TIMSS and PIRLS 2011: Relationships among reading, mathematics, and science achievement at the fourth grade--implications for early learning

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TIMSS and PIRLS 2011: Relationships Among Reading, Mathematics, and Science Achievement—Implications for Early Learning

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Background Descriptions of TIMSS and PIRLS

TIMSS (Trends in International Mathematics and Science Study) is an international assessment of mathematics and science at the fourth and eighth grades that has been conducted every four years since 1995, with the most recent assessment in 2011. In total, more than 600,000 students participated in TIMSS 2011. Countries and regional benchmarking entities could participate in the fourth grade assessment, the eighth grade assessment, or both: fifty-two countries and seven benchmarking entities participated in the fourth grade assessment, and

45 countries and 14 benchmarking entities participated in the eighth grade assessment. Also, several countries, where fourth and eighth grade students were expected to find the TIMSS assessments too difficult, assessed their sixth and ninth grade students.

The TIMSS 2011 achievement results were reported in two companion publications, the *TIMSS 2011 International Results in Mathematics* (Mullis, Martin, Foy, & Arora, 2012) and the *TIMSS 2011 International Results in Science* (Martin, Mullis, Foy, & Stanco, 2012). These reports summarized mathematics and science achievement at the fourth and eighth grades, documented trends in achievement over time for participants in previous TIMSS assessments, and related achievement to the rich array of information about students' characteristics and attitudes as well as their home, school, and classroom contexts for learning.

PIRLS (Progress in International Reading Literacy Study) is an international assessment of reading comprehension at the fourth grade that has been conducted every five years since 2001. In total, approximately 325,000 students participated in PIRLS 2011, including countries assessing students at the sixth as well as the fourth grades, regional participants or language benchmarking efforts, and prePIRLS (an easier version of PIRLS) for students who are still developing their reading skills. Forty-five countries assessed fourth grade students in 2011.

The PIRLS 2011 results were published in *PIRLS 2011 International Results in Reading* (Mullis, Martin, Foy, & Drucker, 2012). This report, which is similar to the TIMSS 2011 volumes for mathematics and science, contains the 2011 reading achievement results for the participating countries and benchmarking entities, shows trends over time for the countries and benchmarking entities that also participated in previous assessments, and relates reading achievement to a number of home, school, and classroom contexts for learning to read. Full details of the methodology underpinning TIMSS and PIRLS in 2011 are presented in *Methods and Procedures in TIMSS and PIRLS 2011* (Martin & Mullis, 2012).

Both TIMSS and PIRLS 2011 continue series of international assessments in mathematics, science, and reading conducted by the International Association for the Evaluation of Educational (IEA). IEA pioneered international comparative assessments of educational achievement in the 1960s to gain a deeper understanding of the effects of policies and practices across countries' different systems of education. TIMSS and PIRLS are directed by IEA's TIMSS & PIRLS International Study Center at Boston College.

Introduction to the Current Report

In 2011, the TIMSS and PIRLS data collection schedules came into alignment for the first time in the history of these international assessments. This provided countries with the opportunity to assess their fourth grade students in three fundamental curricular areas: mathematics, science, and reading. However, more pertinent to the present report, 34 countries and three benchmarking entities took advantage of this unique opportunity to assess the **same** students in all three subjects. Equally important, because the PIRLS assessment includes a parent questionnaire that provides information describing students' home environments and supports for learning, this home environment information was available for the first time with TIMSS data as well. Taken together, the fourth grade students in these 34 countries and three benchmarking participants have achievement data in the three core academic areas—reading, mathematics, and science—accompanied by an extensive array of background questionnaire data about the home, school, and classroom contexts for learning these three subjects.[1]

Having data on the same students makes it possible to conduct a range of investigations of the important characteristics of home and school influencing early learning, while controlling for extraneous factors. Researchers can apply a variety of modeling techniques to explore these important issues by examining the interrelationships among their underlying components. To facilitate this research, the TIMSS & PIRLS International Study Center created a special international database including only fourth grade students assessed in all three subjects, and achievement scores in reading, mathematics, and science were estimated based on a multidimensional scaling or reading, mathematics, and

1 The TIMSS 2011 fourth grade mathematics and science assessment frameworks were organized around a content dimension (number, geometric shapes and measures, and data display in mathematics; life science, physical science, and earth science in science), and a cognitive dimension (knowing, applying, and reasoning for both mathematics and science). Given the frameworks broad coverage, the assessment item pools were necessarily large—175 items in mathematics, and 217 in science—with about half being multiple choice and half constructed response. TIMSS 2011 also collected extensive information about students' home supports and school environments for learning. The questionnaires given to students, teachers, schools, and parents yielded nearly 20 context questionnaire scales about learning and teaching mathematics and science.

