.17 Nevertheless, Colombia's performance in all domains, both cognitive and content, was far below the international mean and indicates substantial room for improvement in all areas of mathematics achievement. Colombia's relative performance in each of the domain areas relative to the mean (represented as a white line at 0 on the Y axis) is demonstrated below in Figure 12. (See Annex 9 for a detailed description of the cognitive domains, tables and graphs showing average eighth grade scores in the TIMSS 2007 math assessment, and graphs of average scores in cognitive and content domains for all participants).

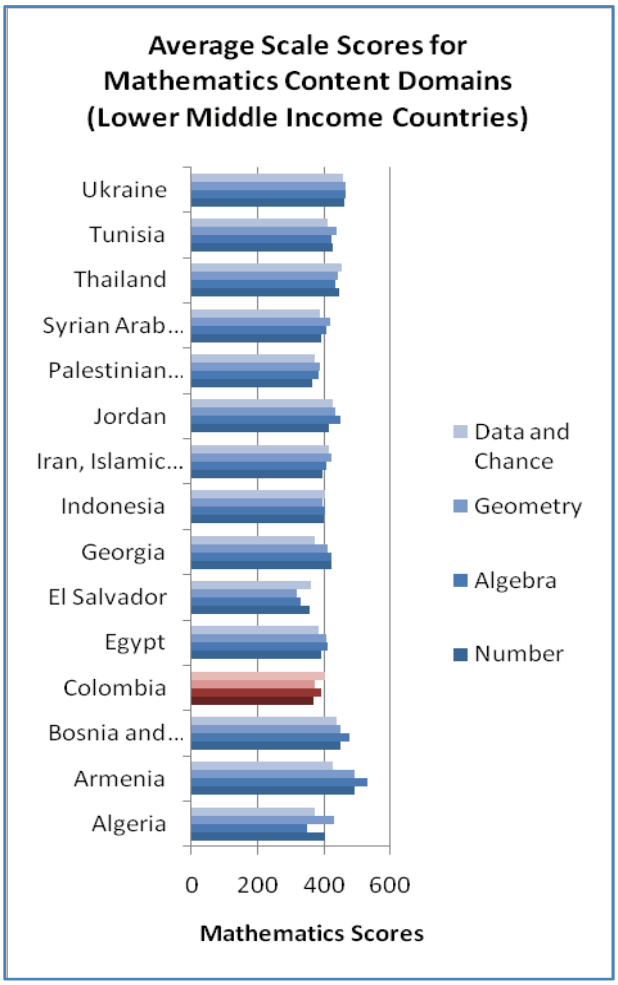
**Figure 12: Performance of Colombian 8th grade students in the content and cognitive domains[56]**




[53] IEA, *TIMSS 2007 International Mathematics Report*, p. 119, 2008.
[54] Content domain descriptions taken from: IEA. *TIMSS 2007 Assessment Frameworks*, 2008, pp. 23-31. Available at: http://timss.bc.edu/timss2007/pdf/t07_af_chapter1.pdf
[55] Domain descriptions taken from: IEA, *TIMSS 2007 International Mathematics Report*, 2008, p. 117. Available at: http://timss.bc.edu/timss2007/pdf/t07_m_ir_chapter3.pdf.
[56] Average relative performance is represented by a small circle, with a bar extending above and below the circle to denote a 95 percent confidence interval for this average. (Source: p. 130 of the TIMSS Report, available at: http://timss.bc.edu/timss2007/pdf/t07_m_ir_chapter3.pdf.

**Figure 13: Average Content and Cognitive Domain scores, lower middle-income countries (TIMSS 2007)**



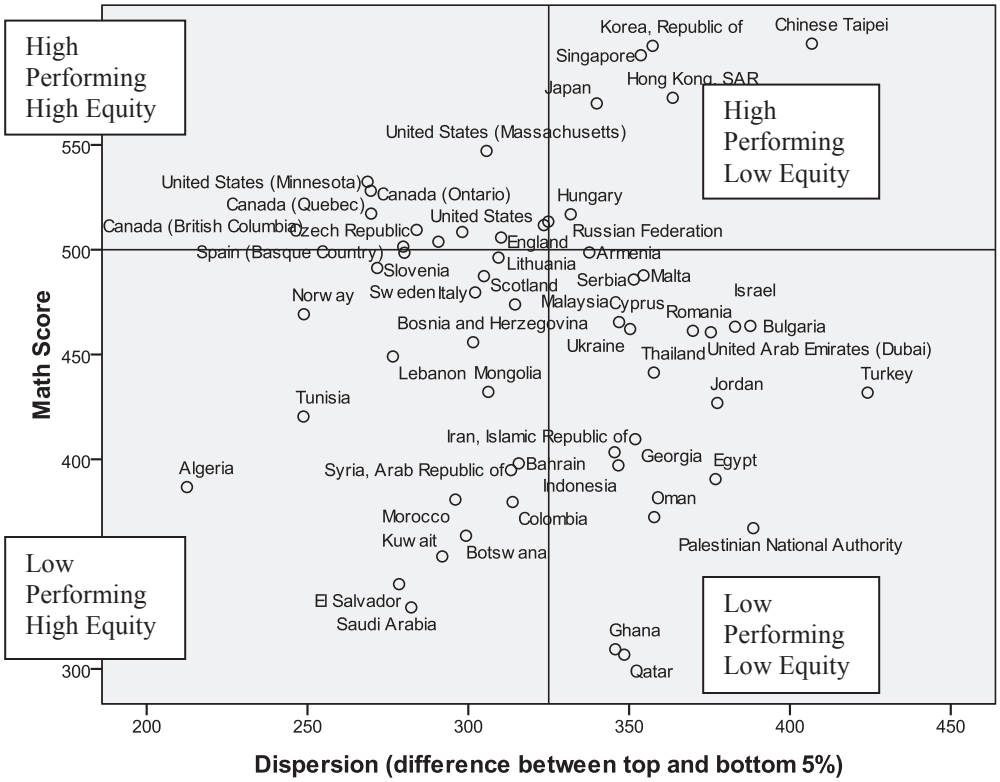
### *Section 3: Equity in Scores and Proficiency Distributions (TIMSS 2007)*

2.18 In addition to examining Colombia's overall performance, it is necessary to analyze the extent to which the Colombian educational system provides a high-quality and equitable education, relative to other participating countries. This section examines equity using three different methodologies: overall test score dispersion, the distribution of test scores by proficiency level, and the distribution of test scores by highest and lowest score percentiles.[57] The distribution of test scores by proficiency level shows the proportions of students performing at different performance levels, each indicating a certain degree of knowledge and skill. A concentration of students around any given proficiency level indicates a high degree of equity.

### *Overall test score dispersion*

2.19 Dispersion in test scores characterizes the level of heterogeneity in learning outcomes and therefore constitutes a measure of inequality.[58] A low level of dispersion indicates a high level of equity and a high level of dispersion signifies a large gap between the top and the bottom performing students. Figure 14 presents the average test scores and the dispersion between the top five percent versus the bottom five percent of eighth grade students in the TIMSS 2007 math assessment.

**Figure 14: Dispersion vs. Math Means, all countries**




[57] It is important to note that these measures are imperfect proxies for equity of high achievement, given that it is possible to show a high degree of equity but at a low level of achievement.
[58] Overall test score dispersion is an indicator of how compressed the test score distribution is around the mean.

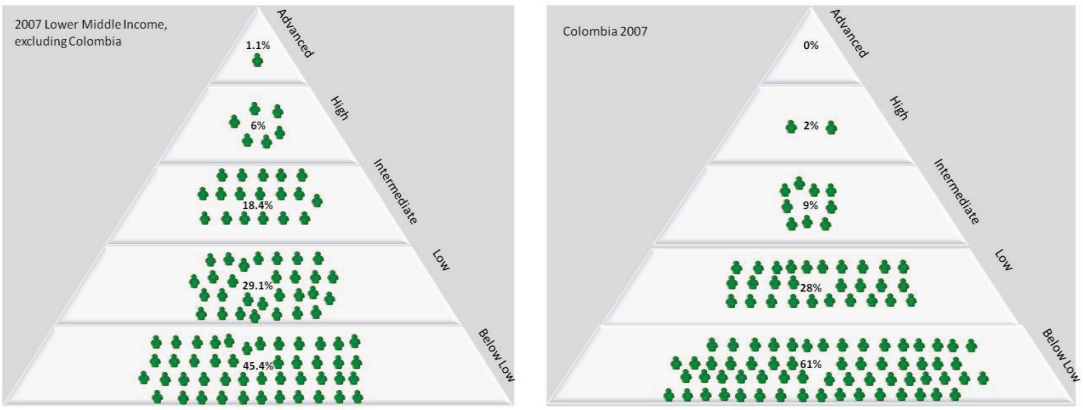
2.20 Relatively low dispersion between top and bottom performers, along with low test scores suggests that the Colombian educational system achieves fairly high equity but delivers low quality. Comparing Colombia against its economic peers, it is apparent that while Colombia is not the most inequitable in terms of schooling, its system offers less equality in opportunity than that of six of the 14 other lower middle-income countries, indicating that room for improvement exists. Also, as shown in the figure above, in terms of quality (as measured by test scores) all lower middle-income countries score at or below the international mean (500 points). This confirms findings from Colombia's 2006 participation in the PISA test.

***Distribution of test scores by proficiency levels***

2.21 A second measure of equity and quality evaluated is the proportion of students performing at or above desired proficiency levels. TIMSS has established four different levels of proficiency, also known as "the International Benchmarks." From highest to lowest, these include: Advanced, High, Intermediate, and Low. Students' proficiency levels are determined according to the difficulty of the items in the test. (Annex 11 provides the TIMSS description of what eighth grade students should know and be able to do at each benchmark level) For example, students in the Advanced Benchmark can successfully answer items with the highest degree of difficulty, showing understanding and knowledge in a variety of relatively complex situations. By contrast, students at the Low Benchmark can only answer basic questions in which all the information is given. An additional fifth level, "Below Low," is comprised of those students who are not able to answer the most basic questions. (IEA, TIMSS, 2007).

2.22 The distribution of test scores by proficiency level shows the proportion of students performing at different performance levels, each indicating a certain degree of knowledge and skill. A concentration of students around any given proficiency level indicates a high degree of equity. In three countries, Chinese Taipei (45 percent), the Republic of Korea (40 percent), and Singapore (40 percent), a large percentage of students scored at or above the Advanced Benchmark. In all three, the overwhelming majority of students (95 percent, 98 percent and 97 percent, respectively) scored at or above the Low Benchmark. In comparison, no student from Colombia performed at the Advanced Benchmark and only 39 percent performed at or above the Low Benchmark. ***This means that 61 percent of Colombia's eighth graders did not score high enough to reach the Low International Benchmark on TIMSS 2007***. (See Figure 15 below).

**Figure 15: Comparative Distribution of test scores in 8th Grade Math by Proficiency level, Colombia (Right) and all TIMSS 2007 lower-middle income participants (Left)[59]**

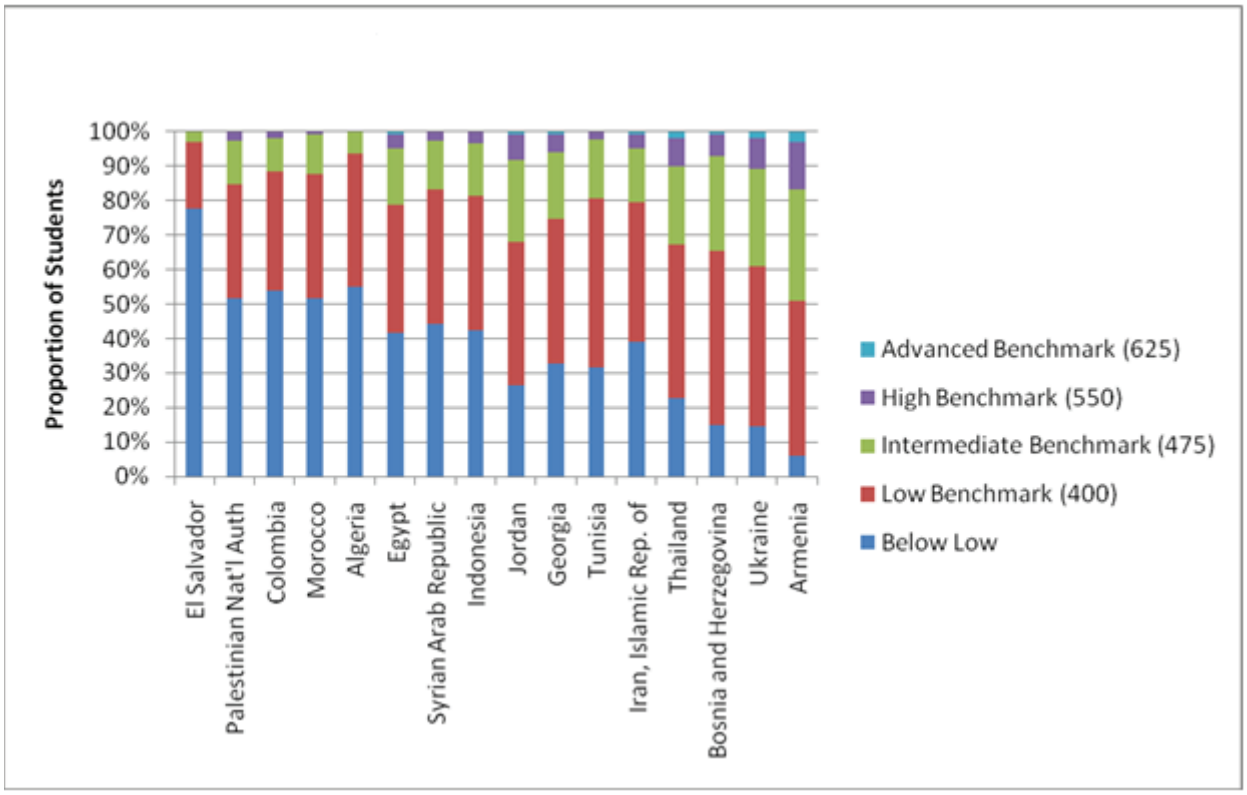



(For a presentation of descriptive statistics for Colombia, based on the international benchmarks, see Annex 12.)

2.23 Comparing Colombia against its peers at the lower middle-income level, it is apparent that Colombian eighth graders fall short of expectations based on the country's level of economic development. However, for the average lower middle-income country the bulk of the distribution of students is concentrated at the Low Benchmark, showing a distribution that is heavily skewed towards lower proficiency and therefore indicating a relatively high degree of inequity. This is particularly the case among countries like the Ukraine, Bosnia and Herzegovina, and Thailand, where although each country had students scoring in all four benchmarks, distribution among all four was highly unequal despite the countries' overall high relative position among its economic peers. In Colombia, as in other relatively low-scoring lower middle income countries like El Salvador and Algeria, proficiency is more evenly distributed, albeit among the lowest two proficiency levels (Low and Below Low). This indicates that while quality is low and students in these countries are not scoring as well as their economic peers on the whole, their education system is more equitable than that of a number of higher scoring lower middle-income countries. (Figure 16 below shows the comparative distribution of TIMSS 2007 eighth grade math scores among lower middle income countries, by proficiency level.)

[59] Note: Colombia has been removed from the list of fifteen lower middle income countries, in order to preserve the clarity of the comparison between Colombia and its economic peers in 2007.

**Figure 16: Comparative Distribution of TIMSS Mathematics Scores by Proficiency Level in Lower Middle Income Countries**



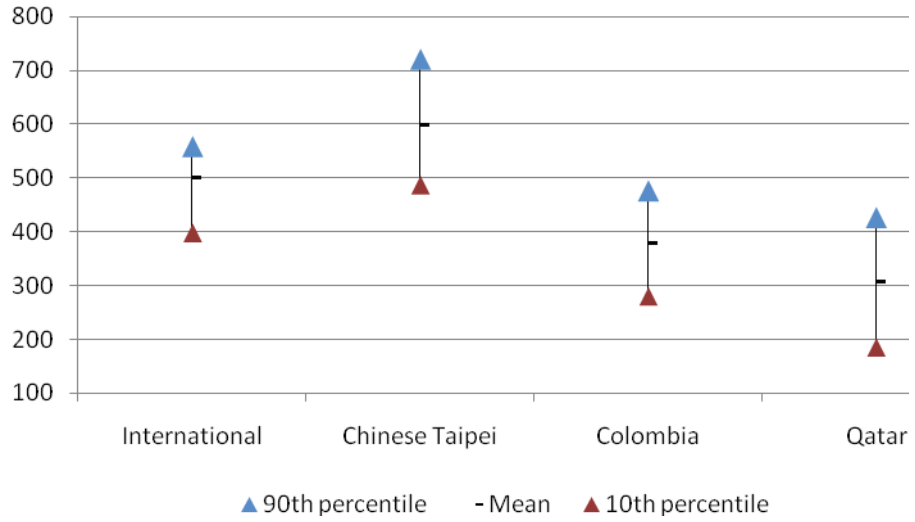

2.24 As mentioned earlier, while Colombia and Jordan have similar GDP levels, Jordanian students scored higher on average than Colombian students (see Box 1 for more information about Jordan's advances in educational achievement.) Not surprisingly then, more Jordanian students reached the higher international benchmarks (Advanced: 1 percent of Jordanians versus 0 percent of Colombians; High: 1 percent of Jordanians versus 2 percent of Colombians).

***Distribution of scores***

2.25 Percentile dispersion comparisons between the highest and lowest scoring countries in TIMSS 2007 math and Colombia allow for a cross-national snapshot of how well Colombia's eighth grade students are learning relative to the international average and relative outliers (highest and lowest scoring countries).

2.26 The international cut-point score for eighth-graders at the 90$^{th}$ percentile was 559 and 339 for the 10$^{th}$ percentile. The cut-score for the highest performing country, Chinese Taipei, at the 90$^{th}$ percentile was 721 and for the 10$^{th}$ percentile, 488. The cut-score for the lowest performing country, Qatar, at the 90$^{th}$ percentile was 427 and for the 10$^{th}$ percentile, 186. For Colombia, the cut point for the 90$^{th}$ percentile was 477 and for the 10$^{th}$ percentile, 281. Figure 17 shows that ***Colombia's highest performing eighth-grade students are performing at the level of Chinese Taipei's lowest performing students***.

**Figure 17: TIMSS 2007 Math Score, by countries with highest and lowest performing percentile averages, International and Colombia.**




## Summary

2.27 In sum, Colombia's education quality, as measured by the TIMSS 2007, is low relative to the highest performing countries and lower than expected given its GDP level. It is of significant concern that the performance distribution in mathematics shows almost half of eighth grade students are unable to answer even the most basic questions on the test, which calls into question their knowledge acquisition and ability to later perform effectively at upper grade levels. Against this background of low quality (as measured by test scores), Colombia's relatively higher equity, in comparison to the highest and lowest performing countries on TIMSS 2007, is less impressive and also shows room for improvement. With respect to the overall performance of the country and from variables of student characteristics, the model used in this analysis explains only 17.3% of the difference in the results of Colombia between 1995 and 2007. Alarmingly, the lowest performers in Colombia face a great gap to reach the level of the highest performers in Colombia, who are just able to meet the level of the lowest performing students in the highest performing nations.

# CHAPTER 3. FACTORS ASSOCIATED WITH LEARNING IN COLOMBIA (BASED ON TIMSS 2007 AND PISA 2006 RESULTS)

3.1 This chapter provides further insight on the factors associated with learning in Colombia by applying the Vegas and Petrow model mentioned earlier to analyze correlations between eighth grade achievement on TIMSS 2007 with various student, school and institutional variables and, when available,[60] comparing these correlations to those found in the PISA Report. Next, a more detailed analysis is conducted using a production function including all TIMSS 2007 variables found to have **significant correlations** with Colombia's eighth grade math scores on TIMSS 2007, taking into consideration student characteristics and interactions between a larger set of variables. Finally, the same production function used for Colombia, with one exception (the variable on public vs. private schooling is removed[61]), is applied to a selected group of economic peers (Jordan, Bosnia-Herzegovina, Tunisia, and El Salvador) in an effort to determine which factors are similar across this group. Analysis involves the use of econometric models to estimate the size and direction of the variables' effect on determining overall test scores. While the analysis is not causal, the estimation method applied allows for a close approximation of the degree and direction of association between two variables, a significant piece of information for policymakers to use in designing interventions aimed at improving educational outcomes. (See Annex 7 and 13 for a presentation of descriptive statistics).

## *Section 1: Predictions of Student Outcomes*

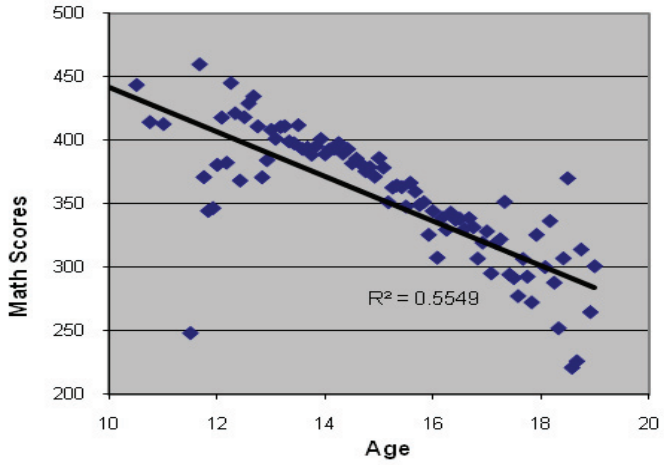
### Student Factors

3.2 ***Gender*** is a strong predictor of test scores in Colombia. Females scored lower than males in mathematics in TIMSS 2007 (by 32 test score points) and in PISA 2006 (by 13.54 points). Such results may be a factor of classroom practices and expectations, as well as societal and family attitudes toward girls' education in general and mathematics education in particular in Colombia.

3.3 ***Age*** was found to have a significantly negative correlation with student achievement on TIMSS 2007 (see Figure 18 below). The older a student is in eighth grade, the less well he or she is expected to perform. This underlines the need to continue efforts to reduce overage students through targeting repetition and late entry. In the PISA 2006 analysis, this factor was not found to be significantly positive or negative.

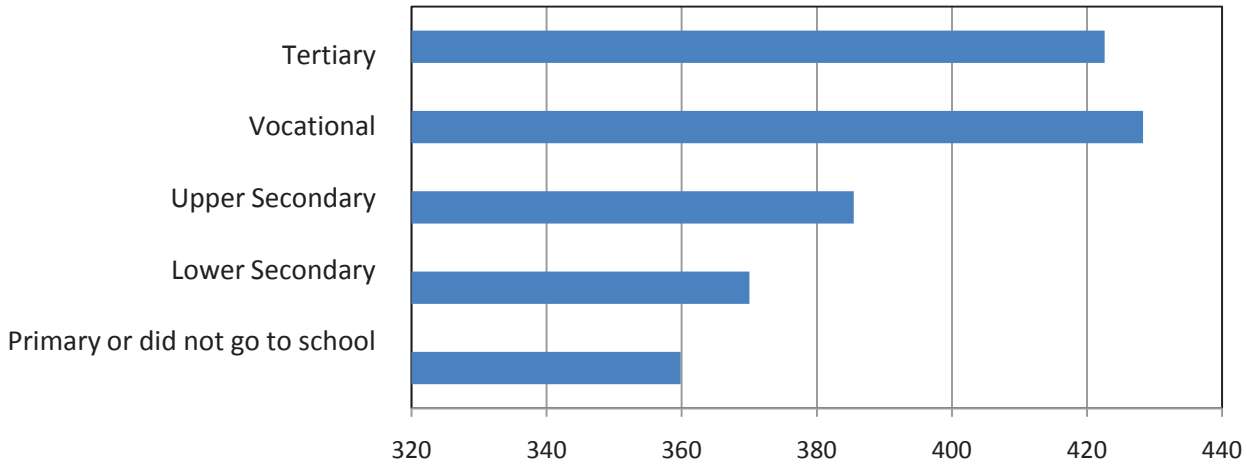
[60] TIMSS 2007 provides a wider set of variables than does PISA 2006.
[61] Public vs. private schooling was not considered due to varying country classifications and comparability concerns.

**Figure 18: Correlation between age and eighth grader performance on TIMSS 2007**



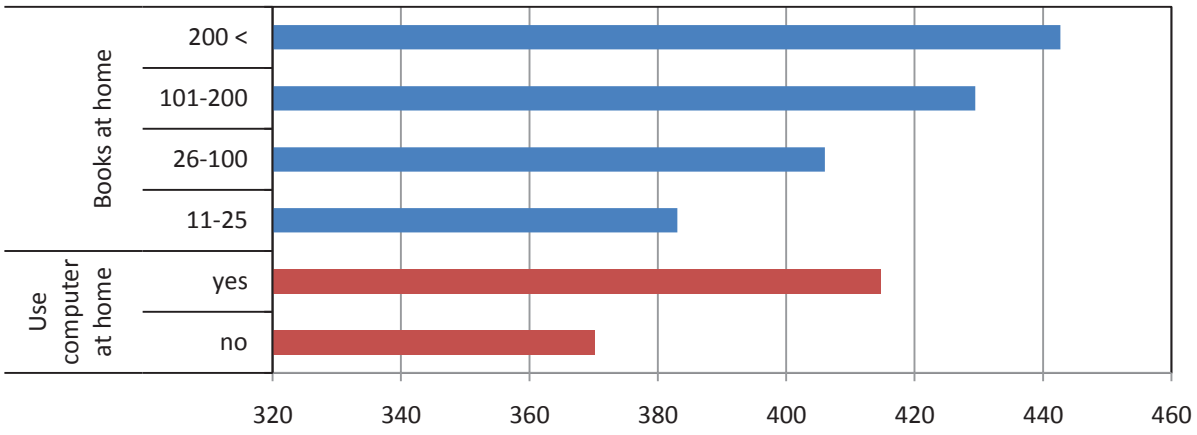

3.4 ***Mothers' education*** has been established in earlier research as a contributing factor to student performance and this report confirms these findings. A third of the mothers of eighth grade Colombian students taking TIMSS 2007 Math has only primary school education or did not go to school at all. Figure 19 demonstrates that children of these mothers scored significantly lower than their counterparts, with the highest performing Colombian students having mothers with considerably higher education. This finding is consistent with that found in analysis of PISA 2006, where mothers' completion of university studies was found to have a positive and statistically significant correlation with student performance in Colombia.

**Figure 19: Difference in Colombian eighth grade performance on TIMSS 2007, by mother's education**




3.5 ***Books in the home*** were associated with an approximate increase of 30 points for eighth grade Colombian student over their classmates. Also, students with a computer at home scored approximately 50 points higher than those that did not. As seen in Figure 20, Colombian students with more learning resources at home performed better on TIMSS 2007.

**Figure 20: Colombia's eighth grade performance on TIMSS 2007 Math, by home possessions**




3.6 These results are consistent with those obtained by 15-year-old Colombian students in PISA 2006, where those with a computer at home scored an average of 22.91 points more than those who did not (this difference was statistically significant) and having between 101-500 books in the home had a similarly high association (21.55), while the correlation of having 11-100 books was more moderate (12.40), but still positive and statistically significant. Given that books and computers at home are a proxy for family income, these correlations are unsurprising. They may also reflect parental orientation toward knowledge and learning that independently drives student achievement.

## School Factors

3.7 Analysis of Colombia's performance on TIMSS in 1995 and 2007 has provided additional areas of study regarding factors of learning, particularly at the school level, which allow an expansion of the conclusions that were drawn from the PISA analysis. Beyond the education level of teachers, additional factors not studied in PISA were studied in the TIMSS analysis, including: (i) teacher expectations of students; (ii) teacher gender; (iii) teacher satisfaction; (iv) professional development opportunities for teachers; (v) the presence of computers, textbooks, and calculators in the school; (vi) time spent in lectures and time spent learning math; (vii) socioeconomic make up of schools; and (viii) perceptions of school safety.

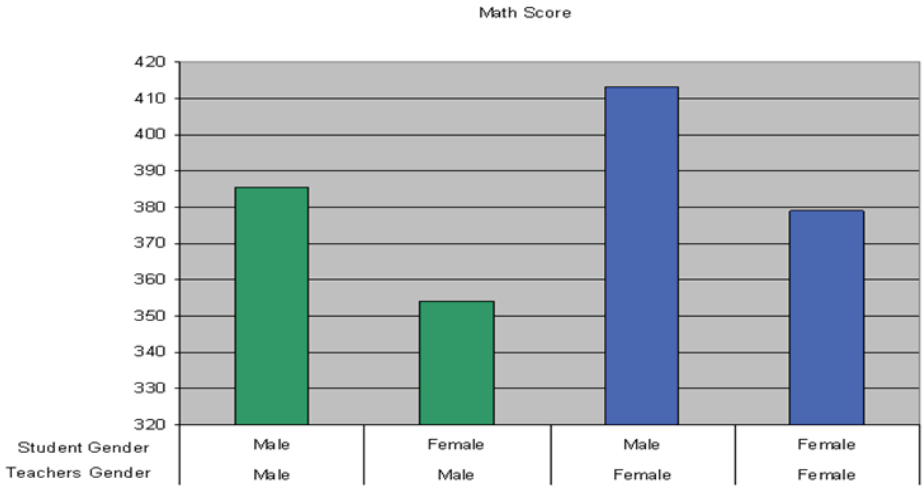
3.8 ***The education level of teachers***, already included in the PISA analysis, surprisingly does not appear to be a significant predictor of student performance on TIMSS 2007. This finding is in sharp contrast to PISA 2006 analysis where teachers with a certificate comprised the school factor with the highest correlation with student achievement for Colombia. However, Colombian students whose teacher's major area of study was mathematics[62] performed better (by an average of 31 scale score points) on TIMSS 2007 than those whose teacher had not majored in math. These findings could be a result of the limitations of the model used. National assessment data could provide more insight into this factor, which warrants further research.

[62] Of the eighth grade teachers in the study, 77 percent had mathematics as their major area of study.

3.9 ***High expectations of teachers for students*** had a positive relationship with student performance on TIMSS 2007. In the background questionnaire for teachers, 75 percent of respondents said they had high expectations for their students; the students of these teachers performed at a significantly higher level than their counterparts. This confirms international research on this subject.

3.10 ***Teacher gender*** emerges as an important predictor of student achievement on TIMSS 2007 in Colombia; eighth graders with female teachers score approximately 25 scale score points more than those with male teachers. Figure 21 shows that while there are more male (62 percent) than female (38 percent) eighth grade math teachers in Colombia, both male and female students tend to score higher with female teachers. Also, boys generally appear to do better with male teachers than girls do. These findings suggest that it may be important to conduct further analysis on why male teachers correlate with lower scores among female students.

**Figure 21: Teacher Gender is related to student performance in Colombia**




3.11 ***Teacher satisfaction and professional development opportunities*** have been linked in various studies to student achievement. In Colombia, a little more than half (55 percent) of teachers say they are highly satisfied with their job. However, no significant difference was found in the performance of students of these teachers and students of teachers who expressed greater job satisfaction. Also, while 90 percent[63] of all teachers reported having participated in professional development training in mathematics over the last 2 years, this factor also did not correlate with the performance of students on TIMSS 2007. However, it is important to note that these analyses are subject to a self reporting bias as teachers were asked in a questionnaire their level of satisfaction and participation in professional development.

3.12 ***The presence of a computer in school*** was not related to higher student performance in Colombia on TIMSS 2007, unlike having a computer at home (a common proxy for family income). While 26 percent of students reported that they do not have access to computers at school, there was no significant difference in mathematics scores between students who have the

[63] Here it is important to note that there may be a self-reporting bias in the data.

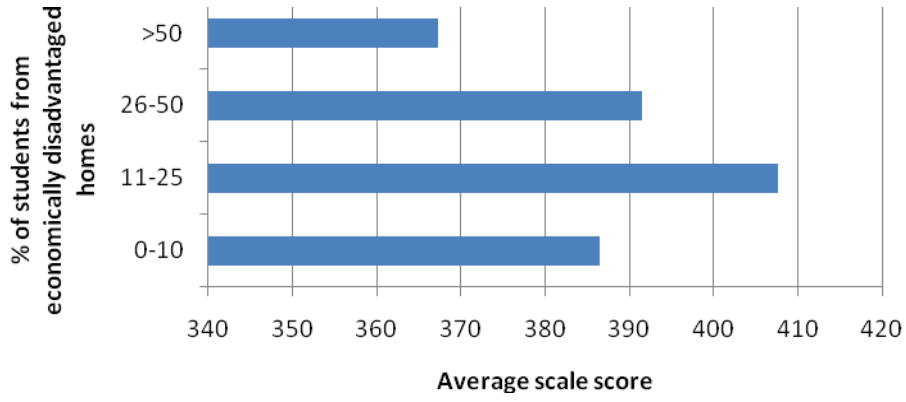
use of computers at school and those who do not. Although the data are not sufficient to address these inconsistencies, one could hypothesize that first, computers at home represent a socioeconomic variable and that what is really being measured is an interaction between socioeconomic status and performance. Secondly, the lack of difference in performance between students who have and do not have computers at school may be a reflection of how computers are used at school. Unfortunately, the TIMSS 2007 data is not sufficient to address these questions, and this is an area that warrants further research.

3.13 ***The presence of school resources*** did not have a clear relationship with achievement — having a math textbook (77 percent reported using a mathematics textbook), enrichment classes (94 percent reported that they do not have enrichment classes), nor remedial classes (68 percent reported that they have remedial classes) had a significant correlation with students' TIMSS 2007 performance in Colombia. Similarly, whether or not students are permitted the use of a calculator is not significantly correlated to how well students performed on TIMSS 2007 math.

3.14 ***Time spent in lectures and time studying math*** does not necessarily lead to higher test scores, a finding supported by research. Increasing time spent in lectures showed no significant correlation between this variable and test scores. Additionally, the amount of time students spend in math classes every week, and how they spend their class time (including how much time is spent working on math problems and whether or not students are grouped by ability) were all found to have no significant correlation to student test scores in Colombia.

3.15 ***The socioeconomic composition of schools*** is related to student performance in Colombia, a finding that is confirmed by numerous studies. In Colombia, 74 percent of school principals at schools participating in TIMSS 2007 reported that their students come from economically disadvantaged homes.[64] Figure 22 shows that students in schools where more than 50 percent of students come from economically disadvantaged homes performed significantly less well than students in schools with lover levels of students in poverty on TIMSS 2007.

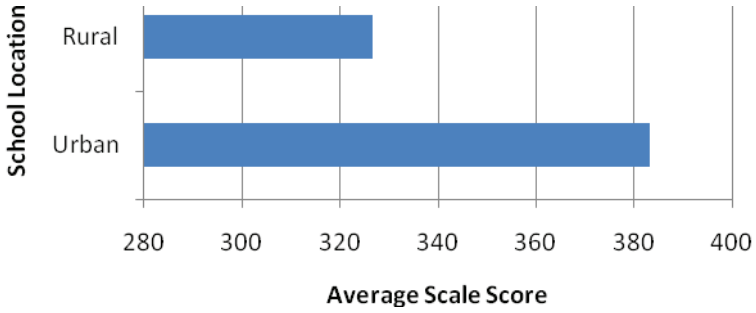
**Figure 22: Colombia's performance on TIMSS 2007 Math, by percentage of students from economically disadvantaged homes**




[64] "Economically Disadvantaged" is determined by principals reports

3.16 ***School location*** is significantly correlated with student performance in Colombia. As Figure 23 below shows, Colombian students in schools located in rural areas (population of 3000 or less) scored significantly less well on the TIMSS assessment than did their urban counterparts. These findings for TIMSS 2007 are consistent with those obtained in the PISA 2006 analysis where 15-year-olds Colombians from rural schools were found to score an average of 15 points less than their urban peers. Furthermore, in PISA, rural schools were also associated with lower test scores, independently of the students' income quintile and the effects were particularly large (and negative) for those in the 40th percentile.

**Figure 23: Colombia's performance on TIMSS 2007 Math, by school location**




3.17 ***School type*** also has an important relationship with student performance in Colombia. In TIMSS 2007, the proportionately smaller amount (17 percent) of Colombian eighth grade students enrolled in private schools performed significantly better (by approximately 60 points) than their peers in public schools. This finding further confirms findings from PISA 2006, where Colombian students from public schools also scored significantly lower (by 32.51 points) than those attending private schools. However, it is important to note that both of these analyses do not account for key unobservable factors, notably differences in student selection policies that tend to render public and private schools' student populations systematically different from one another. Therefore, it is impossible to draw a conclusion regarding the relative efficacy of public versus private schools from the analysis of correlations (see next section for further discussion of this variable in relation to production functions).

3.18 ***The lack of school safety*** is correlated with student performance on TIMSS 2007 in Colombia. In Colombia, 80 percent of fourth-grade teachers and 84 percent of eighth-grade teachers report a high to medium perception of the safety of their school. In the fourth grade, 79 percent of students report a high to medium perception of being safe in school, 88 percent of eighth-grade students report a high to medium perception of being safe in school. In schools where teachers say they do not feel safe student performance is significantly lower than their counterparts and in schools with greater numbers of bullying incidents between students, student scores on TIMSS 2007 math were significantly lower than in schools reporting fewer bullying incidents.

**Institutional Factors**

3.19 Two variables studied at the institutional level for TIMSS 2007, which were not studied in PISA 2006, were high parental support for student achievement and high parental participation in school activities. In Colombia, both of these factors were found to have a positive and significant correlation with student scores.

***Section 2: Summary of Relevant Factors, TIMSS 2007***

3.20 In sum, certain family, student, and school variables have a statistically significant association with student performance in Colombia, whether positive or negative, while other variables show inconsistent or wholly insignificant results. Table 3 summarizes the relationship between student achievement on TIMSS 2007 Math and the numerous factors discussed above. (See Annex 13 for a summary of the variables identified with significant effects on learning outcomes in Colombia).

**Table 3: Correlation between eighth grade student achievement in TIMSS and student, school and institutional factors in Colombia**

| Level | Variable | Correlation |
|---|---|---|
| Student | Gender (Female) | -* |
| | Age | -* |
| | Mothers education | +* |
| | Books at home | +* |
| | Computer at home | +* |
| School | School size | + |
| | Math textbook availability | - |
| | Computer availability | - |
| | Time spent problem solving | + |
| | Time for learning | - |
| | Time spent listening to lecture | - |
| | Frequency of homework | - |
| | Ability grouping | + |
| | Remedial or enrichment class | + |
| | Use of calculator | + |
| | Teacher education | + |
| | Teacher recent training | + |
| | Teachers feeling safe | + |
| | Teachers feeling satisfied | + |
| | School located in rural area | -* |
| | Economic disadvantage context | -* |
| | Bullying incidents | -* |
| | Teachers gender (female) | +* |
| | Teachers expectations of students | +* |
| | Teacher having math as major area of study | +* |
| | Attending a private school | +* |
| Institutional | Evaluation of teachers practice | + |
| | Parental participation in school activities | +* |
| | Parental support in student achievement | +* |

Note: **(+)** means that the variable is positively correlated and **(-)** is the opposite case, (*) means that the correlation is statistically significant ($p < .10$). (See Annex 12 for a Table of the correlation coefficients)

### *Section 3: Further Analysis of Interaction between Predictors of Learning in Colombia*[65]

3.21 Further analysis of the factors potentially related to student performance is carried out by estimating a production function of learning outcomes that includes all variables found to have a significant correlation with student achievement in Colombia on the TIMSS 2007 eighth grade math assessment. Empirical evidence on education production functions exists for both developed (for example, Hanushek 1986, 2002) and developing countries (for example, Glewwe 2002) however, this research does not always agree on which student, school, and/or institutional factors (known in the literature as "inputs") serve to improve children's achievement. Examples

[65] For this analysis, five plausible values and the weight replicas according to IEA methodology using the IDB analyzer were used.

are the disagreements found on the role of schooling inputs, including class-size, teacher experience, teacher education and mother's employment. For a largely comprehensive survey of this literature, see Todd and Wolpin (2003).