PIRLS assesses two purposes for reading that account for most of the reading done by students in and out of school: for literary experience and to acquire and use information. Within each of these two major purposes four comprehension processes are assessed: retrieving, inferencing, integrating, and evaluating. PIRLS gives students reading passages (texts) approximately 800 words in length and asks them 13–16 questions about each passage. PIRLS 2011 contained 10 passages (5 for each purpose) and 135 questions in total. The PIRLS achievement scale was used to summarize students' performance on the assessment questions. PIRLS also included questionnaires given to students, teachers, schools, and parents that were developed in parallel to those administered with TIMSS. Like TIMSS, the PIRLS background data yielded nearly 20 context questionnaire scales about students' attitudes toward reading as well their supports and instructional experiences in learning to read.

science together (Foy, 2013). The purpose of the special database is to have the most appropriate basis for studying relationships among reading, mathematics, and science teaching and learning. The three separate international reports referenced above, and the separate international databases for TIMSS 2011 mathematics and science (Foy, Arora, & Stanco, 2013) and for PIRLS 2011 reading (Foy & Drucker, 2013) should be used for information about the results in one or another of the three subjects assessed in 2011.

It is anticipated that the primary value of this special TIMSS and PIRLS 2011 data will be realized through in-depth national research, as participating countries use the data for school improvement at the primary level. The intention of this initial book examining relationships among reading, mathematics, and science teaching and learning is to illustrate the potential of the special TIMSS and PIRLS 2011 database and to make some headway in the analysis process. To this end, the book includes four very different analyses as described in the following sections.

Profiles of Achievement in Reading, Mathematics, and Science

In examining the relationships among students' achievement in reading, mathematics, and science, a good starting place is to look at whether primary schools are providing students with a thorough grounding in these core subjects, and establishing a solid foundation for later learning. The first chapter in the book sets the stage for the following three chapters by examining patterns of achievement in reading, mathematics, and science within each of the 34 countries and 3 benchmarking entities.

For each TIMSS and PIRLS 2011 participant, achievement is profiled at the TIMSS and PIRLS High International Benchmark and Low International Benchmark, by providing the percentages of students reaching these benchmarks in all three subjects as well as in each of the three subjects separately.[2] The data also are shown graphically in displays that simultaneously show the results in all three subject areas. These graphics show at a glance which countries are most successful in educating their fourth grade students to high levels, and whether countries are equally successful across all three subjects. Interestingly, most countries are more successful in one or two of the subjects than another, especially when it comes to educating substantial percentages of students to high levels.

2 The Advanced, High, Intermediate, and Low International Benchmarks are specific points on the TIMSS and PIRLS achievement scales. As described in Chapter 1, TIMSS and PIRLS use a scale anchoring procedure to describe what students scoring at these benchmarks know and can do.

Students performing at the High International Benchmarks in all three subjects are very accomplished fourth grade students—able to read relatively complex materials with in-depth understanding, solve a variety of mathematics problems, and show familiarity with a range of scientific information. These students have developed an extremely solid basis for further learning and are well positioned to take advantage of future educational opportunities. However, the TIMSS and PIRLS 2011 data provide evidence that it is a very challenging task to educate students to the level of the high benchmarks by the fourth grade. Only Singapore had more than half of its students reach the high benchmark in all three subjects, and only two more countries, Chinese Taipei and Finland, had at least half of their fourth grade students reach the high benchmark in each subject separately.

More than half the countries, however, were successful in educating 90 percent of more of their students to the Low International Benchmark in all three subjects. These students showed that they can read and comprehend facts, read a variety of simple graphs and tables, know simple mathematics (such as adding, subtracting, and basic geometric figures), and know science facts about health, ecosystems, and animals. Although these students have lower achievement than those at the high level, they do have a well-rounded foundation in core concepts and skills that provides a good basis for further learning. In comparison, students who have not learned the basic fundamentals of reading, mathematics, and science by the end of their fourth year of schooling may be at some risk for future academic success.

The profiles across countries of the percentages of fourth grade students reaching high and basic levels of achievement help to situate countries with respect to their relative performance in reading, mathematics, and science. In addition, these profiles provide a good foundation for considering the results of the more complicated analyses presented in the subsequent three chapters.