3.22 Evidence suggests that socioeconomic and family background variables, such as parent's education and the number of books a child has at home, are very important determinants of test scores at early ages (Fryer and Levitt 2002). Similarly, a large body of evidence points to the existence of persistent effects in educational achievement across generations (Fertig 2003; Fertig and Schmidt 2002; Currie and Thomas 1999). Consequently, it is important to control for individual pupil characteristics, as well as family background, when constructing a production function to estimate the returns in student scores to various inputs. Recent evidence from the literature on early test score differentials suggests that differences in children's cognitive abilities across families tend to: appear at an early age, persist over time, and (in some instances) widen with age. In general, children from families that promote cognitive, social and behavioral skills tend to perform better than their counterparts. This is important in determining what policy interventions can be successful. (Carneiro and Heckman 2003)

3.23 Results of the production function regressions used to further analyze significant correlations for Colombia on TIMSS 2007 data are presented in Table 4 below.[66] The analysis suggests that, after controlling for student characteristics, the frequency of bullying incidents during the last month, having a female teacher and having a teacher with high expectations of his/her students have a significant correlation with math achievement in the eighth grade. On average, having a female teacher has a positive effect of 12.6 points and having a teacher with high expectations has an effect of 16.35 points.

[66] The production function used in this analysis has key limitations in that it can only evaluate the relevance of variables included in the model. Therefore, it is unable to account for the interaction of other variables which are not included in the model.

**Table 4: Colombia, Factors associated with mathematics achievement**

| | | Coef | P>\|t\| |
|---|---|---|---|
| System | High parental support for student achievement | -1.43 | 0.93 |
| | High parental participation in school activities | 7.40 | 0.48 |
| School | School located in rural area | -17.24 | 0.25 |
| | 50 < of students comes from economic disadvantage families | -10.29 | 0.23 |
| | bully incidents during the last month | -5.89 | 0.00 |
| | Having a female teacher | 12.60 | 0.06 |
| | Teacher with math as a major area of study | 1.45 | 0.88 |
| | Teachers have high expectations for students | 16.35 | 0.01 |
| | Attending to a private school | 10.74 | 0.25 |
| Student | Age of student | -16.03 | 0.00 |
| | Female | -34.04 | 0.00 |
| | Mother with higher education (vocational or tertiary) | 13.52 | 0.02 |
| | 11-25 books at home | 11.00 | 0.02 |
| | 26-100 books at home | 19.01 | 0.00 |
| | 101-200 books at home | 22.89 | 0.03 |
| | 200 < books at home | 21.05 | 0.09 |
| | Computer available at home | 11.18 | 0.04 |
| | Constant | 610.11 | 0.00 |

Note: R-Squared = 0.24

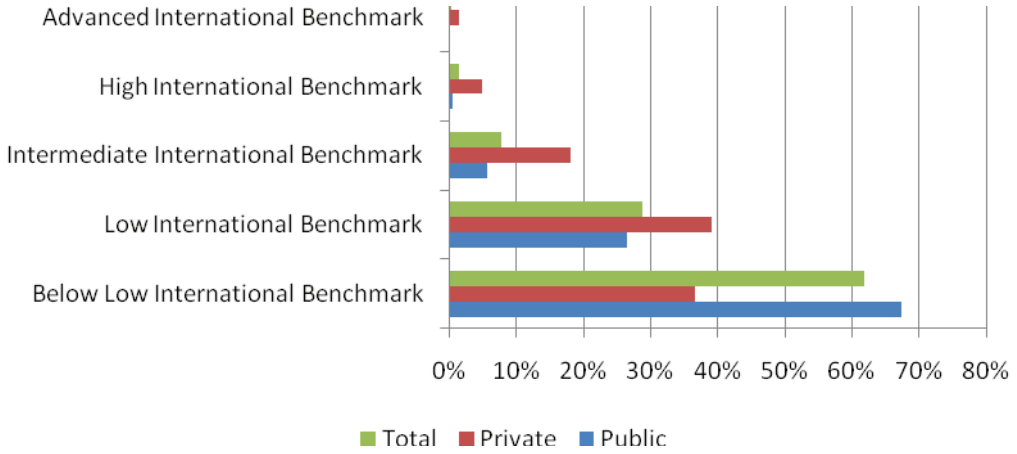
3.24 ***Rural schools*** are low performers, as mentioned previously. When analyzing some of the factors that may contribute to lower school performance in rural schools, three factors stand out—expectations of teachers, parental support ***for*** high achievement, and teachers having a major in mathematics. In Colombia, one hundred percent of teachers[67] in rural areas report that parents do not support high student achievement, nor are they involved in school activities. The data show that these students perform significantly less well than their counterparts on TIMSS 2007. A quarter (24.55 percent) of teachers in rural communities report that they do not hold high expectations for their students, compared to 21.54 percent of teachers in more populated areas. Students of teachers with low expectations also performed significantly less well than their counterparts.

3.25 34 percent of teachers in rural areas of Colombia do not have a major in mathematics, compared to 19.86 percent of teachers in more highly populated areas. Similarly, 97 percent of teachers in more populated areas have finished their first or second stage of tertiary education, compared to 84.92 percent of teachers in rural areas. While there was no difference in the performance of students by the teachers' level of school completion, there was a significant positive difference between student performance and teachers having a major in mathematics. Approximately 15 percent of teachers in rural areas said they had not participated in teacher professional development training in mathematics during the past 2 years, compared to 8 percent of teachers in urban areas.

[67] Here it is important to notice that results may be influenced by a self-reporting bias.

3.26 ***School type*** has also been shown to have an important relationship with student performance. In Colombia, the small proportion of students (2 percent) reaching the Advanced and High Benchmarks attended private schools; no public school student in Colombia scored above the Intermediate International Benchmark, and the majority (over 65 percent) scored in the Below Low International Benchmark category, as illustrated in Figure 24 below.

**Figure 24: Percentage of Colombian eighth graders reaching international benchmarks of TIMSS 2007 Math, by school type**




3.27 Furthermore, although school type initially appears to explain a significant amount of the difference in scores between public and private school students, as the model is corrected for student (including household or family) factors, this significance becomes less pronounced. Moreover, when the model is corrected for school and institutional level factors, there appears to be no statistically significant difference between the average score of eighth grade Colombian students at private schools versus that of their peers at public schools. (See Annex 14 for results from the production function analysis of Colombia's private school on TIMSS 2007 Math.)

***Section 4: Factors affecting low benchmark attainment***

3.28 In order to determine possible reasons why some students score above the lowest benchmark, the Logit Model (Verhulst, 19th century, and others) is applied. This model can be used to determine the variables that are likely to keep a student from attaining a higher score.[68] Results from the Logit Model analysis (shown in Annex 17) suggest that five variables are significantly related to students' scoring above the lowest international benchmark; three of these variables (lack of school safety, female gender, and higher student age,) are significant predictors for falling into the lowest international benchmark and two (books at home, and student has a female math teacher) are significant predictors for achieving higher than the lowest benchmark.

[68] Using binary probability to estimate the maximum likelihood that a student will achieve a score that is above the lowest benchmark category, this model uses one explanatory variable (not falling into the lowest benchmark category) to estimate unknown parameters (to determine to what extent other variables may be related to this outcome).

***Section 5: Predictors of learning outcomes in Colombia and other lower middle-income countries***

3.29 To test the validity of the model used to analyze the factors associated with learning in Colombia, the same model was applied to a select group of four economic peer countries. In this section, details are presented regarding the predictors of test scores as a result of the interaction of different student, school, and institutional characteristics in Colombia and four economic peer countries (El Salvador, Jordan, Tunisia, and Bosnia and Herzegovina). The production function applied to Colombia in the previous section is again used, with one difference: the school type variable is removed because of country sampling categorization variations. The resulting production function, an econometric model, is applied individually to all five countries (the four comparator lower middle income countries and Colombia) to estimate the size and direction of the variables' effects on determining overall test scores in each.[69] Annex 15 presents the results of an econometric model incorporating country-wide, institutional, school, family, and student characteristics to measure their effects on education outcomes among eighth grade students, across five lower middle income countries.

3.30 When the production function for Colombia[70] is applied to the four comparator lower middle income countries, several key findings are interesting to note. First, bullying incidents are negatively and significantly related to student performance in each of the peer countries analyzed. This suggests that efforts to mediate this concern would also positively impact learning. Second, in all of the sample countries the number of overage students has a significant and negative relationship with student achievement in mathematics, suggesting that efforts to reduce repetition and late entry will improve learning outcomes. Third, the presence of books and computers in the home is positively and significantly correlated with student achievement in all of the countries. While this is a common proxy for family income, it presents the possibility that increasing access to these learning materials for low income students could have a positive impact on learning. Finally, being a female student emerged as a factor affecting negative performance in all of the observed countries, with the exception of Jordan, suggesting that greater attention is needed to understand the role of gender in math learning.

***Section 6: Understanding the difference between Colombia and higher performing countries (TIMSS 2007)***

3.31 While it is necessary to understand how Colombia compares to its economic peers, it is also important to evaluate how it compares to a group of high performing countries. This section details the predictors of test scores as a result of the interaction of different student, school, and institutional factors in Colombia and three high-performing comparison countries with varying GDP levels (Korea, Hungary and Jordan). Korea - chosen for its outstanding performance and relatively higher GDP, Hungary - chosen for higher than expected score given its level of GDP, and Jordan – chosen because it has a similar GDP to Colombia and yet scores higher than Colombia. An analysis of these three countries and associated factors with learning will facilitate

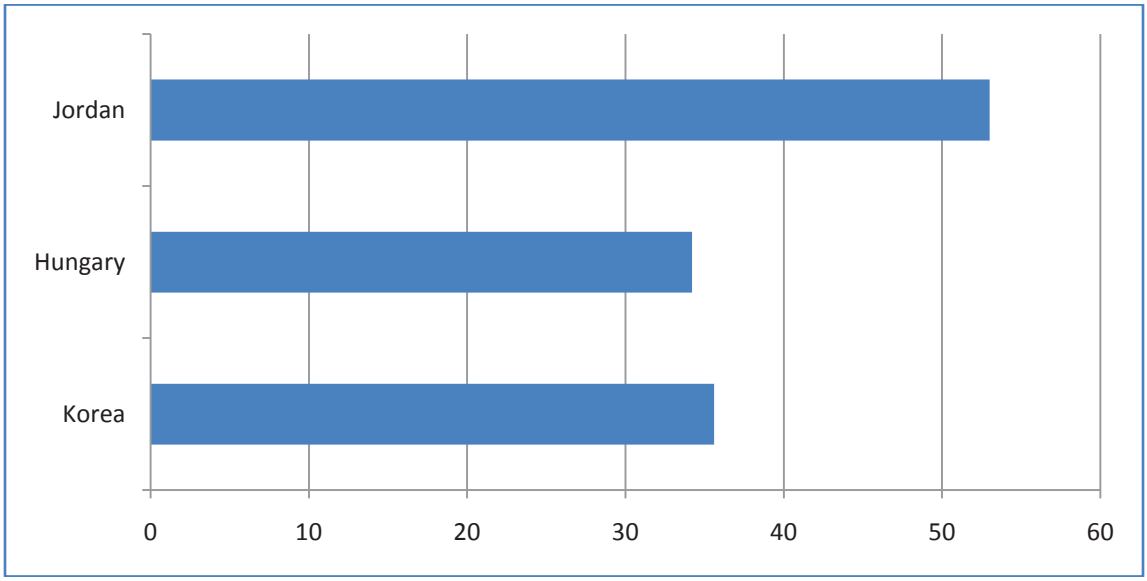
[69] Again, while the analysis is not causal, the estimation method applied allows for a close approximation of the degree and direction of association between two variables, a significant piece of information for policymakers designing interventions aimed to improve educational outcomes.

[70] The production function applied to the four other lower middle income countries was equivalent to that applied to Colombia with one exception: public vs. private schooling was not considered due to country context differences.

a deeper understanding of where Colombia's gaps are and how they could be bridged. (See Annex 16 for more information regarding these high performing countries.)

3.32 GDP is a well established predictor of test scores; however some countries manage to perform better than expected given their GDP level (see Figure 10). Despite improvements, Colombia does not yet reach the trend line, which suggests that substantial room for improvement remains for Colombia to perform as expected. The presence of countries above this trend line indicates that GDP and economic wealth are not the sole factors affecting educational achievement and that there are other factors that allow certain countries to perform well despite being relatively less wealthy. The model presented here is not able to capture all of the potential factors that allow high performing countries to succeed; however, it is able to isolate the relationship of certain observed student characteristics, which are often used as proxies for socioeconomic status. As illustrated in Figure 25 below, student characteristics account for just over a third of the test score differential between Colombia, Korea, and Hungary. This suggests that two thirds of the test score differential cannot be explained by student characteristics or family background and instead may be due to differences between the relevant education systems. In Jordan, half of the test score differential can be explained by students characteristics, which is to be expected as Jordan and Colombia share similar student characteristics as two lower middle income countries. However, this also suggests that half of the difference in scores between a higher performing Jordan and a lower performing Colombia are not related to the socioeconomic status of students and rather refer to other variables present in and adding value to the education system. Further research and analysis is needed to determine which of the many possible variables could be responsible for high achieving school systems; however the section that follows is a first attempt.

**Figure 25: Percentage of Observed Test Score Differential Explained by Variables Included in the Model**



***Analysis of Factors of Learning between Colombia and high-performing comparator countries***

***Korea: high income top performer***

3.33 Analysis to isolate the factors that explain why students in top performing Korea scored higher on TIMSS than students in Colombia reveals that a third (35.6 percent) of the observed test score differential (219.5 points) between Korea and Colombia is explained by the variables in the model. Thus, slightly less than two thirds (64.4 percent or 141.4 points) of the score differential are not captured by the variables in the model and are due to factors not related to student characteristics. (See Box 2 for more information about Korea). It is therefore necessary to examine other factors that may explain why the average Korean scored much higher than the average Colombian student. However, results indicate that the education system itself in Korea may be doing a better job of delivering a quality education than the Colombian system.

3.34 Of the overall difference between test scores in Korea versus Colombia, 17 percent can be attributed to the higher proportion of Korean students (98 percent, vs. 35 percent in Colombia) with a computer at home. Interestingly, having a computer in Korea appears to have a greater impact on score than in Colombia: while Colombians with a computer at home score an average of 16.92 points more than those who do not, in Korea students with a computer average 59.31 more points than those without. Another important factor in explaining the difference between Korea and Colombia's TIMSS performance is the number of books available at home: 7.2 percent of the explained differential can be attributed to students having between 101 and 200 books at home and 11.4 percent can be attributed to students having more than 200 books at home. With this second factor, the differences between Korea and Colombia are large. In Korea, 55 percent of eighth graders have over 101 books at home, while in Colombia only 8 percent of students have access to this many books at home. This gap may be due to differences in income and underline the need to increase access to learning materials in low income countries.

***Hungary: upper middle income good performer***

3.35 Analysis of the extent to which differences in student factors can be attributed to higher scores in Hungary shows that a third (34.2 percent) of the observed test score differential (134.1 points) between Hungary and Colombia is explained by the variables in the model, similar to Korea. Thus, roughly two thirds (65.8 percent or 88.3 points) of the score differential are not captured by the student characteristic variables in the model and are due to any number of external factors, which might explain why the average Hungarian student scored much higher than the average Colombian student.

3.36 Of the overall difference between Colombia and Hungary's performance on TIMSS 2007, according to the analysis, 16.7 percent can be attributed to having over 200 books in the home and 10.3 percent to having a computer at home. It is interesting to note that while 38 percent of Hungarian eighth grade mothers have a tertiary degree and just 23 percent of Colombian mothers do, mother's education only accounts for 2.8 percent of the reason that students in Hungary score higher than those in Colombia, which may indicate that Hungary is

able to promote educational opportunities for all students, even those who are not from an educated background.

***Jordan: economic peer with higher test scores***

3.37 Analysis to explain why students in Jordan, a country with similar GDP, scored higher on TIMSS than students in Colombia revealed valuable information. Results suggest that over half (53 percent) of the observed test score differential (50.9 points) between Jordan and Colombia is explained by the variables in the model listed above. Accordingly, less than half (47 percent or 23.9 points) of the score differential cannot be explained by the student characteristic variables listed in the model.

3.38 The importance of having a computer in the home was the largest contributing factor to the higher test scores in Jordan (22.7 percent). Interestingly, the relationship between having a computer at home is relatively the same for students in Jordan and Colombia,[71] unlike in the earlier comparison between Colombia and Korea where a computer at home had a much larger relative correlation with test scores in Korea. Mother's education is the second highest explanatory variable for higher scores in Jordan: 9.2 percent of the explained score differential between these two lower middle-income countries can be attributed to whether or not a student's mother has a tertiary degree (in Jordan 35.17 percent of mothers do while in Colombia 23.83 percent do). Surprisingly, gender has precisely the opposite effect in Jordan as it does in Colombia: female Jordanian eighth graders average 16.43 more points on TIMSS 2007 math than their male counterparts while females in Colombia score an average of 32.29 points lower than their male peers, indicating that Jordan has made better progress educating girls. According to the United Nations 2007/2008 Human Development Report, Colombia had a much higher Gini Index than did Jordan (by approximately 20 points[72]). This indicates that wealth and certain opportunities (including education) are more equitably distributed in Jordan and may account for why Jordanian mothers have more education on average than Colombian mothers, and also for part of the reason that Jordanian eighth graders scored higher on the TIMSS 2007 eighth grade math assessment than did their Colombian peers. (See Box 1 for more information about Jordan).

3.39 Student factors related to income are important for educational achievement; however, they are only part of the story. In both Korea and Hungary, student factors account for just a third of the difference in score between those countries and Colombia. This leaves a large amount of room for school and institutional factors to contribute to a value added system and improved student achievement. This indicates that policy changes could be made to improve Colombia's performance and add more value to the education system. (See Annex 15 for the decomposition results for the three comparison countries).

[71] Students in Jordan with a computer score an average of 30 points higher than those who do not, while those in Colombia with a computer score an average of 16.92 points more, but the overall impact on score is half as much in Colombia (.35) as in Jordan (.73).

[72] Data given in the 2007/2008 HDR: Colombia's Gini reported as 58.6 (2003) and Jordan's Gini reported as 38.8 (2002/2003).

# CHAPTER 4: POLICY AMENABLE OPTIONS: MAIN FINDINGS AND RECOMMENDATIONS

4.1 ***The first chapters of this report provide background information on Colombia's education system and the TIMSS assessment, analyses of new TIMSS 2007 data in light of the country's previous scores on TIMSS 1995, and further analysis of the factors that are associated with student learning in Colombia, based on the country's participation in TIMSS 2007 and PISA 2006***. The findings contribute to the international body of knowledge on the factors related to student achievement over time and comprise an important addition to the research on quality of education in developing countries, which is relatively scant. The TIMSS analysis presented in this report highlights the glaring performance gaps among students, first observed in the PISA Report, and serves as a call to action for the Colombian government. The international and Colombian research base, as well as successful approaches of other countries facing similar challenges, suggest a number of policy options for addressing these gaps. While the TIMSS (and PISA) results on the predictors of student learning show correlation rather than causation and should therefore be used with caution in formulating policy recommendations, they suggest areas for further research that may aid policy development.

### *Main Findings, International Comparisons, and Recommendations*

4.2 Colombia has made significant improvement between 1995 and 2007, more than any of the other participating countries. This improvement is all the more impressive when viewed in the context of changes that have taken place in Colombia's education sector over the period, including increased access to education among low-income families and lower dropout and repetition rates among eighth grade students.

4.3 Despite the notable progress made, Colombia performs less well than several countries that have the same or lower per capita GDP and urgent improvements in quality and equity are needed. Most of the country's students (61 percent) did not manage to reach the Low Benchmark on the TIMSS 2007 assessment.

### *Recommendations*

4.4 ***Reducing the proportion of students at the bottom proficiency levels of international assessments has to be the number one priority of education policymakers in Colombia***. For Colombia to achieve sustainable and equitable economic growth, it needs to improve learning outcomes among all students, but particularly among the significant proportion of its population that does not achieve minimum levels of performance. Based on the analysis of TIMSS results presented in this report, which confirms and further supplements that provided in the PISA Report, Colombia's participation in international assessments reaffirms the importance of:

- Continuing participation in and learning from international and national assessments
- Enabling disadvantaged populations to achieve high standards
- Systematically enhancing the quality and accountability assurance system

4.5 ***(a) Continue participation in and learning from international assessments***. The regular and systemic use of accurate assessment data provides a strong foundation for education quality by enabling system benchmarking, informing decision-making at all levels, and galvanizing public involvement and support. Colombia could use its participation in international assessments - including TIMSS and PISA - to benchmark the performance of its education system against international standards and to adapt policy[73] so as to progress toward achievement of those standards. In particular, it might consider setting performance targets for future rounds of assessments as part of its National Education Plan and supporting studies that examine effective processes and procedures used in countries with similar or lower GDPs and having higher levels of student achievement. Further, by participating in each future application of TIMSS and PISA, Colombia could build a data set that allows for closer evaluation of the effect of time changes on student learning. In addition, by ensuring that key programs (such as *Escuela Nueva*) are included in Colombia's country-specific background questionnaires for TIMSS, data could be gathered and used to analyze the results of particular policies and/or programs. In relation to these ideas, Colombia could learn from the experience of Jordan (see Box 1 below), a lower middle-income country that has used international assessments and other benchmarking tools to achieve impressive gains.

**Box 1: Jordan's use of international education assessment to improve the quality of education**

Jordan has taken a bold step by using the results of international assessments as a catalyst for a full-fledged education reform. In 1990, Jordan participated in the second International Assessment of Educational Progress (IAEP II), a predecessor to TIMSS, which triggered further inquiry because students had answered only 40 percent of mathematics questions (and 57 percent of science questions) correctly. After a series of investigations and an item-by-item examination of the test, school curricula, and the administration of practice tests, Jordan re-administered the tests. The results were almost identical to previous scores.

These findings led to the 1995 education reform in which data from IAEP II served to (1) establish benchmarks of 13-year-olds' achievements in mathematics vis-à-vis the performance of 20 countries; (2) reveal areas of weakness and strength in each subject; (3) compare the performance of students in schools that are run by different education authorities, in different administrative regions, and in different regions; (4) identify certain cognitive processes involved in learning and respond with a view to informing teachers' pre-service and in-service training programs; (5) analyze the family and home characteristics associated with student achievement in mathematics (and science); and (6) target the negative and positive influences of various classroom practices, out-of-school student activities, and student attitudes on achievement in mathematics and science.

[73] A number of countries have used their scores on the cognitive and content domains of TIMSS to inform curriculum changes. After analyzing its results in earlier rounds of TIMSS, Japan noticed that its students were relatively stronger in computational skills than in analysis and applications. This observation led to a change in the curriculum to reduce emphasis on computational skills and today Japan is one of the top performers in both TIMSS and PISA. In preparing new teacher guides and curricular reforms, New Zealand has also placed special emphasis on strengthening areas of math where students scored relatively poorly on TIMSS (2003). In addition, Cyprus and South Africa have made commitments to alter their curriculums in response to their TIMSS (2003) results. (Kellaghan and Greaney 2001)

Jordan's case demonstrates the importance of government's commitment to use the results of international assessments for informing policymakers and the general public, policy analysis for education reform, and national capacity-building in assessment and analysis.[74]

4.6 In addition, assessment data could be more broadly and consistently disseminated and used at all levels to enable participants to contribute more fully in the education improvement process. Information from assessments can be used to identify where schools and regions are failing students and to target policies and programs that improve teaching and administrative practices and to support struggling students. Currently, school improvement plans are used; however, no monitoring is carried out to determine the extent to which test result data contributes to their design. Parents can use assessment data to monitor their children's learning and help their local schools improve. Colombia could also consider using assessment results to engage the public and mobilize support for education, as it has done with the *Plan Decenal*. These policy options rest on the strength of the national assessment system itself, which Colombia has taken important steps to develop and improve[75] and should continue to do moving forward.

4.7 ***(b) Enable disadvantaged populations to achieve high standards***. Colombia faces a systemic problem in providing a quality education to certain populations, which the country must rectify through carefully targeted and continuously evaluated policies and programs. Both the TIMSS and PISA analyses point to the need to identify and implement strategies to raise the achievement of the lowest-performing students, and the literature indicates a strong correlation between family income and student achievement. Colombia has demonstrated its openness to experimentation and rigorous impact evaluation in the implementation of education programs, including those targeting disadvantaged students and families (such as *Familias en Acción, Escuela Nueva*, *Concesiones*, PER I and PER II, and PACES). In this spirit, it is important that Colombia continues to implement, evaluate, refine, and expand programs proven to increase enrollment, advancement, and achievement among poor, rural, and ethnic minority students, as well as those affected by violence. Improving school readiness through improvements in coordinated delivery of high-quality early childhood development (ECD) services is particularly important. Colombia has recently taken key steps towards accomplishing this (with the National Policy for Early Childhood Development *Colombia por la Primera Infancia*" presented in CONPES 109 and the new (2009) ECD policy -"*Política Educativa para la Primera Infancia*"); these efforts should continue. In addition, Colombia needs to identify the source(s) of the academic disparities between girls and boys and expand appropriate and effective strategies to address these disparities. The gap between female and male student achievement identified by

[74] Patrinos, Harry *et al.* "Brief on the Use of International Assessments to Benchmark Education Systems for Results," unpublished: Washington, D.C. June 25, 2009.

[75] In 2009, Colombia's Congress passed Law 1324 which supports the institutional transformation of its national assessment institute (ICFES) from a public entity focused primarily on assessment and the reporting of results, into an *empresa estatal de carácter social.* As such, ICFES will play a larger role in evaluating primary and secondary schooling to improve education quality in Colombia while at the same time gaining administrative autonomy from MEN and being allowed to conduct work on a commercial basis at the local and international levels. This transformation, which took place within the sector's ongoing decentralization, provides an excellent opportunity for ICFES to improve its ability to design, conduct, analyze and disseminate the results of national assessments and other forms of evaluation, and to promote a culture of evaluation and results-based learning throughout the sector.

the TIMSS analysis suggests the need for a greater understanding of the problem through research and the corresponding development of an appropriate strategy, be it school-based, family-based, or both. For example, if research determines that classroom dynamics, peer effects, or teacher gender are negatively affecting female student achievement, then an appropriate strategy would include teacher and administrator training, classroom modules for students, or same-sex classrooms for certain subjects. In addition to supply-side strategies, demand-side interventions may also be needed to attract and retain girls in school. If research finds that female students have greater work and home responsibilities that compete with school for their time and attention, or families place less value on girls' education, then a potential strategy would include conditional cash transfer or voucher programs specifically targeted at girls.[76] Colombia should also seek to provide increased opportunities for all students to access ICT and other learning materials by developing strategies to increase the books and computers available to families for use at home.[77] Finally, Colombia might consider adopting strategies that would increase the number of female mathematics teachers and providing greater incentives for teachers to work in rural and high poverty schools. Colombia could learn from the experience of other countries regarding how to address the needs of disadvantaged students and the teachers and schools that serve them. Korea (see Box 2 below) provides an instructive example of how a sequential policy approach can be used to improve education quality and equity.

**Box 2: Korea: A sequential approach to improving education quality and equity**

Korea's consistently strong performance in recent international assessments - 4th overall in PISA 2006 math assessment with an equitable distribution of student scores among international benchmarks and 2nd overall in TIMSS 2007 eighth grade math with 40 percent scoring at the highest "Advanced" international benchmark - is a reflection of an education system that has consistently focused on providing quality education opportunities to all children by adopting a sequential approach to reform. A number of policies have contributed to Korea's success:

- **Linking education policies to macroeconomic development:** Past top-down education planning (1962-1991) has been replaced by adoption of a coordinated approach under the National HRD Plan (2001-2008), in which education policies form a key part of government strategy to use human

[76] Evaluations of Mexico's *Oportunidades* program indicate that the program significantly increased the enrollment and retention of girls.

[77] Recent efforts in Uruguay provide an interesting reference point: In May 2007, Uruguay launched an ambitious plan to increase these percentages known as the Basic Information Educational Program for Online Learning (CEIBAL). The program's objective is to provide all public primary school students and teachers with free laptop access and the training necessary in order to build ICT competencies. To accomplish this, multiple government agencies and volunteers are working together to provide teachers with the resources and training necessary to adapt instruction to a digitized classroom to allow for a more dynamic learning environment that encourages innovation and creates a culture of life-long learning. CEIBAL is not oriented toward creating an IT-friendly environment merely inside the classroom, but also outside as students are expected to take their laptops home so that the computer can then be shared among family members. By going a step further and combining the distribution of computers with a program to train teachers in the cognitive skills needed to use IT for maximum benefit and encouraging children to bring technology home, CEIBAL is different from previous efforts to bridge the digital divide in Uruguay and other Latin American countries that simply involved distribution of computers with little or no training in how to use them. (Source: America's Quarterly, Winter 2009, article available at: http://www.americasquarterly.org/node/370).

resources as an engine for growth.

- **Providing equitable education for all**: From 1974 Korea has instituted an equalization policy to assign students to upper secondary schools via a lottery system instead of by academic performance[78] producing well-integrated schools with students of varying abilities.[79]
- **Sequential expansion of education investment**: Prior to 1975, 65 percent of the education budget was spent on primary education. Investment was then extended to secondary education and, since the late 1990s, to tertiary education, where public funding for performance-based university programs is provided as a mechanism to improve quality.
- **Restructuring the entire system**: In 1995, a comprehensive sector reform began, which included school deregulation, school-based management, and expanded school choice through School Councils ("Hak-Un Wi"). Additionally, over 300 autonomous schools were created, curriculum was reformed to be more student-centered (with focus on enhancing individual talents and creativity for a knowledge-based economy), relevant ICT use was promoted, and public financing was increased (to 5 percent of GDP).
- **Using the results of international assessments to set education goals**: Korea has used the results from international assessments such as TIMSS and PISA to set education goals, which include attaining or surpassing average international standards on each assessment.

**As a result of these efforts, Korea has made important advances** in education over the past several decades. In particular:

- **Enrollment rates are high and rising**: Primary and secondary rates are over 90 percent, and tertiary rates are rising rapidly (over 70 percent in 2009), and there are no discernable differences in education access across different socio-economic groups (UNESCO 2009).
- **Dropout rates have decreased**: In 1980, the middle school dropout rate was 3.5 percent, while in 2009 it had fallen to less than 2 percent. Reductions are similar for high school and primary school.
- **Nearly all students are completing secondary school**: In 2009, Korea achieved the OECD's highest level (just under 100 percent) of secondary education attainment among 25-34 year olds. This achievement is even more impressive when viewed against that of earlier generations: among 55-64 year olds, Korea had one of the lower rates (less than 40 percent). This means that in just one generation, 60 percent more Koreans are successfully completing secondary school.
- **More students are entering tertiary education**: As of 2009, roughly 65 percent of Koreans aged 25-34 years have completed tertiary education, with Korea ranking second highest in the OECD in terms of tertiary attainment (behind Canada). This achievement is particularly striking given that just 10 percent of the prior generation (55-64 year olds) managed to complete a tertiary degree.

4.8 ***(c) Systematically enhance the quality and accountability assurance system***. While Colombia possesses elements of an accountability system, it needs to strengthen them by aligning authority and capacity with responsibility for performance at each level of the system. At the student level, Colombia might consider establishing "high stakes" examinations (such as exit exams) and evaluate their impact on student learning. At the school level, Colombia could establish and enforce standards for school performance, for example through a quality certification process as outlined in the National Education Plan. School improvement programs providing support for teachers and disadvantaged or low-achieving schools could also provide

[78] Initially the policy's official name was the "Equalization of High School Policy" (Educators without Borders 2007).
[79] Kim et al. 2006; Educators without Borders 2007

important benefits. Also, training could be provided to principals to facilitate increased parent participation and both parent and teacher support for high student achievement. It may be instructive to learn from the experience of Chile (see Box 3 below) in improving the efficacy of an evaluation system. While a teacher evaluation system has already been established, the system could be further strengthened. Finally, parents and community members might be granted a greater voice and degree of authority in the school improvement process.

**Box 3: Recent developments in Chile's National System of Evaluation (SIMCE)**

Chile's National System of Evaluation (SIMCE) analyzes student learning results for the Ministry of Education on a number of national and international assessments including SIMCE, TIMSS, PISA, and LLECE. SIMCE's primary objective is to contribute to the improvement of educational quality and equity in Chile, informing stakeholders on student development in relation to the national curriculum and other countries, and relating this development to the school and socio-economic context in which Chilean students are studying.

At the national level, SIMCE are given to all 4th and 8th grade students every year in the subject areas of math, language, and natural and social sciences. In order to get a clear sense of how well students are learning over time, in 2004 SIMCE began using the SIMCE to also test different cohorts of students as they moved through the education system, in addition to conducting census exams by grade level, on an annual basis.

In 2007, SIMCE established three national benchmarks (Beginning, Intermediate and Advanced) to relate students' achievement on SIMCE to their level of accomplishment according to the content and development standards set by the current national curriculum. In order to raise awareness among teachers of the newly strengthened relevance of SIMCE to the national curriculum, SIMCE has published a series of short booklets for teachers that explain how the national benchmarks were established and highlight questions from SIMCE that correspond to each benchmark to give teachers a clear indication of the types of things they might focus on in the classroom to improve both student learning of the curriculum and student scores on SIMCE.

Source: www.simce.cl

4.9 ***(d) Systematically monitor, evaluate and refine accountability mechanisms***. The TIMSS analysis may indirectly suggest that parents' orientation toward learning, manifested by making educational resources such as computers and books available in the home, has a positive correlation with their children's achievement. While parents may have the desire, incentive, and capacity to improve their children's school, they often lack any voice or authority in the school improvement process. A strengthened accountability framework would therefore involve parents and the community to a greater extent and enable them to participate in setting clear goals and visions for the school system. Policies and programs that foster parent involvement might be evaluated to determine their most effective elements.

The important gains made in terms of educational quality in Colombia can be better understood and expanded upon with greater utilization and application of test result data, combined with a continuation of efforts to reach disadvantaged populations and enhance quality and control mechanisms within the education system.

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# ANNEX 1: SUMMARY OF COLOMBIA'S PERFORMANCE ON INTERNATIONAL AND REGIONAL ASSESSMENTS (IN CHRONOLOGICAL ORDER)

| Assessment | Subject(s) | Year | Grade levels participating | Number of countries participating | Colombia's performance |
|---|---|---|---|---|---|
| Trends in International Mathematics and Science Study (TIMSS) | Math and science | 1995 | Grades 7 and 8 | Grade 7: 39<br><br>Grade 8: 41 | Mean scores, Colombia vs. International average:<br><br>**Math:**<br>**Grade 7: 369 v.484**<br>**Grade 8: 385 v. 512**<br><br>Science:<br>7 grade: 387 v. 479<br>8 grade: 41 1 v. 516 |
| *Primero Estudio Internacional Comparativo* | Language, math and associated factors | 1997 | Grades 3 and 4 | 13 | For both subjects:<br>Grade 3: < reg. mean<br>Grade 4: > reg. mean |
| Progress in International Reading Literacy Study (PIRLS) | Reading | 2001 | Grade 4 | 35 | Mean scores, Colombia vs. International average: 422 v. 500 |
| *Segundo Estudio Regional Comparativo y Explicativo* (SERCE) | Language and math (grade 3 and 6), Natural sciences (grade 6) | 2006 | Grades 3 and 6 | Language and Math: 16 (+ 1 Mexican state)<br><br>Sciences: 9 (+ 1 Mexican state) | Language:<br>Grade 3: > reg. mean<br>Grade 6: > reg. mean<br><br>**Math:**<br>**Grade 3: at reg. mean**<br>**Grade 6: at reg. mean**<br>Sciences: at reg. mean |
| Programme for International Student Assessment (PISA) | Reading, math and science | 2006 | Grades 8,9, 10, 11 (15 yr-olds) | 57 | Mean scores, Colombia vs. OECD countries:<br>Reading: 381 v. 492<br>**Math: 370 v. 498**<br>Science: 388 v. 500 |

| Assessment | Subject(s) | Year | Grade levels participating | Number of countries participating | Colombia's performance |
|---|---|---|---|---|---|
| | | | | | Mean scores, Colombia versus LAC average:<br>Reading: 381 v. 403<br>Math: 370 v. 394<br>Science: 388 v. 408 |
| Trends in International Mathematics and Science Study (TIMSS) | Math and science | 2007 | Grades 4 and 8 | | Mean scores, Colombia vs. International average:<br><br>**Math:**<br>**4th grade: 355 v. 500**<br>**8th grade: 380 v. 500**<br><br>Science:<br>4th grade:# v. 500<br>8th grade: # v. 500 |

Sources: UNESCO, OECD, IEA

## ANNEX 2: DESCRIPTION OF *PLAN DECENAL*

The current *Plan Decenal* was developed through a four-phase participatory process that took place between November 2005 and September 2007. The highly structured process, guided by a steering committee, provided multiple opportunities through various channels for the public to shape and refine the contents of the *Plan*. In the first phase, spanning November 2005 to October 2006, research organizations and the government laid the groundwork for the process by documenting reflections on the prior *Plan Decenal* and establishing a vision for the future, articulated in *Visión 2019*. The steering committee developed an initial, ten-point agenda for the new *Plan*, and in the second phase, from October 2006 to January 2007, institutions involved in education were given the opportunity to respond to these points online. The steering committee then studied these responses and, in coordination with the *Plan* management team, revised the agenda. The third phase, from January to May 2007, comprised a public debate, in which stakeholders reacted to and expanded upon the agenda through 13,000 phone calls and 1,000 emails, online forums, and work groups formed across the country. All of their contributions were systematically summarized and made publicly available. In the fourth phase, a National Assembly for Education, representatives from work groups, virtual forums, and citizen proposals gathered to review these data and deliberate on the *Plan*'s objectives, goals and actions.

These deliberations were consolidated in the preliminary document, "*Plan Nacional Decenal de Educación*," which outlines the *Plan*'s priority areas, as well as the mechanisms for its implementation.

The document elaborates objectives and goals for the following 10 themes:

1. Purpose and Quality of Education in the 21st Century
2. Education in and for Peace, Living Together, and Civic Involvement
3. Pedagogical Improvement and the Use of Information Technology in Education
4. Integrating Science and Technology into Education
5. More and Better Investment in Education
6. Early Childhood Development and Education
7. Educational Equity, Access, Persistence, and Quality
8. Leadership, Management, Transparency, and Accountability in the Education System
9. Professional Development, Professionalization, and Capacity-Building for Teachers and School Directors
10. Other Actors in and beyond the Education System

A National Implementation Commission, whose process for formation the document describes and who are tasked with managing the implementation of the *Plan*, will assume responsibility for developing a strategic plan and convening assemblies in which the MEN and *Secretarías de Educación* report on their progress in achieving the *Plan*. A National Implementation Network and the *Plan*'s web portal will continue to inform the public and enable its participation in the implementation of the *Plan*, which will be monitored by an *Observatorio.*

# ANNEX 3: COUNTRY PARTICIPATION IN THE TIMSS ASSESSMENTS, BY GRADE AND YEAR [80] [81]

## Country participation in the TIMMS mathematics assessment

| | Grade Four | | | Grade Eight | | | | | Grade Four | | | Grade Eight | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **1995** | **2003** | **2007** | **1995** | **1999** | **2003** | **2007** | **Country** | **1995** | **2003** | **2007** | **1995** | **1999** | **2003** | **2007** |
| **Total** | **26** | **25** | **36** | **41** | **38** | **46** | **48** | | **26** | **25** | **36** | **41** | **38** | **46** | **48** |
| Algeria | | | √ | | | | √ | Korea, Rep. of | √ | | | √ | √ | √ | √ |
| Armenia | | √ | √ | | | √ | √ | Kuwait | √ | | √ | √ | | | √ |
| Australia | √ | √ | √ | √ | √ | √ | √ | Latvia | √ | √ | √ | √ | √ | √ | |
| Austria | √ | | | | | | | Lebanon | | | | | | | |
| Bahrain | | | √ | √ | | | | Lithuania | | √ | √ | √ | √ | √ | √ |
| Belgium (Flemish) | | √ | | √ | √ | √ | | Macedonia. Rep. of | | | | | √ | √ | |
| Belgium (French) | | | | √ | | | | Malaysia | | | | | √ | √ | √ |
| Bosnia and Herzegovina | | | | | | | √ | Malta | | | | | | | √ |
| Botswana | | | | | | √ | √ | Moldova, Rep. of | | √ | | | √ | √ | |
| Bulgaria | | | | √ | √ | √ | √ | Morocco | | √ | √ | | √ | √ | |
| Canada | √ | | | √ | √ | | | Netherlands | | | | | | | |
| Chile | | | | | √ | √ | | New Zealand | √ | √ | √ | √ | √ | √ | |
| Chinese Taipei | | √ | √ | | | | | Norway | √ | √ | √ | √ | | √ | √ |
| Colombia | | | | √ | √ | √ | √ | Oman | | | | | | | √ |
| Cyprus | √ | √ | | √ | √ | √ | √ | Palestinian Nat'l Auth. | | | | | | √ | √ |
| Czech Republic | √ | | √ | √ | √ | | √ | Philippines | | √ | | | √ | √ | |
| Denmark | | | √ | √ | | | | Portugal | √ | | | √ | | | |
| Egypt | | | | | | √ | √ | Qatar | | | √ | | | | √ |
| El Salvador | | | √ | | | | √ | Romania | | | | √ | √ | √ | √ |
| England | √ | √ | √ | √ | √ | √ | √ | Russian Federation | | √ | √ | √ | √ | √ | √ |
| Estonia | | | | | | √ | | Saudi Arabia | | | | | | √ | √ |
| Finland | | | | | √ | | | Scotland | √ | √ | √ | √ | | √ | √ |
| France | | | | √ | | | | Serbia | | | | | | √ | √ |

[80] Source: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2007.