Impact of Reading Ability on Mathematics and Science Achievement: An Analysis by Item Reading Demands

The *TIMSS 2011 Assessment Frameworks* (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009), developed collaboratively with the participating countries through a series of reviews, describe the mathematics and science content and cognitive processes that were to be assessed. Both the mathematics and science frameworks require assessing rather sophisticated reading demands even at the fourth grade. For example, topics in the mathematics and science content domains specify that students should be able to solve routine and non-routine problems set in everyday contexts and conduct inquiries about various phenomena. Understanding the descriptions of the situations for these types of problems necessarily involves reading. Moreover, in mathematics, the Data Display content area is based on "reading and interpreting" tables, pictographs, bar graphs, and pie charts as well as creating such data displays. The science framework requires comprehending descriptions of experiments and investigations as well as a variety of models and diagrams. Finally, and perhaps most importantly, both mathematics and science can be generally regarded as specialized languages with their own technical vocabularies.

In developing items to assess student achievement in mathematics and science, TIMSS makes every effort to avoid unnecessary reading so that the language used is no more complex than necessary to frame the question (and responses for multiple choice items). However, inevitably the assessment items in both mathematics and science assessments vary considerably in the reading demands they place on students. Reading requirements can be quite minimal, as in items requiring students to complete a calculation or identify the smallest or largest quantity, and most of these items are short. However, some items can have more substantial reading demands, as in those requiring students to understand a description of a science experiment or phenomenon and then apply their knowledge or explain their reasoning.

The availability of PIRLS 2011 data on reading achievement provided an ideal opportunity to investigate the relationship between reading ability and the reading demands of the TIMSS 2011 fourth grade mathematics and science assessment items. Fourth grade students are likely to be at a disadvantage in learning mathematics and science as well as demonstrating high performance on the TIMSS assessment if they lack reading skills.

Essentially, the study examined the hypothesis that students with high reading ability would not be impacted by the level of reading demands in the TIMSS items, but that poorer readers would score lower on the items with highest reading demands than on the items with the lowest reading demands.

Essentially, a coding scheme was used to categorize the TIMSS mathematics and science items into groups (low, medium, and high) in terms of the reading demands they place on the student. The coding scheme evaluated each item in terms of length, technical vocabulary, and density of graphical displays (pictorial representations, models, tables, and graphs). The basic approach used in the analysis was to examine, for each participating country and benchmarking participant, the relationship between fourth grade students' reading ability as measured by PIRLS and their performance on TIMSS items with increasing levels of reading demands.

The methods used to evaluate the reading demands of the items provided additional insight into the TIMSS items from the perspective of "mathematics reading" and "science reading." Although the total number of words was the strongest factor, technical vocabulary and complicated diagrams also contribute to reading demands. The most significant contribution, however, was gaining a deeper understanding of the interconnectedness among curriculum coverage, instructional emphasis, cognitive processing, and reading ability and the challenges in trying to disentangle the various roles they have in affecting student achievement. The results varied from country to country and even between mathematics and science within countries, yet there was support for the idea that more reading demands can make the fourth grade TIMSS items more challenging for weaker readers even in the context of variation in curriculum coverage and that assessing more complex cognitive processing often involves more reading.

What are the Characteristics of Effective Schools in Reading, Mathematics, and Science?

In order to address this question, school effectiveness analyses were conducted to study what makes schools successful, beyond having a majority of students in attendance from advantaged socioeconomic backgrounds. From an analytic perspective, school effectiveness studies make use of multilevel modeling in order to analyze the relationship between school factors and achievement after controlling for the influences of students' home backgrounds.

The research in this chapter began with a strong conceptual model of school effectiveness based on the existing body of school effectiveness research and the factors that influenced school quality as documented in the *TIMSS 2011* and *PIRLS 2011 International Reports*. According to the conceptual model, an effective school was safe and orderly, supported academic success, had adequate facilities and equipment, was staffed with well-prepared teachers, had well-resourced classrooms, and provided effective instruction. From the vast amount of contextual background data available in TIMSS and PIRLS 2011, eventually eleven context questionnaire scales were combined into five robust school effectiveness measures that were available in parallel across reading, mathematics, and science: three measures of effective school environment, and two measures of effective school instruction. The Home Background Control model also included two measures: the Home Resources for Learning scale, and an index of students' ability to do numeracy and literacy tasks when they started school.

Separately for each country—and for reading, mathematics, and science within each country—a series of multilevel regression models were formulated. These models were used to describe how the school explanatory measures were associated with achievement, both before and after controlling for home background at the student and school level.

Although there was variation from country to country, the Home Background Control model was successful in capturing the relationship between home background and students' achievement in reading, mathematics, and science in every country, with the Home Resources for Learning variable the strongest predictor. In fact, 16 of the participants had just one significant predictor after controlling for home background.

The school variables posited by the conceptual model were positively correlated with student achievement in most countries, providing support for the validity of the model. After controlling for home background, of the school environment variables, **Schools Are Safe and Orderly** was related to higher achievement in at least one subject in 15 countries, and **Schools Support Academic Success** in 10 countries. **Students Engaged in Reading, Mathematics, and Science Lessons** was the most powerful school instruction variable, related to higher achievement in at least one subject in 15 countries, again after controlling for home background. All in all, a school that was safe and orderly, promoted academic excellence, and provided engaging instruction, could be considered to have several important characteristics for effectiveness.

It should be realized, however, that countries with little or no differences from school to school in student achievement (including at least seven in this research) provide little scope for an effective school analysis of the type described here. Factors such as the ones considered in this research are still important school factors for supporting high student achievement, but an analysis focused on differences between schools cannot show evidence of their effects.

Home Support for Literacy and Numeracy Achievement

One of the most stable findings in educational research is the impact of students' background on achievement, especially parents' level of education and occupation or earnings. Also, a great deal of research on child development has highlighted the importance of home environments that stimulate the development of early literacy skills. Consistent with this research, in each PIRLS assessment cycle the PIRLS home background data have shown a strong positive association between student reading achievement at the fourth grade and home educational resources, parents' emphasis on early literacy activities, and children's literacy skills when entering school.

Although there has been less research conducted about early numeracy skills, this is an area of growing interest. Therefore, the PIRLS 2011 Home Background Questionnaire, which was administered to parents of students who participated in both TIMSS and PIRLS, was designed also to collect data on early numeracy activities and children's numeracy skills upon entering school. The literacy and numeracy background data, in association with students' reading, mathematics, and science achievement, provide an excellent opportunity to examine the differential effects of aspects of home environment on student achievement in these essential subjects.

The fourth research study presented in this book, conducted by Jan-Eric Gustafsson, Kajsa Yang Hensen, Monica Rosen from the University of Gothenburg in Sweden, took particular advantage of the information about children's early literacy and numeracy experiences provided by the Home Background Questionnaire. This research adopted a path modeling approach to investigate the extent of the influence of Parental Education and Gender on mathematics, science, and reading achievement at the fourth grade; and the mechanisms through which Parental Education and Gender influence achievement via books in the home, frequency of early literacy and numeracy activities, and the child's ability to carry out literacy and numeracy tasks when starting school. The variables in the model were ordered chronologically and logically. In general, Parental Education and Gender preceded the number of books in the home, which preceded the literacy and numeracy activities with the pre-school child, which preceded the child's early literacy and numeracy skills at the beginning of first grade, which preceded the PIRLS 2011 reading achievement and TIMSS mathematics and science achievement scores at the fourth grade.

In the first step of estimation, a common model was fit based on the pooled data from all 34 countries and three benchmarking entities, after which separate models were fit for each country. In the pooled data, the total effects of Parental Education were substantial for mathematics, science, and reading (.33, .35, and .35, respectively), and books in the home was an important mediating variable. The common model provided strong support for the hypothesized chain of influence via books, early activities, and ability entering school to achievement. The number of books was related to frequency of activities in the home oriented towards both literacy and numeracy, and these activities influenced the general levels of literacy and numeracy skills the child had developed at the time of entering school. Interestingly, a stronger emphasis on early literacy activities than on numeracy activities influenced both the levels of children's literacy and numeracy skills when entering school as well as their achievement in the fourth grade. Similar results have been found in other studies, perhaps because adequate language skills are a prerequisite for learning mathematics. In comparison, the effects of Gender were much weaker. There were essentially no gender differences in mathematics or science, although the total effect on reading achievement was rather substantial (.12). Also, only a small part of the Gender effect was mediated via the variables in the model, although for girls the early learning activities were oriented more toward literacy than numeracy.

While the overall findings and mechanisms described above were identified in most countries, there were interesting differences across the countries. There is much additional TIMSS 2011 and PIRLS 2011 background data that can be used to expand this research, and the research can be extended in many different directions to investigate further variables and hypothesized mechanisms.

Summary

In summary, the TIMSS and PIRLS 2011 fourth grade combined database provides an important resource for researching the contexts for early in reading, mathematics, and science. The achievement measures are extremely robust and there is a rich array of context questionnaire data. It is hoped that the four chapters of this books will inspire many others to conduct further research and mine this valuable data.

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Chapter 1

Profiles of Achievement Across Reading, Mathematics, and Science at the Fourth Grade

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Overview

TIMSS routinely reports about students' achievement in mathematics and science, and PIRLS routinely reports about achievement in reading. However, the cycles of the two assessments coinciding in 2011 made it possible for countries to have the same fourth grade students participate in both TIMSS and PIRLS. Thirty-four countries and three benchmarking participants took advantage of this opportunity to collect internationally comparable reading, mathematics, and science achievement on the same fourth grade students together with a large amount of background data.