[81] The countries in this Table and all data throughout the report are of participating countries and *do not* include benchmarking participants.

| | Grade Four | | | Grade Eight | | | | | Grade Four | | | Grade Eight | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **1995** | **2003** | **2007** | **1995** | **1999** | **2003** | **2007** | **Country** | **1995** | **2003** | **2007** | **1995** | **1999** | **2003** | **2007** |
| **Total** | **26** | **25** | **36** | **41** | **38** | **46** | **48** | | **26** | **25** | **36** | **41** | **38** | **46** | **48** |
| Georgia | | | √ | | | | √ | Singapore | √ | √ | √ | √ | √ | √ | √ |
| Germany | | | √ | √ | | | | Slovak Republic | | | √ | √ | √ | √ | |
| Ghana | | | | | | √ | √ | Slovenia | √ | √ | √ | √ | √ | √ | √ |
| Greece | √ | | | √ | | | | South Africa | | | | √ | √ | √ | |
| Hong Kong SAR | √ | √ | √ | √ | √ | √ | √ | Spain | | | | √ | | | |
| Hungary | √ | √ | √ | √ | √ | √ | √ | Sweden | | | √ | √ | | √ | √ |
| Iceland | √ | | | √ | | | | Switzerland | | | | √ | | | |
| Indonesia | | | | | √ | √ | √ | Syrian Arab Republic | | | | | | | √ |
| Iran, Islamic Rep. of | √ | √ | √ | √ | √ | √ | √ | Thailand | √ | | | √ | √ | | √ |
| Ireland | √ | | | √ | | | | Tunisia | | √ | √ | | √ | √ | √ |
| Israel | √ | | | √ | √ | √ | √ | Turkey | | | | | √ | | √ |
| Italy | | √ | √ | | √ | √ | √ | Ukraine | | | √ | | | | √ |
| Japan | √ | √ | √ | √ | √ | √ | √ | United States | √ | √ | √ | √ | √ | √ | √ |
| Jordan | | | | | √ | √ | √ | Yemen | | | | | | | |
| Kazakhstan | | | √ | | | | | | | | | | | | |

# ANNEX 4: DETAILED OVERVIEW OF TIMSS 2007[82]

## Overview of TIMSS

IEA's Trends in International Mathematics and Science Study (TIMSS) provides information to improve teaching and learning in mathematics and science. TIMSS assesses achievement in mathematics and science at the fourth and eighth grades and collects a rich array of background information to address concerns about school resources and the quality of curriculum and instruction. Conducted every four years on a regular cycle, TIMSS provides countries with an unprecedented opportunity to measure progress in educational achievement in mathematics and science.

As a project of the International Association for the Evaluation of Educational Achievement (IEA), TIMSS has the benefit of drawing on the cooperative expertise provided by representatives from countries all around the world. The IEA is an independent international cooperative of national research institutions and government agencies that has been conducting studies of cross-national achievement since 1959.

As of 2005, IEA had 62 institutional members. TIMSS 2007 is the most recent in the series of IEA studies to measure trends in students' mathematics and science achievement. The first cycle of TIMSS was in 1995 in 41 countries. The second cycle in 1999 involved 38 countries (26 were able to measure trends). Continuing the regular cycle of studies at four-year intervals, TIMSS 2003 involved more than 50 countries and approximately 60 countries were expected to participate in TIMSS 2007. Nearly 40 of these countries will have trend data, some covering more than a decade back to 1995.

Additionally, to provide each participating country with an extensive resource for interpreting the results and to track changes in curriculum and instructional practices, TIMSS asks students, their teachers, and their school principals to complete questionnaires about the contexts for learning mathematics and science. TIMSS also collects detailed information about the mathematics and science curricula in each country. Trend data from these questionnaires provide a dynamic picture of changes in the implementation of educational policies and practices and help to raise new issues relevant to improvement efforts.

TIMSS data have had an enduring impact on reform and development efforts in mathematics and science education around the world, leading on one hand to continuing demand for trend data to monitor development and on the other to a need for more and better policy relevant information to guide and evaluate new initiatives.

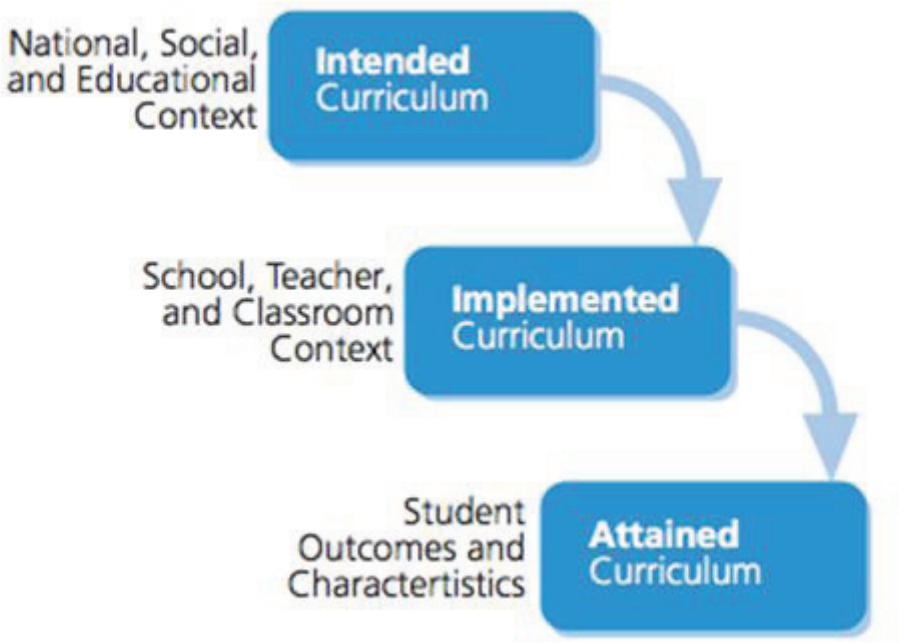
## The TIMSS Curriculum Model

Building on earlier IEA studies of mathematics and science achievement, TIMSS uses the curriculum, broadly defined, as the major organizing concept in considering how educational opportunities are provided to students, and the factors that influence how students use these

[82] From IEA

opportunities. The TIMSS curriculum model has three aspects: the intended curriculum, the implemented curriculum, and the achieved curriculum (see Exhibit 1 below). These represent, respectively, the mathematics and science that society intends for students to learn and how the education system should be organized to facilitate this learning; what is actually taught in classrooms, who teaches it, and how it is taught; and, finally, what it is that students have learned, and what they think about these subjects.

**Exhibit 1: TIMSS Curriculum Model**




Working from this model, TIMSS uses mathematics and science achievement tests to describe student learning in the participating countries, together with questionnaires to provide a wealth of information. The questionnaires ask about the structure and content of the intended curriculum in mathematics and science, the preparation, experience, and attitudes of teachers, the mathematics and science content actually taught, the instructional approaches used, the organization and resources of schools and classrooms, and the experiences and attitudes of the students in the schools.

**The Development Process for the TIMSS 2007 Assessment Frameworks**

The TIMSS Assessment Frameworks for 2007 rely heavily on the extensive effort expended to update the frameworks for TIMSS 2003. For TIMSS 2003, the TIMSS & PIRLS International Study Center engaged in a lengthy and intensive process to update the frameworks used in 1995 and 1999. Supported by the U.S. National Science Foundation, this process involved widespread participation and reviews by educators around the world to ensure the frameworks were appropriate for the many TIMSS countries. To permit the content assessed by TIMSS to evolve, the frameworks used in the 1990s were revised to reflect changes during the last decade in curricula and the way mathematics and science are taught. In particular, for the first time, the Mathematics and Science Frameworks were expanded to provide specific objectives for assessing students at the fourth and eighth grades. An international panel of mathematics and science education and testing experts provided guidance for the general form the assessment frameworks should take and representatives from national centers in the participating countries were asked to play an important role in contributing critiques and advice as the frameworks were developed.

Using an iterative process, successive drafts were presented for comment and review by the TIMSS 2003 National Research Coordinators (NRCs), national committees within participating countries, and expert panel members. The participating countries completed detailed questionnaires, providing valuable feedback about the topics included in their curricula and the suitability and desirability of assessing particular topics at the fourth and eighth grades. As such, the frameworks do not consist solely of content and behaviors included in the curricula of all participating countries. The aim of the thorough consultation on curriculum within countries was to ensure that goals of mathematics and science education regarded as important in a significant number of countries were included.

Beginning with TIMSS 2007, IEA and the TIMSS & PIRLS International Study Center have decided to update the TIMSS Assessment Frameworks with every cycle. Updating the frameworks regularly provides participating countries greater opportunity to review and provide information about the frameworks and results in more coherence from assessment to assessment, permitting the frameworks, the instruments, and the procedures to evolve gradually into the future.

For TIMSS 2007, the frameworks were discussed by the NRCs at their first meeting. Participating countries also consulted with their national experts and responded to questionnaires about the possibility of combining some content areas receiving low priority in previous assessments to improve the potential for measuring trends over time in content areas. The questionnaires also attempted to garner each country's views about adding or deleting particular assessment topic areas and objectives. Revised on the basis of input from the participating countries, the frameworks were reviewed in-depth by the TIMSS 2007 Science and Mathematics Item Review Committee (SMIRC). Using an iterative process, the frameworks as further revised by SMIRC were once again reviewed by the NRCs and updated finally prior to publication.

The *TIMSS 2007 Assessment Frameworks* document closely resembles that for TIMSS 2003. Since it is crucial to have continuity in a study designed to measure trends in educational

achievement over time, this is very appropriate. However, there are some notable revisions. In the Mathematics and Science Frameworks, the content domains are presented separately for the fourth and eighth grades, and there has been a concerted effort to better reflect fourth-grade curricula. At both grades, there was an effort to consolidate the major content areas and adjust the assessment topic areas and objectives to make them more appropriate and feasible in the context of a large-scale international assessment.

The cognitive domains in the Mathematics and Science Frameworks also have been revised for TIMSS 2007. To increase the potential for analyzing and reporting the mathematics and science results according to cognitive domains, the U.S. National Center for Education Statistics provided support to examine and refine the mathematics cognitive domains used in TIMSS 2003. The issue of reporting results for cognitive domains in both mathematics and science was discussed by the NRCs, and the SMIRC mathematics and science experts worked to recast the cognitive domains in mathematics and science, respectively, to develop a classification scheme that encompassed the important cognitive domains assessed by TIMSS while sharpening the distinction among mutually exclusive categories. These revisions were reviewed by the TIMSS 2007 NRCs in parallel with the updates to the content domains.

The Contextual Framework for TIMSS 2007 has changed little from TIMSS 2003, being modified simply to reflect updates to the TIMSS questionnaires given to students, their teachers, and their principles as well as the questionnaires completed by countries about the topics covered in their intended curricula. The Assessment Design, however, has been modified to ensure that students have ample response time and to have a more straightforward booklet design.

In the discussions about updating the frameworks held by the NRCs and the SMIRC as well as by the IEA and TIMSS management and technical groups, the emphasis has been on improving the quality of measurement in the assessments for TIMSS 2007 and on increasing the utility of results for participating countries. This includes assessing content appropriate to the students and important to their future lives, ensuring adequate response time for students, increasing operational feasibility, and maximizing the potential to improve reporting achievement in the content and cognitive domains assessed.

**More about TIMSS[83]**

To be particularly relevant to decision-making and implementing school policy, TIMSS assesses students at two important educational milestones – at the end of four years of formal schooling (end of primary school) and the end of eight years of formal schooling (end of lower-secondary education). Because TIMSS studies the effectiveness of curriculum and instruction in relation to student achievement, it is important for TIMSS to assess mathematics and science achievement at the same point in schooling across countries. That is, for fair comparisons, students should

[83] For detailed information about TIMSS, please see the TIMSS websites: timss.bc.edu and www.iea.nl. Also, see the *TIMSS 2003 International Mathematics Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., & Chrostowski, S.J. (2004) Chestnut Hill, MA: Boston College and the *TIMSS 2003 International Science Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., & Chrostowski, S.J. (2004). Chestnut Hill, MA: Boston College.

have had the opportunity to learn mathematics and science for an equivalent number of years of formal schooling. TIMSS data complement IEA's Progress in International Reading Literacy Study (PIRLS) conducted at the fourth grade. By participating in TIMSS and PIRLS, countries can have information at regular intervals about how well their students read and what they know and can do in mathematics and science. TIMSS also complements the OECD's Programme for International Student Achievement (PISA), which assesses the mathematics, science, and reading literacy of 15- year-olds.

With each cycle, TIMSS releases test questions to the public and then replaces these with newly developed questions. To develop the new questions, the TIMSS & PIRLS International Study Center works with representatives from the participating countries to develop items that measure objectives in the frameworks and adhere to the TIMSS guidelines. The items then undergo an extensive review process involving numerous experts in education, mathematics, science, and measurement, including the SMIRC and the NRCs. The items are field tested in each of the participating countries and then reviewed again by SMIRC and the NRCs prior to selection for data collection.

The tests contain questions asking students to select appropriate responses or to solve problems and answer questions in formats requiring them to construct their own answers. Beginning in TIMSS 2003, an effort was made to place more emphasis on questions and tasks that offer better insight into students' analytical, problem-solving, and inquiry skills and capabilities. Subsequent to instrument development and production, TIMSS is administered to representative samples of students in the participating countries. An enormous amount of energy is devoted to ensuring high quality data. Attention is given to meeting rigorous standards every step of the way through sampling, translation verification, instrument production, test administration, scoring, database construction and documentation, analysis, scaling, reporting, technical documentation, dissemination of the database, and training in how to use the data for secondary analyses.

TIMSS is a major undertaking of the IEA, and together with PIRLS, comprises the core of IEA's regular cycles of studies. IEA has entrusted responsibility for the overall direction and management of the project to its TIMSS & PIRLS International Study Center at Boston College. In carrying out TIMSS, the TIMSS & PIRLS International Study Center works closely with the IEA Secretariat in Amsterdam on country membership and translations verification, the IEA Data Processing Center in Hamburg on database creation and documentation, Statistics Canada in Ottawa on sampling, and Educational Testing Service in Princeton, New Jersey on the psychometric scaling of the data.

**What is the value of TIMSS?**

TIMSS helps countries monitor and evaluate their mathematics and science teaching across time and across grades. By participating in TIMSS, countries can:

- Have comprehensive and internationally comparable data about what mathematics and science concepts, processes, and attitudes students have learned by the fourth and eighth grades.

- Assess progress internationally in mathematics and science learning across time for students at the fourth grade and for students at the eighth grade.
- Identify aspects of growth in mathematical and scientific knowledge and skills from fourth grade to eighth grade.
- Monitor the relative effectiveness of teaching and learning at the fourth as compared to the eighth grade, since the cohort of fourth-grade students is assessed again as eighth graders.
- Understand the contexts in which students learn best. TIMSS enables international comparisons among the key policy variables in curriculum, instruction, and resources that result in higher levels of student achievement.
- Use TIMSS to address internal policy issues. Within countries, for example, TIMSS provides an opportunity to examine the performance of population subgroups and address equity concerns. It is efficient for countries to add questions of national importance (national options) as part of their data collection effort.

## ANNEX 5: TRENDS IN AVERAGE EIGHTH GRADE TIMSS MATH SCORES, BY COUNTRY (1995-2007) [84]

**Trends in average eighth grade math scores, by country, 1995 to 2007**

| Country | Average score | | Difference |
|---|---|---|---|
| | 1995 | 2007 | 2007-1995 |
| **Colombia** | **332** | **380** | **47*** |
| Lithuania | 472 | 506 | 34* |
| Korea, Rep. of | 581 | 597 | 17* |
| United States | 492 | 508 | 16* |
| England | 498 | 513 | 16* |
| Slovenia | 494 | 501 | 07* |
| Hong Kong SAR | 569 | 572 | 04 |
| Cyprus | 468 | 465 | -2 |
| Scotland | 493 | 467 | -6 |
| Hungary | 527 | 517 | -10* |
| Japan | 581 | 570 | -11* |
| Russian Federation | 524 | 512 | -12 |
| Romania | 474 | 461 | -12* |
| Australia | 509 | 496 | -13* |
| Iran, Islamic Rep. of | 418 | 403 | -15* |
| Singapore | 609 | 593 | -16* |
| Norway | 498 | 469 | -29* |
| Czech Republic | 546 | 504 | -42* |
| Sweden | 540 | 491 | -48* |
| Bulgaria | 527 | 464 | -63* |

[84] *$p$< .05 Within-country difference between 1995 and 2007 average scores is significant.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2007.

Fourth-grade students did not participate in TIMSS in 1995 consequently no trend data are available.

## ANNEX 6: THE OAXACA - BLINDER METHOD

The first step of this method is to specify and estimate cognitive achievement production functions that relate students' achievement to individual, family, school, and institutional inputs. The analysis then proceeds to decompose the over time test score gap into an explained component (accounting for student, family, and school characteristics) and an "unexplained" – which signifies returns, or the efficiency by which the country is able to convert characteristics into student learning outcomes as measured by test scores – component, using the traditional Oaxaca (1973)-Blinder (1973) decomposition method.

The model specification for the estimation of the production function for cognitive achievement is as follows:

$$T_{ija} = T_a(A_{ija}, S_{ija}, I_{ija}) + \epsilon_{ija} \qquad (1)$$

where $T_{ija}$ is the observed test score (from TIMSS math) of student $i$ in household $j$ at time $a$ (time of the test), $A_{ija}$ is a vector of individual, student, characteristics, $S_{ija}$ is a vector of school-related inputs, $I_{ija}$ is a vector of institutional characteristics and $\epsilon_{ija}$ is an additive error, which includes all the omitted variables including those which relate to the history of past inputs, endowed mental capacity and measurement error. Todd and Wolpin (2003) discuss in detail the assumptions that would satisfy the application of this specification, in which the achievement test score depends solely on the contemporaneous measures of family, school and other inputs. These assumptions state that: (a) current input measures capture the entire history of inputs or, alternatively, only contemporaneous inputs matter and (b) contemporaneous inputs are unrelated to endowed mental capacity.

In its linear specification (after dropping subscript $a$) is given by:

$$T_{ij} = \beta_0 + \beta_1 A_{ij} + \beta_2 S_{ij} + \beta_3 I_{ij} + \epsilon_{ij} \qquad (2)$$

where $\beta_0$ to $\beta_3$ are coefficients to be estimated. In order to compare production functions that are similar over time, we were forced to drop the school and institutional variables in our model.