Most relevant for this chapter, having TIMSS and PIRLS achievement data on the same students enables a comparison of achievement across the three subject areas in each country, although such a comparison has its challenges. This research addresses the question:

> Are primary schools around the world providing students a solid foundation in core subjects—reading, mathematics, and science?

The chapter presents profiles of fourth grade achievement across reading, mathematics, and science for each of the 34 countries and three benchmarking participants. Because both excellence and equity are important educational goals for countries around the world, achievement is profiled at the high level and also at the basic level. For a healthy citizenry and economy, it is important to have fourth grade students well prepared in reading, mathematics, and science concepts so that they can take full advantage of their further educational opportunities, and it also is important to understand how many students have a grasp of the basics across reading, mathematics, and science, as well as how many are lagging behind and still struggling with elementary skills and concepts. Those lagging behind may be at risk for academic success in the future.

The TIMSS and PIRLS achievement results at the fourth grade, as reported separately, suggest that some countries are remarkable in the high levels of achievement their students attain in particular subjects. For example, the East Asian countries, including Singapore, Korea, Hong Kong SAR, Chinese Taipei, and Japan excel in mathematics from assessment cycle to assessment cycle, and the Russian Federation and Finland are top performers in reading (please see *TIMSS 2011 International Results in Mathematics and PIRLS 2011 International Results in Reading*). This raises the question: Are fourth grade students receiving a well-rounded education across the core subject areas, or is there less emphasis on some areas in some countries?

It is well known that performance on the TIMSS and PIRLS achievement scales cannot be compared directly in terms of the content they represent (i.e., a "tablespoon" of mathematics achievement, for example, does not equal a "tablespoon" of reading achievement). However, the TIMSS and PIRLS International Benchmarks do provide a basis for comparisons from subject to subject, because they define the same points on each subject's achievement scale in terms of what students performing at those points know and do in reading, mathematics, or science.

The TIMSS and PIRLS 2011 International Benchmarks at the Fourth Grade

The TIMSS and PIRLS achievement scales summarize students' performance on large numbers of test items designed to measure breadth of understanding and cognitive processing in mathematics, science, and reading, respectively. At each grade, the achievement results are reported on the mathematics, science, and reading achievement scales, each with a range of 0—1,000 (although student performance typically ranges between 300 and 700). In each of the three subjects in addition to average achievement, TIMSS and PIRLS report achievement at four points along the scales as international benchmarks: Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400). The percentage of students reaching each of these international benchmarks provides information to a country on student achievement all across the achievement spectrum. The TIMSS & PIRLS International Study Center worked with its subject matter expert advisory committees, the PIRLS 2011 Reading Development Group and the TIMSS 2011 Science and Mathematics Item Review Committee, to conduct detailed scale anchoring analyses to describe achievement at the benchmarks in reading, mathematics, and science, respectively. In a scale anchoring analysis, the students' achievement on the items in the assessment is used to identify what knowledge and skills are associated with achievement at particular points on the achievement scale. For example, fourth grade students scoring at the High International Benchmark (550) in mathematics were likely to solve an algebra problem requiring reasoning, whereas students scoring at lower levels on the scale were much less likely to answer this problem correctly.

In every participating country, TIMSS and PIRLS can identify the students that reached each of the various international benchmarks, and so it was decided to use the data on students reaching the high and low international benchmarks to conduct the analyses presented herein. The High International Benchmark was selected for this study rather than the Advanced International Benchmark, because only small percentages of students (if any in some countries) reached the advanced level.

Exhibit 1.1 contains the descriptions of students' achievement in reading, mathematics, and science at the High International Benchmarks. The High International Benchmark represents a proficient or competent level of fourth grade achievement in each subject and provides an interesting point of comparison from country to country. Although the 50 countries that participated in TIMSS 2011 at the fourth grade did not intersect completely with all 45 countries that participated in PIRLS 2011, the median percentages (half the countries above and half below) of students reaching the high benchmarks in TIMSS and PIRLS 2011, were 28 percent in mathematics, 32 percent in science, and 44 percent in reading (indicating countries had somewhat less difficulty reaching the High International Benchmark in reading than in mathematics or science).

Exhibit 1.1: Descriptions of High International Benchmarks of Achievement at the Fourth Grade

Reading
When reading literary texts, students can locate and distinguish significant actions and details embedded across text; make inferences to explain relationships between intentions, actions, events, and feeling, and give text-based support; interpret and integrate story events and character actions and traits from parts of texts; evaluate the significance of events and actions across an entire story; and recognize the use of some language features (e.g., metaphor, tone, imagery). When reading informational texts, students can locate and distinguish relevant information with a dense text or a complex table; make inferences about logical connections to provide explanations and reasons; integrate textual and visual information to interpret the relationship between ideas; and evaluate content and textual elements to make a generalization.
Mathematics
Students can apply their knowledge and understanding to solve problems. They can solve word problems involving operations with whole numbers, and use division in a variety of problem situations. They can use their understanding of place value to solve problems, and extend patterns to find a later specified term. They demonstrate understanding of line symmetry and geometric properties. Students can interpret and use data in tables and graphs to solve problems, and use information in pictographs and tally charts to complete bar graphs.
Science
Students can apply their knowledge and understanding of the sciences to explain phenomena in everyday and abstract contexts. They demonstrate some understanding of plant and animal structure, life processes, life cycles, and reproduction. They also demonstrate some understanding of ecosystems and organisms' interactions with their environment, including understanding of human responses to outside conditions and activities. Students demonstrate understanding of some properties of matter, electricity and energy, and magnetic and gravitational forces and motion. They show some knowledge of the solar system, and of Earth's physical characteristics, processes, and resources. Students demonstrate elementary knowledge and skills related to scientific inquiry. They compare, contrast, and make simple inferences, and provide brief descriptive responses combining knowledge of science concepts with information from both everyday and abstract contexts.

Exhibit 1.2 contains the descriptions of students' achievement in reading, mathematics, and science at the Low International Benchmarks. The Low International Benchmark indicates basic proficiency or competence. It is very important for students' future school careers to have developed a solid

foundation of basic understandings and skills across the core subject areas by the early grades. Students not reaching the Low International Benchmarks in one or more core subjects may be at some risk for future success in their educational careers, and may fall farther and farther behind their peers as they continue in school. Again, somewhat different countries participated in TIMSS 2011 at the fourth grade than in PIRLS 2011, but the median percentages of fourth grade students reaching the low benchmarks in TIMSS 2011 and PIRLS 2011, were 90 percent in mathematics, 92 percent in science, and 95 percent in reading. The data across all participating countries indicate a high degree of success in educating students in basic concepts and skills, across reading, mathematics, and science.

Exhibit 1.2: Descriptions of Low International Benchmarks of Achievement at the Fourth Grade

Reading
When reading literary texts, student can locate and retrieve an explicitly stated detail. When reading informational texts, students can locate and reproduce explicitly stated information that is at the beginning of the text.
Mathematics
Students have some basic mathematical knowledge. Students can add and subtract whole numbers. They have some recognition of parallel and perpendicular lines, familiar geometric shapes, and coordinate maps. They can read and complete simple bar graphs and tables.
Science
Students show some elementary knowledge of life, physical, and earth sciences. They demonstrate knowledge of some simple facts related to human health, ecosystems, and the behavioral and physical characteristics of animals. They also demonstrate some basic knowledge of energy and the physical properties of matter. Students interpret simple diagrams, complete simple tables, and provide short written response to questions requiring factual information.

Looking across the descriptions of achievement at the High International Benchmarks in reading, mathematics, and science presented in Exhibit 1.1, it can be seen that students performing at the High International Benchmarks in all three subjects were very accomplished fourth grade students—able to read complex materials with in-depth understanding, solve a variety of problems in mathematics, and show familiarity with a range of scientific information. In comparison, looking across the descriptions of achievement at the low benchmark presented in Exhibit 1.2, it can be seen that students reaching only the low benchmark showed that they can read and comprehend facts, read a variety of simple graphs and tables, know simple mathematics (such as adding, subtracting, and basic geometric figures), and know science facts about health, ecosystems, and animals. Although these students had lower achievement than those at the high level, they do have a well-rounded foundation in core concepts and skills that provides a good basis for further learning.

Profiles of Achievement Across the International Benchmarks

For each country, data are provided about the percentages of fourth grade students reaching the PIRLS 2011 High International Benchmark in reading, the TIMSS 2011 High International Benchmark in mathematics, and the TIMSS 2011 High International Benchmark in science, as well as the percentage of students reaching the High International Benchmark in all three subjects. Students that reached the high benchmark in all three subjects would be proficient in reading, mathematics, and science; and very well-equipped to pursue more advanced study in a variety of subject areas.

Similarly, data are provided for each country and benchmarking participant showing the percentages of students reaching the Low International Benchmarks in each of the subjects, as well as the percentage reaching the low benchmark in all three subjects. Countries that have educated most of their fourth grade students to the low benchmark in all three subjects are to be congratulated, because essentially no students are being "left behind." A certain degree of equity has been achieved, because all students can continue in their schooling, building upon their basic foundation of knowledge and skills across the core curriculum areas.