Therefore, our model would be:

$$T_{ij} = \beta_0 + \beta_1 A_{ij} + \epsilon_{ij} \qquad (3)$$

The standard procedure for analyzing the determinants of the test score differences over time is to fit equations between test scores and observed characteristics. The observed test score differential can be decomposed as:

$$T_{2007} - T_{1995} = (X_{2007} - X_{1995})\beta_{2007} + X_{1995}(\beta_{2007} - \beta_{1995}) \qquad (4)$$

where $T$ is the standardized test score, $X_i$ is a vector of student characteristics for the $i$th individual, $\beta$ is a vector of coefficients and 1995, 2007 subscripts are identifiers of the TIMSS test score in math in years 1995 and 2007; evaluated at 2007 prices.

The overall test-score increase can, therefore, be decomposed into two components: one is the portion attributed to differences in characteristics ($X_{2007} - X_{1995}$) evaluated with the 2007 prices, or 2007 group performance ($\beta_{2007}$); the other portion is attributable to differences in effects on performance ($\beta_{2007} - \beta_{1995}$) of 1995 and 2007 students derived from the same characteristics. This second (unexplained) component, while more difficult to interpret in the present context compared to an earnings gap decomposition framework, can be assigned more than one interpretation.

# ANNEX 7: DECOMPOSITION OF MATH SCORES FOR COLOMBIA, TIMSS 1995-2007

**Math Scores Decomposition for Colombia, TIMSS 1995 - 2007**

| Test Scores | $b_{1995}$ | $b_{2007}$ | $X_{1995}$ | $X_{2007}$ | Determinants of Test scores Differentials | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | *as % of total test score diff* | |
| | | | | | *Endowments* $b_{2007}(X_{2007}-X_{1995})$ | *Unexplained* $X_{1995}(b_{2007}-b_{1995})$ | *Endowments* | *Unexplained* |
| Constant | 386.87 | 635.14 | 1.00 | 1.00 | 0.00 | 248.27 | 0.0 | 534.6 |
| **Student characteristics** | | | | | | | | |
| Female | -22.87 | -32.74 | 0.49 | 0.52 | -0.71 | -4.88 | -1.5 | -10.5 |
| Age of student | -4.66 | -17.77 | 14.88 | 14.40 | 8.56 | -195.18 | 18.4 | -420.3 |
| Mother with ISCED5 | 17.26 | 13.02 | 0.10 | 0.15 | 0.69 | -0.41 | 1.5 | -0.9 |
| 11-25 books at home | 20.31 | 16.37 | 0.33 | 0.37 | 0.54 | -1.31 | 1.2 | -2.8 |
| 26-100 books at home | 48.86 | 29.50 | 0.28 | 0.22 | -1.82 | -5.37 | -3.9 | -11.6 |
| 101-200 books at home | 61.73 | 46.20 | 0.09 | 0.05 | -2.17 | -1.44 | -4.7 | -3.1 |
| 200 < books at home | 62.28 | 51.38 | 0.07 | 0.03 | -1.89 | -0.76 | -4.1 | -1.6 |
| Computer available at home | 24.89 | 20.39 | 0.11 | 0.35 | 4.83 | -0.50 | 10.4 | -1.1 |
| | | | | | *8.0* | *-209.9* | *17.3* | -451.9 |
| Total | | | | | **8.0** | **38.4** | **17.3** | **82.7** |
| Overall | | | | | **46.4** | | **100.0** | |

Source: TIMSS 1995 and 2007

# ANNEX 8: HYPOTHESES ON FACTORS ASSOCIATED WITH LEARNING OUTCOMES IN COLOMBIA (PISA 2006)

Both the international and Colombian literature has shown that a number of student, school and institutional factors are associated with student learning. This annex summarizes these findings and includes PISA 2006 data variables shown to have significant positive, significant negative and mixed correlations with learning outcomes. Findings from Phase I of the AAA (PISA analysis) point to the need for further research through hypothesis testing (discussed below):

**Family Factors**

Two family background factors (computers and books in the home and mothers' attainment of a university degree) were identified in the PISA analysis to have a positive association with student performance, and may be associated with a number of omitted variables. For example, these factors may simply be a function of higher household income, which consistently correlates with higher student achievement. Alternatively, the presence of educational resources and an educated parent who can provide guidance and support may in and of themselves aid in student learning. Finally, these factors may indicate a higher level of parent engagement in student learning; the presence of educational materials may signal a household highly motivated toward academic success, and the most educated parents might place a particular premium on their children's achievement in school. These factors suggest that the following hypotheses be tested with augmented data that include both household income and variables pertaining to student and parent attitudes:

- *Controlling for household income, the strong positive association of educational materials in the home or mother's university attainment with student performance diminishes or disappears.*
- *Student access to educational materials in the home, independent of household income and parent attitudes, has a positive association with academic achievement.*
- *Students whose parents are involved in their children's education, as reflected by parents' attitudes and actions, are more academically successful. Policies that encourage parental support for and participation in their children's education can have a positive impact on achievement*.

**Student Factors**

The difference in performance between girls and boys suggests the need for greater understanding of what factors cause this difference and which policies are effective in addressing it. Two general areas of hypotheses to be tested include:

- *School factors, such as classroom dynamics, peer effects, and/or teacher expectations, negatively affect female student achievement. Teacher and school administrator training, as well as single-sex classrooms and schools, can alter the attitudes and behaviors of school personnel and students to rectify inequity of achievement.*

- *Family factors, such as parent expectations and/or girls' competing work and home responsibilities, negatively affect female student achievement. CCT programs can provide an incentive to families to invest in girls' education.*

Also, the positive and significant correlation of being enrolled in a higher grade may suggest that students in higher grades are exposed to higher-level content or have advanced more quickly, or that a higher percentage of students in lower grades have repeated at least one grade. In addition, Colombia's overall performance relative to other countries suggests that its course content ought to be more rigorous across grades. In this sense, hypotheses to be tested might therefore include:

- *Controlling for students' rates of advancement or repetition relative to their age, the positive association of being enrolled in a higher grade diminishes or disappears.*
- *Colombia's academic content, as evaluated by national assessments, does not match international standards of rigor, even at the upper secondary level.*
- *Increasing the rigor of academic standards at all grade levels can improve achievement on international assessments, increase attendance, and reduce repetition and dropout.*

In particular, struggling or at-risk students are most successful when they are expected to meet high academic standards. Furthermore, their likelihood of success increases when they are provided with the necessary support (e.g., accelerated programs, extra time, etc.) to excel at a higher level of rigor.

Finally, given that the impact of age was positive and significant at the two lowest quintiles, a possible implication is that at-risk students perform better when they slightly delay entry into school (e.g., by no more than one year) and may therefore be more mature and prepared upon entry.

**School Factors**

At the school level, the strong, positive correlation between teachers with a certificate and student achievement, both overall and at all performance quintiles, may suggest that either the teacher certification process itself or what certification signals correlates with student achievement. Hypothesis testing may generate insight into which specific factors associated with certification are in fact correlated with student achievement. Such an inquiry may lead to deeper analysis into the extent to which those characteristics are equitably represented across schools and regions, and how they may be expanded, particularly in high-need areas.

The moderate, positive correlation between the number of hours spent on mathematics study and student achievement in that subject may either suggest that time on task *per se* is correlated with student achievement or reflect the presence of an omitted variable such as a community's orientation toward education that increases the time available for study. Increased time on task in particular subjects could be evaluated in different contexts, both as part of an independent of broader reform policies.

The difference in performance between public and private school students suggests the investigation of unobservable factors, such as student selection and population, as well as school

autonomy and incentives. For example, while public schools are generally required to accept all students, special public schools that share admissions criteria with private schools (e.g., academic aptitude) provide the opportunity to test the hypothesis that public and private schools with academically similar student populations have comparable academic results. In addition, school concession programs that create public schools that have aspects of autonomy and incentives similar to those of private schools allow for the testing of the hypothesis that those factors positively impact achievement.

The strong, negative association between rural schools and student achievement suggests many possible related factors, including a disadvantaged student population, curriculum that students perceive as boring and irrelevant to their context, under-resourced schools, and structural constraints such as long distances and low population density. The presence of these factors may all be verified through an analysis of policies and programs designed to address them. A program such as PER, which consists of nine different programs, may provide a unique opportunity to test multiple hypotheses, since programs share some elements but not others.

**Institutional Factors**

Finally, the institutional factor positively and significantly associated with student achievement, the use of achievement data to evaluate teachers, may suggest the importance of data-driven decision-making. In order to improve their practice, it follows that teachers examine assessment data to determine the extent to which students are mastering the material, so that they may adjust their teaching accordingly. Data may also be used as an input in the personnel evaluation process, disseminated to inform the public about school and system quality, and serve as a basis for positive and negative consequences for personnel and/or schools. It is important to develop a better understanding of which data are used and how, as well as whether this practice is part of a larger policy or specific program that might influence achievement independent of the use of data *per se*. Hypotheses to be tested therefore may include:

- *National and/or other student assessment data (to be identified) are used on a regular basis (intervals to be defined) to inform teaching practice and/or school resource allocation decisions and/or to evaluate teacher and school director performance.*
- *Such data are part of the formal performance appraisal system for school personnel and/or lead to positive or negative consequences.*
- *Data are disseminated to inform families and the community about school quality.*

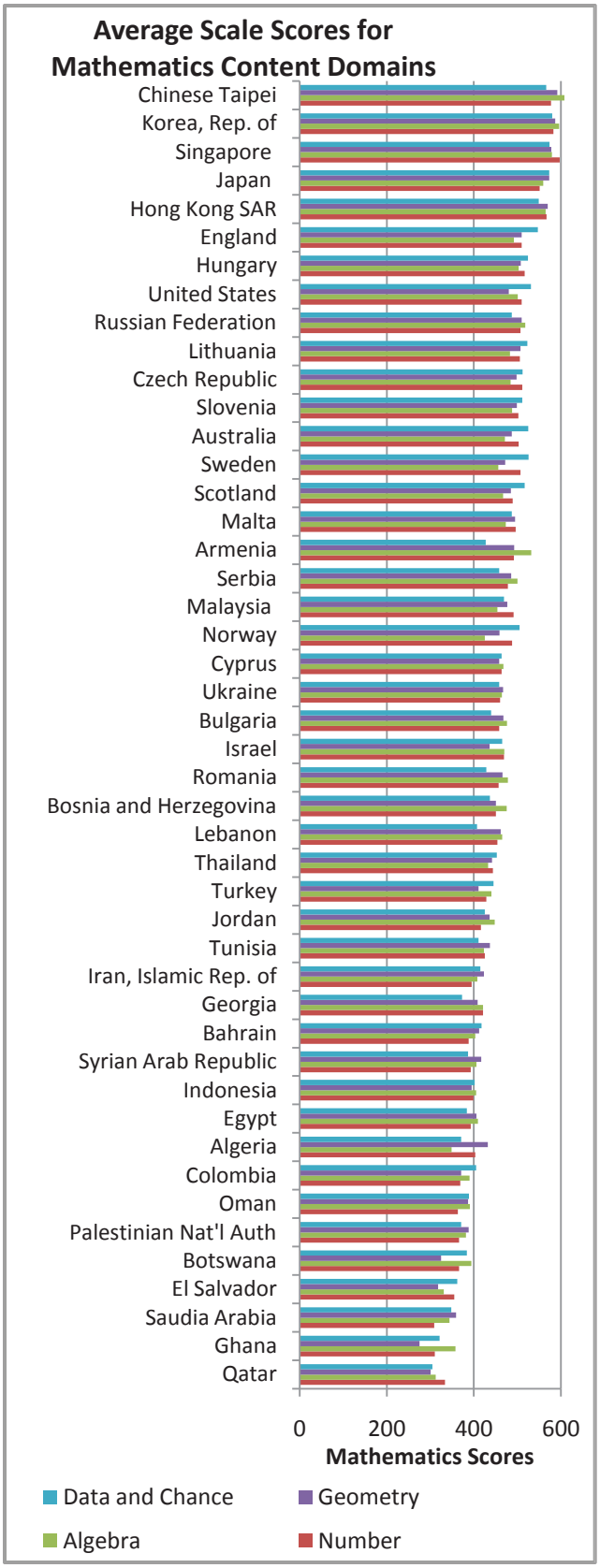
# ANNEX 9: MATH SCORES FOR EIGHTH GRADE STUDENTS, BY COUNTRY

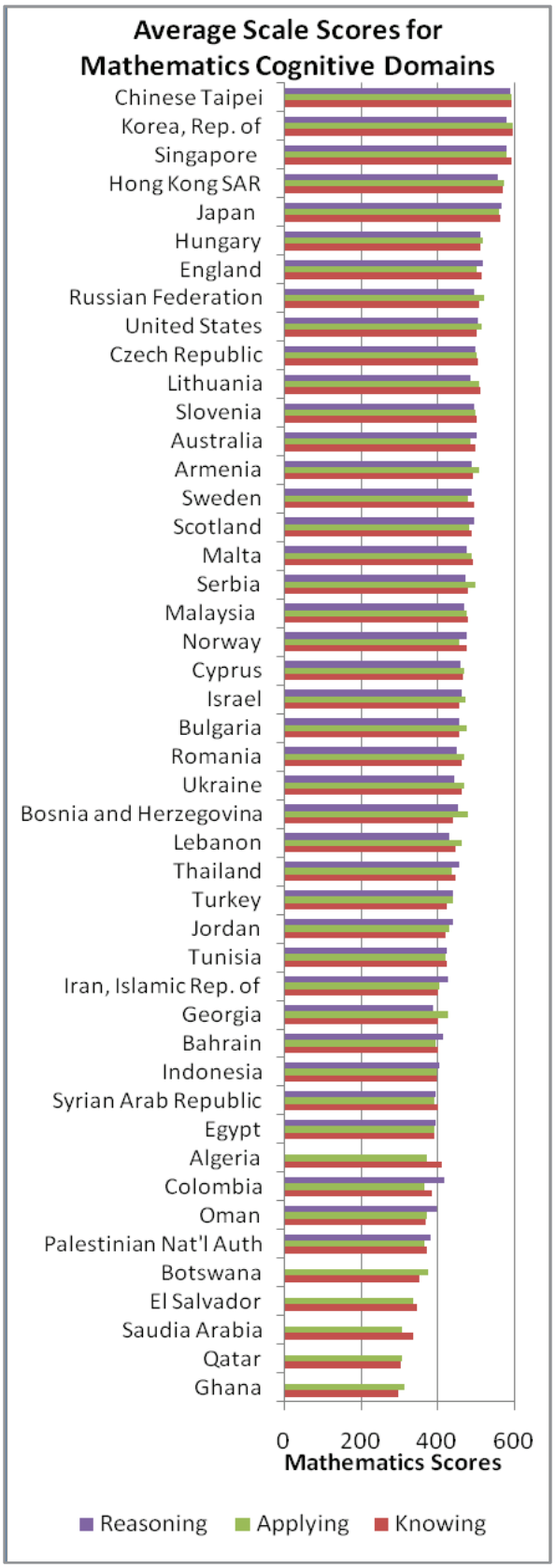
**Average overall scale scores among all participants in the TIMSS 2007 eighth grade math assessment**

| **Eighth Grade Country** | **Average scale score** |
|---|---|
| Chinese Taipei | 598 |
| Korea, Rep. of | 597 |
| Singapore | 593 |
| Hong Kong SAR | 572 |
| Japan | 570 |
| Hungary | 517 |
| England | 513 |
| Russian Federation | 512 |
| United States | 508 |
| Lithuania | 506 |
| Czech Republic | 504 |
| Slovenia | 501 |
| **TIMSS scale average** | **500** |
| Armenia | 499 |
| Australia | 496 |
| Sweden | 491 |
| Malta | 488 |
| Scotland | 487 |
| Serbia | 486 |
| Italy | 480 |
| Malaysia | 474 |
| Norway | 469 |
| Cyprus | 465 |
| Bulgaria | 464 |
| Israel | 463 |
| Ukraine | 462 |
| Romania | 461 |
| Bosnia and Herzegovina | 456 |
| Lebanon | 449 |
| Thailand | 441 |
| Turkey | 432 |
| Jordan | 427 |
| Tunisia | 420 |
| Georgia | 410 |
| Iran, Islamic Rep. of | 403 |
| Bahrain | 398 |
| Indonesia | 397 |
| Syrian Arab Republic | 395 |
| Egypt | 391 |
| Algeria | 387 |

| **Eighth Grade** Country | **Average scale score** |
|---|---|
| **Colombia** | **380** |
| Oman | 372 |
| Palestinian Nat'l Auth. | 367 |
| Botswana | 364 |
| Kuwait | 354 |
| El Salvador | 340 |
| Saudi Arabia | 329 |
| Ghana | 309 |
| Qatar | 307 |

**Average eighth grade scores in the content and cognitive domains of the TIMSS 2007 math assessment**



| Country | Average Scale Scores for Mathematics Content Domain | | | | Average Scale Scores for Mathematics Cognitive Domain | | |
|---|---|---|---|---|---|---|---|
| | Number | Algebra | Geometry | Data and Chance | Applying | Knowing | Reasoning |
| Algeria | 403 | 349 | 432 | 371 | 412 | 371 | ++ |
| Armenia | 492 | 532 | 493 | 427 | 493 | 507 | 489 |
| Australia | 503 | 471 | 487 | 525 | 500 | 487 | 502 |
| Bahrain | 388 | 403 | 412 | 418 | 403 | 395 | 413 |
| Bosnia and Herzegovina | 451 | 475 | 451 | 437 | 440 | 478 | 452 |
| Botswana | 366 | 394 | 325 | 384 | 351 | 376 | ++ |
| Bulgaria | 458 | 476 | 468 | 440 | 458 | 477 | 455 |
| Chinese Taipei | 577 | 617 | 592 | 566 | 592 | 594 | 591 |
| **Colombia** | **369** | **390** | **371** | **405** | **384** | **364** | **416** |
| Cyprus | 464 | 468 | 458 | 464 | 465 | 468 | 461 |
| Czech Republic | 511 | 484 | 498 | 512 | 504 | 502 | 500 |
| Egypt | 393 | 409 | 406 | 384 | 393 | 392 | 396 |
| El Salvador | 355 | 331 | 318 | 362 | 347 | 336 | ++ |
| England | 510 | 492 | 510 | 547 | 514 | 503 | 518 |
| Georgia | 421 | 421 | 409 | 373 | 401 | 427 | 389 |
| Ghana | 310 | 358 | 275 | 321 | 297 | 313 | ++ |
| Hong Kong SAR | 567 | 565 | 570 | 549 | 569 | 574 | 557 |
| Hungary | 517 | 503 | 508 | 524 | 513 | 518 | 513 |
| Indonesia | 399 | 405 | 395 | 402 | 398 | 397 | 405 |
| Iran, Islamic Rep. of | 395 | 408 | 423 | 415 | 402 | 403 | 427 |
| Israel | 469 | 470 | 436 | 465 | 456 | 473 | 462 |
| Italy | 478 | 460 | 490 | 491 | 483 | 476 | 483 |
| Japan | 551 | 559 | 573 | 573 | 565 | 560 | 568 |
| Jordan | 416 | 448 | 436 | 425 | 422 | 432 | 440 |
| Korea, Rep. of | 583 | 596 | 587 | 580 | 595 | 596 | 579 |
| Kuwait | 347 | 354 | 385 | 366 | 361 | 347 | ++ |
| Lebanon | 454 | 465 | 462 | 407 | 448 | 464 | 429 |
| Lithuania | 506 | 483 | 507 | 523 | 511 | 508 | 486 |
| Malaysia | 491 | 454 | 477 | 469 | 478 | 477 | 468 |
| Malta | 496 | 473 | 495 | 487 | 492 | 490 | 475 |
| Norway | 488 | 425 | 459 | 505 | 477 | 458 | 475 |
| Oman | 363 | 391 | 387 | 389 | 368 | 372 | 397 |
| Palestinian Nat'l Auth. | 366 | 382 | 388 | 371 | 371 | 365 | 381 |
| Qatar | 334 | 312 | 301 | 305 | 305 | 307 | ++ |
| Romania | 457 | 478 | 466 | 429 | 462 | 470 | 449 |
| Russian Federation | 507 | 518 | 510 | 487 | 510 | 521 | 497 |
| Saudi Arabia | 309 | 344 | 359 | 348 | 335 | 308 | ++ |
| Scotland | 489 | 467 | 485 | 517 | 489 | 481 | 495 |
| Serbia | 478 | 500 | 486 | 458 | 478 | 500 | 474 |
| Singapore | 597 | 579 | 578 | 574 | 593 | 581 | 579 |
| Slovenia | 502 | 488 | 499 | 511 | 503 | 500 | 496 |
| Sweden | 507 | 456 | 472 | 526 | 497 | 478 | 490 |
| Syrian Arab Republic | 393 | 406 | 417 | 387 | 401 | 393 | 396 |
| Thailand | 444 | 433 | 442 | 453 | 446 | 436 | 456 |
| Tunisia | 425 | 423 | 437 | 411 | 423 | 421 | 425 |
| Turkey | 429 | 440 | 411 | 445 | 425 | 439 | 441 |
| Ukraine | 460 | 464 | 467 | 458 | 464 | 471 | 445 |
| United States | 510 | 501 | 480 | 531 | 503 | 514 | 505 |
| Morocco | 389 | 362 | 396 | 371 | 389 | 365 | 383 |

## Detailed description of the cognitive domains[85]

### *Knowing*

*Knowing* addresses the facts, procedures, and concepts that students need to know to function mathematically. The key skills of this cognitive domain include recalling definitions, terminology, number properties, geometric properties, and notation; recognizing mathematical objects, shapes, numbers, and expressions; recognizing mathematical entities that are mathematically equivalent; computing algorithmic procedures for basic functions with whole numbers, fractions, decimals, and integers; approximating numbers to estimate computations; carrying out routine algebraic procedures; retrieving information from graphs, tables, and charts; reading simple scales; using appropriate units of measure and measuring instruments; estimating measures; classifying or grouping objects, shapes, numbers, and expressions according to common properties; making correct decisions about class membership; and ordering numbers and objects by attributes.