For each country, the percentages of students reaching the benchmarks in each subject are presented together with graphic illustrations known as radar charts (or star charts). These types of charts are used to plot the values of different categories—in this case, the three percentages of students reaching the high benchmarks in reading, mathematics, and science—along a separate axis in the same graph, with the value of each point represented as the distance from the center of the chart. Depicting the data in this way illustrates the relative strengths and weaknesses across the three subjects, with the strengths depicted by results farther from the center of the graph. As hypothesized based on achievement results reported separately from subject to subject, there are interesting differences across countries, in that some have considerably higher percentages reaching the benchmarks in one or another of the subjects. That is, in some countries students reach considerable higher levels of achievement in mathematics, for example, than they do in science or reading, while in other countries students are achieving at considerably higher in reading, than in mathematics or science.

Exhibits 1.3 through 1.39 contain the country-by-country results, ordered from highest to lowest according to the percentage of students reaching the High International Benchmark in all three subjects—reading, mathematics, and science.

Singapore was the only country that had more than half its students reaching the High International Benchmark in all three subjects. Two other countries, Chinese Taipei and Finland, had 50 percent or more of their students reaching each benchmark separately, but they were not the same students. Chinese Taipei had 40 percent of its students reaching the high benchmark in all three subjects and Finland had 39 percent as did Hong Kong SAR, followed by the Russian Federation with 35 percent. All the other participants in this study had fewer than 30 percent of their students reaching the high benchmark in all three subjects, providing evidence that this is a very challenging educational task. The percentages were very small in a number of countries.

As would be anticipated, more countries had success in raising most students to the Low International Benchmark in all three subjects. More than half the countries had 90 percent or more of their fourth grade students reaching the high benchmark in all three subjects.

Countries at the Fourth Grade

SINGAPORE The Singaporean fourth grade students showed a particular strength in mathematics, with 78 percent reaching the high benchmark, although achievement was also very good in science (68%), and in reading (62%). More than half the students (54%) reached the High International Benchmark in all three subjects, and essentially all of them (95%) reached the Low International Benchmark in all three subjects.

CHINESE TAIPEI The fourth grade students in Chinese Taipei also showed a particular strength in mathematics, with about three-fourths (74%) reaching the High Benchmark. Again, however, achievement also was very good in the other two subjects, with more than half reaching the high benchmark in reading (55%) and in science (54%). Forty percent reached the High International Benchmark in all three subjects, and essentially all of the students (96%) reached the Low International Benchmark in all three subjects.

HONG KONG SAR Of the countries included in this study, Hong Kong SAR had the greatest percentage (82%) of students reaching the High International Benchmark in mathematics, and mathematics was a considerable strength. In comparison, two-thirds reached the high benchmark in reading, and less than half (46%) in science. Still, performance in all three subjects was very good, with 39 percent of the students reaching the high benchmark in all three subjects, and virtually all (97%) reaching the low benchmark.

FINLAND In comparison to the three previous East Asian countries, the high performing Finnish students did less well in mathematics than in science and reading. More than three-fifths of the fourth grade students reached the high benchmark in science (65%) and reading (63%), and half reached that level in mathematics. Thirty-nine percent reached the high benchmark in all three subjects, and virtually all (97%) reached the low benchmark in all three subjects.

RUSSIAN FEDERATION The fourth grade students in the Russian Federation demonstrated their particular excellence in reading, and also performed well in mathematics and science. The percentages of students reaching the High International Benchmark were 63% in reading, compared to 52% in science and 47% in mathematics. Thirty-five percent reached the high benchmark in all three subject and essentially all students (96%) reached the low benchmark in all three subjects.