### *Applying*

*Applying* focuses on students' abilities to apply knowledge and conceptual understanding to solve problems or answer questions. The key skills of this cognitive domain include selecting appropriate operations, methods, or strategies for solving problems where there is a known algorithm or method of solution; representing mathematics information and data in diagrams, tables, graphs, and charts; generating equivalent representations for a given mathematical entity or relationship; generating an appropriate mathematical model, such as an equation or diagram for solving a routine problem; following and executing a set of mathematical instructions; drawing figures and shapes given specifications; solving routine problems (i.e., problems similar to those students are likely to have encountered in class); comparing and matching different representations of data (grade eight) and using data from charts, tables, graphs, and maps to solve routine problems.

### *Reasoning*

*Reasoning* goes beyond the cognitive processes involved in solving routine problems to include unfamiliar situations, complex contexts, and multistep problems. The key skills of this cognitive domain include determining and describing relationships between variables or objects in mathematical situations; using proportional reasoning (grade four); decomposing geometric figures to simplify solving a problem; drawing the net of a given unfamiliar solid; visualizing transformations of three-dimensional figures; comparing and matching different representations of the same data (grade four); making valid inferences from given information; generalizing mathematical results to wider applications; combining mathematical procedures to establish results and combining results to produce a further result; making connections between different elements of knowledge and related representations; making linkages between different elements of knowledge and related representations; making linkages between related mathematical ideas; providing a justification for the truth or falsity of a statement by reference to mathematical results or properties; solving problems set in mathematical or real life contexts that students are

[85] The domain descriptions are the same for grades four and eight, except where noted.

unlikely to have encountered before; applying mathematical procedures in unfamiliar or complex contexts; and using geometric properties to solve non-routine problems.

# ANNEX 10: LOWER-MIDDLE INCOME COUNTRIES

***Average scale scores of 15 Lower Middle Income Countries (as defined by the World Bank in 2007) participating in the TIMSS 2007 eighth grade math assessment:***

- Armenia (499)
- Ukraine (462)
- Bosnia and Herzegovina (456)
- Thailand (441)
- Jordan (427)
- Tunisia (420)
- Georgia (410)
- Iran (403)
- Indonesia (397)
- Syrian Arab Republic (395)
- Egypt (391)
- Algeria (387)
- **Colombia (380)**
- Palestinian National Authority (367)
- El Salvador (340)

***Lower Middle Income Countries, World Bank 2007***
**(Bold indicates participation in the TIMSS 2007 eighth grade math assessment)**

Albania, **Algeria,** Angola, **Armenia,** Azerbaijan, Belarus, Bhutan, Bolivia, **Bosnia and Herzegovina,** Cameroon, Cape Verde, China, **Colombia**, Republic of Congo, Rep., Cuba, Djibouti, Dominican Republic, Ecuador, **Egypt, El Salvador**, Fiji, **Georgia,** Guatemala, Guyana, Honduras, **Indonesia, Iran (**Islamic Rep.), Iraq, Jamaica, **Jordan,** Kiribati, Lesotho, Macedonia, Maldives, Marshall Islands, Micronesia, Moldova, Morocco, Namibia, Nicaragua, **Palestinian Nat'l Authority (also known as: West Bank and Gaza)**, Paraguay, Peru, Philippines, Samoa, Sri Lanka, Suriname, Swaziland, **Syrian Arab Republic, Thailand,** Tonga, **Tunisia,** Turkmenistan, **Ukraine,** Vanuatu.

# ANNEX 11: DESCRIPTION OF BENCHMARKS (BY LEVEL)

**Description of eighth grade International Benchmarks in mathematics, TIMSS 2007**

**Eighth grade benchmarks (minimum required scale score)**

**Advanced (625)**
***Students can organize and draw conclusions from information, make generalizations, and solve non-routine problems***. They can solve a variety of ratio, proportion, and percent problems. They can apply their knowledge of numeric and algebraic concepts and relationships. Students can express generalizations algebraically and model situations. They can apply their knowledge of geometry in complex problem situations. Students can derive and use data from several sources to solve multistep problems.

**High (550)**
***Students can apply their understanding and knowledge in a variety of relatively complex situations***. They can relate and compute with fractions, decimals, and percents, operate with negative integers, and solve word problems involving proportions. Students can work with algebraic expressions and linear equations. Students use knowledge of geometric properties to solve problems, including area, volume, and angles. They can interpret data in a variety of graphs and Tables and solve simple problems involving probability.

**Intermediate (475)**
***Students can apply basic mathematical knowledge in straightforward situations***. They can add and multiply to solve one-step word problems involving whole numbers and decimals. They can work with familiar fractions. They understand simple algebraic relationships. They demonstrate understanding of properties of triangles and basic geometric concepts. They can read and interpret graphs and Tables. They recognize basic notions of likelihood.

**Low (400)**
***Students have some knowledge of whole numbers and decimals, operations, and basic graphs***. The few items at this level provide some evidence that students have an elementary understanding of whole numbers and decimals and can do basic computations. They can select a bar graph or line graph that displays a given set of data and can complete a simple bar graph.

**Below Low (<400)**
Students are unable to answer the most basic questions.

# ANNEX 12: DESCRIPTIVE STATISTICS FOR COLOMBIA, BY PROFICIENCY LEVEL (TIMSS 2007)

| xvar | cutvar | n | MATWGT | pct | pct_se | Mean | Mean_se |
|---|---|---|---|---|---|---|---|
| High parental support for student achievement | 1.Below 400 | 2,161.80 | 284,549.37 | 58.05 | 2.40 | 0.10 | 0.04 |
| High parental support for student achievement | 2.From 400 to 475 | 1,109.00 | 147,329.57 | 30.06 | 1.80 | 0.15 | 0.05 |
| High parental support for student achievement | 3.From 475 to 550 | 348.00 | 47,540.81 | 9.70 | 1.03 | 0.19 | 0.07 |
| High parental support for student achievement | 4.From 550 to 625 | 63.80 | 8,802.39 | 1.80 | 0.35 | 0.32 | 0.09 |
| High parental support for student achievement | 5.Above 625 | 17.40 | 1,929.19 | 0.39 | 0.06 | 0.92 | 0.09 |
| High parental participation in school activities | 1.Below 400 | 2,236.40 | 297,853.56 | 58.52 | 2.34 | 0.10 | 0.03 |
| High parental participation in school activities | 2.From 400 to 475 | 1,136.40 | 152,350.02 | 29.94 | 1.72 | 0.15 | 0.04 |
| High parental participation in school activities | 3.From 475 to 550 | 347.20 | 48,078.26 | 9.45 | 1.04 | 0.17 | 0.06 |
| High parental participation in school activities | 4.From 550 to 625 | 62.60 | 8,723.48 | 1.71 | 0.36 | 0.38 | 0.12 |
| High parental participation in school activities | 5.Above 625 | 17.40 | 1,929.19 | 0.38 | 0.06 | 0.92 | 0.09 |
| School located in rural area | 1.Below 400 | 2,858.20 | 379,684.10 | 60.32 | 2.10 | 0.08 | 0.02 |
| School located in rural area | 2.From 400 to 475 | 1,384.60 | 182,357.20 | 28.97 | 1.58 | 0.03 | 0.01 |
| School located in rural area | 3.From 475 to 550 | 421.80 | 56,148.76 | 8.92 | 0.88 | 0.02 | 0.02 |
| School located in rural area | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.48 | 0.30 | 0.00 | 0.00 |
| School located in rural area | 5.Above 625 | 17.40 | 1,929.19 | 0.31 | 0.04 | 0.00 | 0.00 |
| 50 < of students comes from economic disadvantage families | 1.Below 400 | 2,846.80 | 375,445.62 | 62.66 | 2.25 | 0.78 | 0.04 |
| 51 < of students comes from economic disadvantage families | 2.From 400 to 475 | 1,315.40 | 171,854.83 | 28.68 | 1.68 | 0.69 | 0.05 |
| 52 < of students comes from economic disadvantage families | 3.From 475 to 550 | 357.20 | 46,597.62 | 7.78 | 0.83 | 0.57 | 0.07 |
| 53 < of students comes from economic disadvantage families | 4.From 550 to 625 | 39.00 | 5,247.53 | 0.88 | 0.23 | 0.29 | 0.20 |
| 54 < of students comes from economic disadvantage families | 5.Above 625 | 0.60 | 71.73 | 0.01 | 0.02 | 0.00 | 0.00 |
| bully incidents during the last month | 1.Below 400 | 2,854.40 | 376,856.90 | 59.97 | 2.07 | 0.61 | 0.02 |
| bully incidents during the last month | 2.From 400 to 475 | 1,405.60 | 184,196.75 | 29.31 | 1.57 | 0.60 | 0.02 |
| bully incidents during the last month | 3.From 475 to 550 | 424.60 | 56,446.26 | 8.98 | 0.88 | 0.57 | 0.03 |
| bully incidents during the last month | 4.From 550 to 625 | 69.00 | 9,028.69 | 1.44 | 0.28 | 0.48 | 0.08 |
| bully incidents during the last month | 5.Above 625 | 17.40 | 1,929.19 | 0.31 | 0.04 | 0.47 | 0.08 |
| Having a female teacher | 1.Below 400 | 2,840.40 | 375,790.62 | 60.27 | 2.10 | 0.36 | 0.06 |
| Having a female teacher | 2.From 400 to 475 | 1,376.00 | 180,532.81 | 28.95 | 1.58 | 0.47 | 0.07 |
| Having a female teacher | 3.From 475 to 550 | 420.20 | 55,948.40 | 8.97 | 0.88 | 0.51 | 0.08 |
| Having a female teacher | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.50 | 0.30 | 0.69 | 0.10 |
| Having a female teacher | 5.Above 625 | 17.40 | 1,929.19 | 0.31 | 0.04 | 0.98 | 0.07 |

| xvar | cutvar | n | MATWGT | pct | pct_se | Mean | Mean_se |
|---|---|---|---|---|---|---|---|
| Teacher with math as a major area of study | 1.Below 400 | 2,765.40 | 367,829.80 | 60.25 | 2.11 | 0.76 | 0.04 |
| Teacher with math as a major area of study | 2.From 400 to 475 | 1,340.20 | 176,223.67 | 28.87 | 1.59 | 0.82 | 0.04 |
| Teacher with math as a major area of study | 3.From 475 to 550 | 414.00 | 55,157.41 | 9.03 | 0.89 | 0.86 | 0.05 |
| Teacher with math as a major area of study | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.53 | 0.31 | 0.95 | 0.03 |
| Teacher with math as a major area of study | 5.Above 625 | 17.40 | 1,929.19 | 0.32 | 0.04 | 1.00 | 0.00 |
| Teachers have high expectations for students | 1.Below 400 | 2,808.80 | 373,319.60 | 60.28 | 2.10 | 0.73 | 0.04 |
| Teachers have high expectations for students | 2.From 400 to 475 | 1,366.00 | 179,517.30 | 28.99 | 1.59 | 0.82 | 0.03 |
| Teachers have high expectations for students | 3.From 475 to 550 | 414.40 | 55,228.64 | 8.92 | 0.88 | 0.88 | 0.04 |
| Teachers have high expectations for students | 4.From 550 to 625 | 69.40 | 9,268.54 | 1.50 | 0.30 | 0.92 | 0.04 |
| Teachers have high expectations for students | 5.Above 625 | 17.40 | 1,929.19 | 0.31 | 0.04 | 1.00 | 0.00 |
| Attending private school | 1.Below 400 | 2,944.60 | 388,651.45 | 60.55 | 2.08 | 0.11 | 0.02 |
| Attending private school | 2.From 400 to 475 | 1,415.40 | 185,403.38 | 28.88 | 1.58 | 0.23 | 0.03 |
| Attending private school | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.82 | 0.86 | 0.39 | 0.06 |
| Attending private school | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 0.62 | 0.14 |
| Attending private school | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 0.99 | 0.03 |
| AGE | 1.Below 400 | 2,930.00 | 386,543.12 | 60.42 | 2.08 | 14.68 | 0.06 |
| AGE | 2.From 400 to 475 | 1,415.00 | 185,354.10 | 28.97 | 1.57 | 14.19 | 0.06 |
| AGE | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.85 | 0.87 | 13.99 | 0.07 |
| AGE | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 14.08 | 0.16 |
| AGE | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 14.82 | 0.16 |
| FEMALE | 1.Below 400 | 2,944.60 | 388,651.45 | 60.55 | 2.08 | 0.58 | 0.02 |
| FEMALE | 2.From 400 to 475 | 1,415.40 | 185,403.38 | 28.88 | 1.58 | 0.44 | 0.02 |
| FEMALE | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.82 | 0.86 | 0.34 | 0.05 |
| FEMALE | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 0.24 | 0.10 |
| FEMALE | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 0.00 | 0.00 |
| Mother with higher education (vocational or tertiary) | 1.Below 400 | 2,606.20 | 345,526.69 | 59.59 | 2.05 | 0.14 | 0.01 |
| Mother with higher education (vocational or tertiary) | 2.From 400 to 475 | 1,305.60 | 171,398.10 | 29.56 | 1.54 | 0.26 | 0.02 |
| Mother with higher education (vocational or tertiary) | 3.From 475 to 550 | 396.60 | 53,029.24 | 9.15 | 0.84 | 0.46 | 0.06 |
| Mother with higher education (vocational or tertiary) | 4.From 550 to 625 | 61.80 | 8,241.08 | 1.42 | 0.28 | 0.75 | 0.08 |
| Mother with higher education (vocational or tertiary) | 5.Above 625 | 14.80 | 1,599.19 | 0.28 | 0.05 | 0.99 | 0.07 |
| 11-25 books at home | 1.Below 400 | 2,935.20 | 387,544.52 | 60.48 | 2.09 | 0.34 | 0.01 |
| 11-25 books at home | 2.From 400 to 475 | 1,414.80 | 185,337.73 | 28.93 | 1.58 | 0.39 | 0.02 |
| 11-25 books at home | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.83 | 0.87 | 0.36 | 0.03 |

| xvar | cutvar | n | MATWGT | pct | pct_se | Mean | Mean_se |
|---|---|---|---|---|---|---|---|
| 11-25 books at home | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 0.22 | 0.10 |
| 11-25 books at home | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 0.10 | 0.07 |
| 26-100 books at home | 1.Below 400 | 2,935.20 | 387,544.52 | 60.48 | 2.09 | 0.16 | 0.01 |
| 26-100 books at home | 2.From 400 to 475 | 1,414.80 | 185,337.73 | 28.93 | 1.58 | 0.25 | 0.02 |
| 26-100 books at home | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.83 | 0.87 | 0.31 | 0.03 |
| 26-100 books at home | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 0.38 | 0.08 |
| 26-100 books at home | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 0.35 | 0.11 |
| 101-200 books at home | 1.Below 400 | 2,935.20 | 387,544.52 | 60.48 | 2.09 | 0.02 | 0.00 |
| 101-200 books at home | 2.From 400 to 475 | 1,414.80 | 185,337.73 | 28.93 | 1.58 | 0.06 | 0.01 |
| 101-200 books at home | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.83 | 0.87 | 0.10 | 0.02 |
| 101-200 books at home | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 0.15 | 0.06 |
| 101-200 books at home | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 0.08 | 0.12 |
| 200 < books at home | 1.Below 400 | 2,935.20 | 387,544.52 | 60.48 | 2.09 | 0.02 | 0.00 |
| 201 < books at home | 2.From 400 to 475 | 1,414.80 | 185,337.73 | 28.93 | 1.58 | 0.03 | 0.01 |
| 202 < books at home | 3.From 475 to 550 | 425.60 | 56,589.72 | 8.83 | 0.87 | 0.08 | 0.02 |
| 203 < books at home | 4.From 550 to 625 | 70.00 | 9,346.28 | 1.46 | 0.29 | 0.22 | 0.05 |
| 204 < books at home | 5.Above 625 | 17.40 | 1,929.19 | 0.30 | 0.04 | 0.47 | 0.07 |
| Computer available at home | 1.Below 400 | 2,475.20 | 323,414.49 | 57.65 | 2.10 | 0.26 | 0.02 |
| Computer available at home | 2.From 400 to 475 | 1,315.80 | 171,581.00 | 30.58 | 1.57 | 0.41 | 0.02 |
| Computer available at home | 3.From 475 to 550 | 413.00 | 54,796.32 | 9.77 | 0.98 | 0.60 | 0.05 |
| Computer available at home | 4.From 550 to 625 | 69.60 | 9,297.21 | 1.66 | 0.33 | 0.81 | 0.11 |
| Computer available at home | 5.Above 625 | 17.40 | 1,929.19 | 0.34 | 0.05 | 0.99 | 0.03 |

## ANNEX 13: SUMMARY OF VARIABLES IDENTIFIED WITH SIGNIFICANT EFFECTS ON LEARNING OUTCOMES IN COLOMBIA

| Level | Variable | International Literature | Colombian Literature | PISA Analysis (Phase 1 AAA) | TIMSS Analysis (Phase 2 AAA) |
|---|---|---|---|---|---|
| Student | Income / Socioeconomic status | + | + | | + |
| | Parents' education | + | + | Mixed (Mother's education) | + (Mother's education) |
| | Early childhood development | + | + | | |
| | Home educational resources | + | | + | + (books and computer) |
| | Gender (female) | + for reading - for math | | - | - |
| | Continuity of school attended | | + | | |
| | Absenteeism | | - | | |
| | Commuting distance | | - | | |
| | Age | | | Mixed | - |
| | Enrollment in a higher grade | | | + | |
| | Child labor | | - | | |
| School | Teacher quality | + | + | + | + (having math as a major area of study) Mixed (level of education achieved) |
| | Teacher expectations of students | | | | + |

| Level | Variable | International Literature | Colombian Literature | PISA Analysis (Phase 1 AAA) | TIMSS Analysis (Phase 2 AAA) |
|---|---|---|---|---|---|
| | Teaching methods | + | + | | Mixed (grouping students by ability levels, time spent on math problems, time spent on lectures, frequency of homework, remedial or enrichment classes, allowance of calculator use) |
| | Teachers' level of job satisfaction | | | | Mixed |
| | Teacher's gender | | | | + (female) |
| | Teacher having had recent training | | | | Mixed |
| | Length of school day | + | + | | Mixed (time for learning) |
| | Number of class hours | + | | + for Mathematics | Mixed |
| | Infrastructure | | + | | |
| | Enrollment in a public school | | | - | - |
| | Enrollment in a rural school | | | - | - |
| | School materials and textbooks | + for basic level in developing countries | + | | Mixed (for textbooks and computers) |
| | School climate | + | | | Mixed (teacher perception of school safety) |
| | School size | | | | Mixed |
| | Student-teacher ratio | | | Mixed | |
| | Peer group (peers' | | + | | |

| Level | Variable | International Literature | Colombian Literature | PISA Analysis (Phase 1 AAA) | TIMSS Analysis (Phase 2 AAA) |
|---|---|---|---|---|---|
| | mothers' education) | | | | |
| System | Centralization | + for curriculum, assessments and budget | | | |
| | Decentralization | + for pedagogy, personnel and resource decisions | + for high-capacity sub-national govts | | |
| | School choice / competition | + | + | Mixed (to determine pedagogical methods of instruction & autonomy to fire teachers) | |
| | Private provision | | + | | |
| | Accountability/ incentives | + | + | + (For use of data to improve teacher practice) | Mixed (Evaluation of teachers' practice) |
| | Governance | + | | | |
| | Parental/ community participation | + | | | + (parental participation and support for student learning) |

# ANNEX 14: COLOMBIA PRODUCTION FUNCTION RESULTS

**Variables Explaining Performance**

| | *Endowments* | *Endowments ABS* | *% Explained by variable* |
|---|---|---|---|
| Female | -0.71 | 0.71 | 3.4% |
| Age of student | 8.56 | 8.56 | 40.4% |
| Mother with ISCED5 | 0.69 | 0.69 | 3.2% |
| 11-25 books at home | 0.54 | 0.54 | 2.6% |
| 26-100 books at home | -1.82 | 1.82 | 8.6% |
| 101-200 books at home | -2.17 | 2.17 | 10.2% |
| 200 < books at home | -1.89 | 1.89 | 8.9% |
| Computer available at home | 4.83 | 4.83 | 22.8% |
| | *8.0* | 21.2 | |

**Private schools' effect on Colombia's scores on TIMSS 2007 8th grade math**

| | | Coef | SE | | Coef | SE | | Coef | SE | | Coef | SE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| System | High parental support for student achievement | | | | | | | | | | -1.43 | 16.54 | |
| | High parental participation in school activities | | | | | | | | | | 7.4 | 10.37 | |
| School | School located in rural area | | | | | | | | | | -17.24 | 14.99 | |
| | 50 < of students comes from economic disadvantage families | | | | | | | | | | -10.29 | 8.44 | |
| | Bully incidents during the last month | | | | | | | | | | -5.89 | 1.46 | * |
| | Having a female teacher | | | | | | | | | | 12.6 | 6.65 | * |
| | Teacher with math as a major area of study | | | | | | | | | | 1.45 | 9.5 | |
| | Teachers have high expectations for students | | | | | | | | | | 16.35 | 6.37 | * |
| | Attending a private school | 58.17 | 9.13 | * | 30.4 | 7.17 | * | 28.05 | 7.49 | * | 10.74 | 9.2 | |
| Student | Age of student | | | | | | | -16.73 | 2.22 | * | -16.03 | 1.93 | * |
| | Female | | | | | | | -32.37 | 3.47 | * | -34.04 | 4.29 | * |
| | Mother with higher education (vocational or tertiary) | | | | 23.22 | 4.9 | * | 18.09 | 4.47 | * | 13.52 | 5.64 | * |
| | 11-25 books at home | | | | 20.3 | 4.15 | * | 14.51 | 3.52 | * | 11 | 4.33 | * |
| | 26-100 books at home | | | | 33.86 | 3.99 | * | 25.53 | 4.07 | * | 19.01 | 4.81 | * |
| | 101-200 books at home | | | | 43.26 | 8.89 | * | 37.33 | 8.31 | * | 22.89 | 10.46 | * |
| | 200 < books at home | | | | 47.5 | 7.9 | * | 41.47 | 7.28 | * | 21.05 | 12.18 | * |
| | Computer available at home | | | | 15.63 | 4.1 | * | 12.31 | 4.28 | * | 11.18 | 5.25 | * |
| | Constant | 369.19 | | | 352.32 | | | 617.25 | | | 610.11 | | |
| | R2 | 0.08 | | | 0.17 | | | 0.25 | | | 0.24 | | |

## ANNEX 15: PREDICTORS OF MATHEMATICS LEARNING, LOWER-MIDDLE INCOME COUNTRIES (TIMSS 2007)

| | | Colombia | | | El Salvador | | | Jordan | | | Tunisia | | | Bosnia and Herzegovina | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Coef | SE | | Coef | SE | | Coef | SE | | Coef | SE | | Coef | SE | |
| System | High parental support for student achievement | -0.49 | 16.49 | | 4.01 | 14.96 | | 42.13 | 10.95 | * | 3.58 | 7.87 | | 2.22 | 9.88 | |
| | High parental participation in school activities | 11.40 | 11.23 | | 6.79 | 14.67 | | -4.17 | 14.39 | | -13.86 | 8.75 | | -4.02 | 9.59 | |
| School | School located in rural area | -17.83 | 14.88 | | -26.61 | 11.51 | * | -14.23 | 11.39 | | 23.46 | 6.94 | * | -12.27 | 8.00 | |
| | 50 < of students comes from economic disadvantaged families | -11.71 | 8.58 | | -1.97 | 8.69 | | -7.46 | 10.63 | | -8.92 | 8.06 | | -4.23 | 5.67 | |
| | Bully incidents during the last month | -13.17 | 3.61 | * | -14.73 | 4.23 | * | -25.50 | 4.62 | * | -3.28 | 4.55 | | -11.47 | 3.39 | * |
| | Having a female teacher | 12.02 | 6.72 | * | -5.34 | 6.77 | | -12.07 | 21.61 | | 8.90 | 6.19 | | -4.81 | 5.19 | |
| | Teacher with math as a major area of study | 1.93 | 9.47 | | 3.95 | 8.21 | | -13.82 | 10.07 | | 2.91 | 7.93 | | 33.01 | 18.49 | * |
| | Teachers have high expectations for students | 18.36 | 6.23 | * | -0.66 | 9.33 | | 5.52 | 9.31 | | 1.12 | 6.84 | | 2.37 | 5.84 | |
| Student | Age of student | -15.96 | 1.93 | * | -12.89 | 2.74 | * | -7.64 | 3.83 | * | -22.02 | 2.95 | * | -14.81 | 3.88 | * |
| | Female | -33.76 | 4.38 | * | -22.82 | 6.44 | * | 21.29 | 20.87 | * | -21.39 | 3.31 | * | -1.29 | 3.24 | |
| | Mother with higher education (vocational or tertiary) | 14.40 | 5.56 | * | 25.67 | 5.57 | * | 29.20 | 5.89 | | 11.76 | 6.35 | * | 19.24 | 4.57 | * |
| | 11-25 books at home | 11.12 | 4.41 | * | 11.88 | 5.28 | * | 6.53 | 6.77 | | 15.74 | 5.43 | * | 11.72 | 4.01 | * |
| | 26-100 books at home | 19.39 | 4.88 | * | 24.32 | 7.21 | * | 24.99 | 6.34 | * | 28.96 | 7.32 | * | 25.38 | 5.28 | * |
| | 101-200 books at home | 24.08 | 10.00 | * | 26.61 | 14.25 | * | 33.84 | 10.07 | * | 67.40 | 10.32 | * | 30.33 | 10.98 | * |
| | 200 < books at home | 20.90 | 12.58 | * | 14.14 | 10.12 | | 26.76 | 9.03 | * | 33.11 | 13.64 | * | 47.79 | 9.88 | * |
| | Computer available at home | 12.17 | 5.18 | * | 12.12 | 4.69 | * | 17.65 | 5.97 | * | 8.73 | 5.25 | * | 26.40 | 3.98 | * |
| | Constant | 610.7 | | | 549.57 | | | 527 | | | 727.8 | | | 620.4 | | |
| | R2 | 0.24 | | | 0.21 | | | 0.16 | | | 0.31 | | | 0.12 | | |

## ANNEX 16: PREDICTORS OF MATHEMATICS LEARNING, HIGH SCORING COMPARATOR COUNTRIES VS. COLOMBIA (TIMSS 2007)

| | | Colombia | | Korea, Republic of | | Jordan | | Hungary | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Mean SE | Mean | Mean SE | Mean | Mean SE | Mean | Mean SE |
| System | High parental support for student achievement | 0.13 | 0.04 | 0.31 | 0.03 | 0.25 | 0.04 | 0.07 | 0.02 |
| | High parental participation in school activities | 0.13 | 0.03 | 0.22 | 0.03 | 0.16 | 0.04 | 0.11 | 0.02 |
| School | School located in rural area | 0.06 | 0.01 | 0.00 | 0.00 | 0.11 | 0.02 | 0.20 | 0.03 |
| | 50 < of students come from economic disadvantaged families | 0.73 | 0.04 | 0.16 | 0.03 | 0.42 | 0.04 | 0.24 | 0.04 |
| | Bully incidents during the last month | 0.60 | 0.02 | 0.48 | 0.01 | 0.47 | 0.01 | 0.40 | 0.01 |
| | Having a female teacher | 0.41 | 0.06 | 0.64 | 0.03 | 0.52 | 0.03 | 0.81 | 0.03 |
| | Teacher with math as a major area of study | 0.79 | 0.04 | 0.28 | 0.03 | 0.86 | 0.03 | 0.96 | 0.02 |
| | Teachers have high expectations for students | 0.77 | 0.03 | 0.64 | 0.04 | 0.56 | 0.04 | 0.65 | 0.04 |
| Student | Age of student | 14.47 | 0.05 | 14.29 | 0.01 | 13.95 | 0.01 | 14.60 | 0.01 |
| | Female | 0.51 | 0.02 | 0.48 | 0.03 | 0.48 | 0.02 | 0.52 | 0.01 |
| | Mother with higher education (vocational or tertiary) | 0.21 | 0.01 | 0.34 | 0.01 | 0.35 | 0.01 | 0.37 | 0.02 |
| | 11-25 books at home | 0.35 | 0.01 | 0.11 | 0.01 | 0.35 | 0.01 | 0.15 | 0.01 |
| | 26-100 books at home | 0.20 | 0.01 | 0.29 | 0.01 | 0.29 | 0.01 | 0.31 | 0.01 |
| | 101-200 books at home | 0.04 | 0.01 | 0.25 | 0.01 | 0.10 | 0.01 | 0.20 | 0.01 |
| | 201 < books at home | 0.03 | 0.00 | 0.26 | 0.01 | 0.09 | 0.01 | 0.27 | 0.02 |
| | Computer available at home | 0.35 | 0.02 | 0.97 | 0.00 | 0.72 | 0.01 | 0.88 | 0.01 |

**Higher scoring comparison countries, mean math scores by key factors**

| | | | High parental support for student achievement | High parental participation in school activities | 50 < of students comes from economic disadvantage families | Having a female teacher | Teacher with math as a major area of study | Teachers have high expectations for students |
|---|---|---|---|---|---|---|---|---|
| | | Mean | 421.53 | 419.33 | 367.29 | 396 | 384.76 | 386.91 |
| | Yes | SE | 12.75 | 11.45 | 4.63 | 5.52 | 4.41 | 4.1 |
| | | Mean | 379.63 | 378.56 | 394.74 | 369.46 | 363.91 | 357.46 |
| **Colombia** | No | SE | 4.89 | 4.57 | 8.62 | 5.05 | 7.75 | 7.97 |
| | | Mean | 472.78 | 469.65 | 412.45 | 437.83 | 424.98 | 440.83 |
| | Yes | SE | 8.95 | 11.67 | 7.35 | 6.4 | 4.76 | 5.62 |
| | | Mean | 422.7 | 432.07 | 436.9 | 417.84 | 438.99 | 410.89 |
| **Jordan** | No | SE | 5.14 | 5.31 | 6.16 | 5.77 | 13.83 | 6.37 |
| | | Mean | 614.46 | 625.4 | 583.65 | 600.94 | 598.1 | 604.75 |
| | Yes | SE | 5.43 | 6.36 | 6.24 | 3.89 | 5.59 | 3.5 |
| | | Mean | 590.06 | 590.16 | 599.19 | 591.1 | 596.38 | 583.84 |
| **Korea** | No | SE | 3.13 | 2.96 | 2.84 | 4.96 | 3.12 | 4.26 |
| | | Mean | 566.04 | 513.07 | 491.63 | 522.86 | 522.03 | 526.42 |
| | Yes | SE | 18.1 | 12.11 | 7.42 | 4.71 | 4.46 | 6.38 |
| | | Mean | 517.36 | 521.81 | 530.38 | 512.33 | 492.26 | 510.76 |
| **Hungary** | No | SE | 4.25 | 4.74 | 5.25 | 10.76 | 29.05 | 5.58 |

# ANNEX 17: DECOMPOSITION RESULTS FOR THREE COMPARISON COUNTRIES

Decomposition of difference in scores between Colombia and a high performing country (Korea)

**Math Scores Decomposition Colombia-Korea (TIMSS 2007, Math)**

| Test Scores | $b_{Colombia}$ | $b_{Korea}$ | $X_{Colombia}$ | $X_{Korea}$ | **Determinants of Test scores Differentials** | | *as % of total test score diff* | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Endowments* | *Unexplained* | *Endowments* | *Unexplained* |
| | | | | | $b_{Korea}(X_{Korea}-X_{Colombia})$ | $X_{Colombia}(b_{Korea}-b_{Colombia})$ | | |
| Constant | 626.38 | 406.95 | 1.00 | 1.00 | 0.00 | -219.42 | 0.0 | -99.9 |
| **Student characteristics** | | | | | | | | |
| Age of student | -17.24 | 5.27 | 14.40 | 14.30 | -0.56 | 324.17 | -0.3 | 147.7 |
| Female | -32.29 | -10.99 | 0.52 | 0.51 | 0.03 | 10.99 | 0.0 | 5.0 |
| Mother with ISCED5 | 23.83 | 24.54 | 0.23 | 0.35 | 2.88 | 0.17 | 1.3 | 0.1 |
| 11-25 books at home | 14.79 | 20.34 | 0.37 | 0.09 | -5.61 | 2.03 | -2.6 | 0.9 |
| 26-100 books at home | 27.01 | 52.73 | 0.22 | 0.28 | 3.25 | 5.55 | 1.5 | 2.5 |
| 101-200 books at home | 41.13 | 73.18 | 0.05 | 0.26 | 15.91 | 1.47 | 7.2 | 0.7 |
| 200 < books at home | 45.91 | 97.99 | 0.03 | 0.29 | 24.93 | 1.73 | 11.4 | 0.8 |
| Computer available at home | 16.92 | 59.31 | 0.35 | 0.98 | 37.30 | 14.73 | 17.0 | 6.7 |
| | | | | | *78.1* | *360.8* | *35.6* | 164.4 |
| Total | | | | | **78.1** | **141.4** | **35.6** | **64.4** |
| Overall | | | | | **219.5** | | **100.0** | |

Source: TIMSS 2007

Decomposition of difference in scores between Colombia and countries with similar GDP and higher test scores (Jordan)

**Math Scores Decomposition Colombia-Jordan (TIMSS 2007, Math)**

| Test Scores | $b_{Colombia}$ | $b_{Jordan}$ | $X_{Colombia}$ | $X_{Jordan}$ | **Determinants of Test scores Differentials** | | *as % of total test score diff* | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Endowments* $b_{Jordan}(X_{Jordan}-X_{Colombia})$ | *Unexplained* $X_{Colombia}(b_{Jordan}-b_{Colombia})$ | *Endowments* | *Unexplained* |
| Constant | 626.38 | 479.24 | 1.00 | 1.00 | 0.00 | -147.14 | 0.0 | -289.0 |
| **Student characteristics** | | | | | | | | |
| Age of student | -17.24 | -7.63 | 14.40 | 13.94 | 3.50 | 138.37 | 6.9 | 271.8 |
| Female | -32.29 | 16.43 | 0.52 | 0.51 | -0.13 | 25.14 | -0.3 | 49.4 |
| Mother with ISCED5 | 23.83 | 35.17 | 0.23 | 0.37 | 4.68 | 2.65 | 9.2 | 5.2 |
| 11-25 books at home | 14.79 | 13.61 | 0.37 | 0.34 | -0.30 | -0.43 | -0.6 | -0.9 |
| 26-100 books at home | 27.01 | 31.10 | 0.22 | 0.31 | 2.92 | 0.88 | 5.7 | 1.7 |
| 101-200 books at home | 41.13 | 43.69 | 0.05 | 0.10 | 2.50 | 0.12 | 4.9 | 0.2 |
| 200 < books at home | 45.91 | 39.57 | 0.03 | 0.09 | 2.27 | -0.21 | 4.5 | -0.4 |
| Computer available at home | 16.92 | 30.05 | 0.35 | 0.73 | 11.54 | 4.56 | 22.7 | 9.0 |
| | | | | | *27.0* | *171.1* | *53.0* | 336.0 |
| Total | | | | | **27.0** | **23.9** | **53.0** | **47.0** |
| Overall | | | | | **50.9** | | **100.0** | |

Decomposition of difference in scores between Colombia and a good performer (Hungary).

**Math Scores Decomposition Colombia-Hungary (TIMSS 2007)**

| Test Scores | $b_{Colombia}$ | $b_{Hungary}$ | $X_{Colombia}$ | $X_{Hungary}$ | **Determinants of Test scores Differentials** | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Endowments* | *Unexplained* | *as % of total test score diff* | |
| | | | | | $b_{Hungary}(X_{Hungary}-X_{Colombia})$ | $X_{Colombia}(b_{Hungary}-b_{Colombia})$ | *Endowments* | *Unexplained* |
| Constant | 626.38 | 886.90 | 1.00 | 1.00 | 0.00 | 260.52 | 0.0 | 194.2 |
| **Student characteristics** | | | | | | | | |
| Age of student | -17.24 | -31.25 | 14.40 | 14.61 | -6.50 | -201.81 | -4.8 | -150.4 |
| Female | -32.29 | -5.57 | 0.52 | 0.51 | 0.05 | 13.79 | 0.0 | 10.3 |
| Mother with ISCED5 | 23.83 | 25.67 | 0.23 | 0.38 | 3.76 | 0.43 | 2.8 | 0.3 |
| 11-25 books at home | 14.79 | 23.71 | 0.37 | 0.15 | -5.15 | 3.26 | -3.8 | 2.4 |
| 26-100 books at home | 27.01 | 54.16 | 0.22 | 0.31 | 4.84 | 5.86 | 3.6 | 4.4 |
| 101-200 books at home | 41.13 | 78.21 | 0.05 | 0.21 | 12.67 | 1.70 | 9.4 | 1.3 |
| 200 < books at home | 45.91 | 93.77 | 0.03 | 0.27 | 22.39 | 1.59 | 16.7 | 1.2 |
| Computer available at home | 16.92 | 25.43 | 0.35 | 0.89 | 13.79 | 2.96 | 10.3 | 2.2 |
| | | | | | *45.9* | *-172.2* | *34.2* | -128.4 |
| Total | | | | | **45.9** | **88.3** | **34.2** | **65.8** |
| Overall | | | | | **134.1** | | **100.0** | |

Source: TIMSS 2007

**Logit Model of the probability of not being in the lowest International Benchmark**

| Factors affecting the probability of not being in the lowest international benchmark | Significance |
|---|---|
| Parental participation in school activities | - |
| Parental support in student achievement | + |
| School location | - |
| Economic disadvantage school | - |
| School safety (bullying incidents) | - * |
| Female teacher | + * |
| Teachers expectations of students | + |
| Teacher having math as major area of study | + |
| Attending a private school | + |
| Female | - * |
| Age | - * |
| Mothers with tertiary education | + |
| Books at home | - * |
| Computer at home | + |