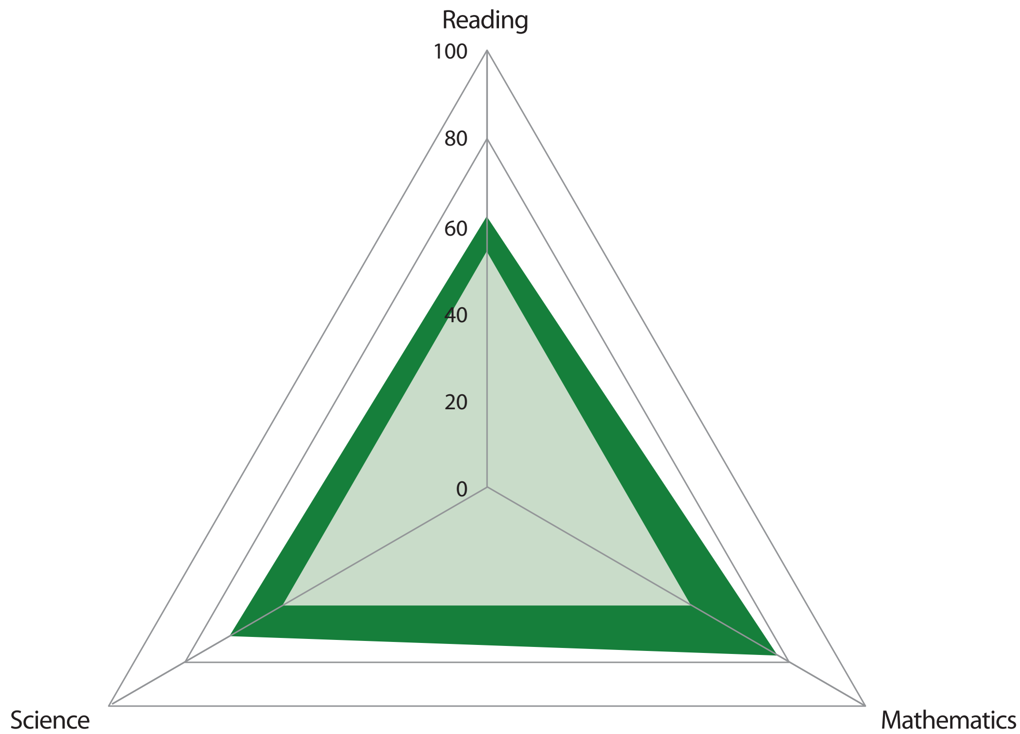
Exhibit 1.3: Singapore

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	54 (1.9)
Reading	62 (1.8)
Mathematics	78 (1.4)
Science	68 (1.7)

( ) Standard errors appear in parenthesis.



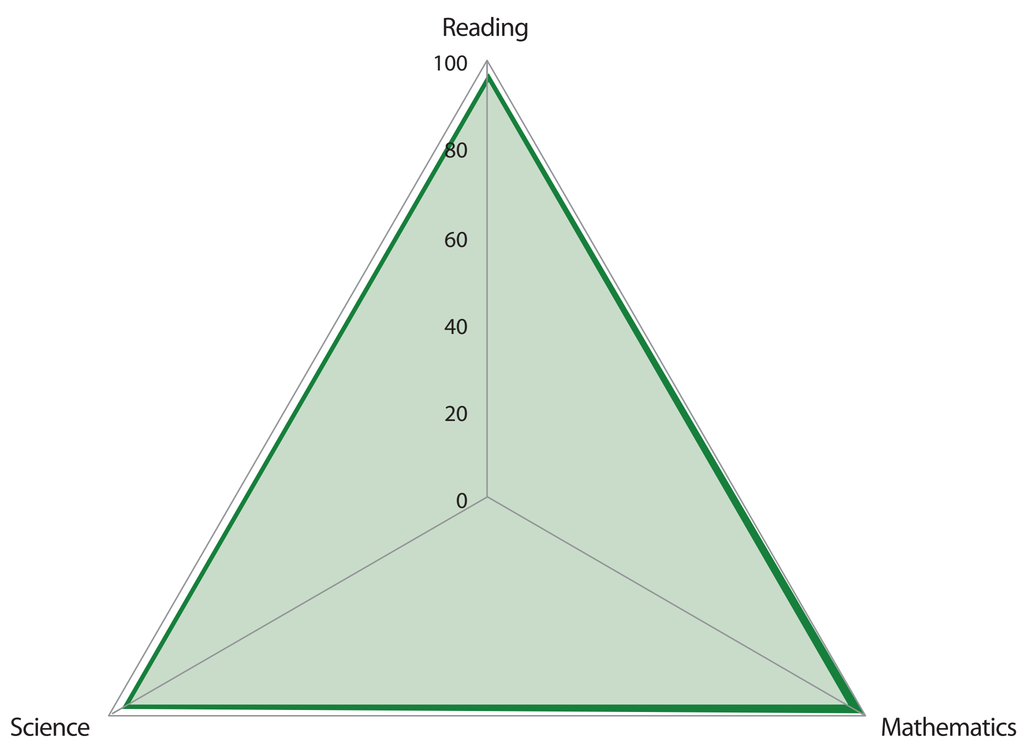
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	95 (0.6)
Reading	97 (0.4)
Mathematics	99 (0.2)
Science	97 (0.4)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.4: Chinese Taipei

Profiles of High and Low Performance in Reading, Mathematics, and Science

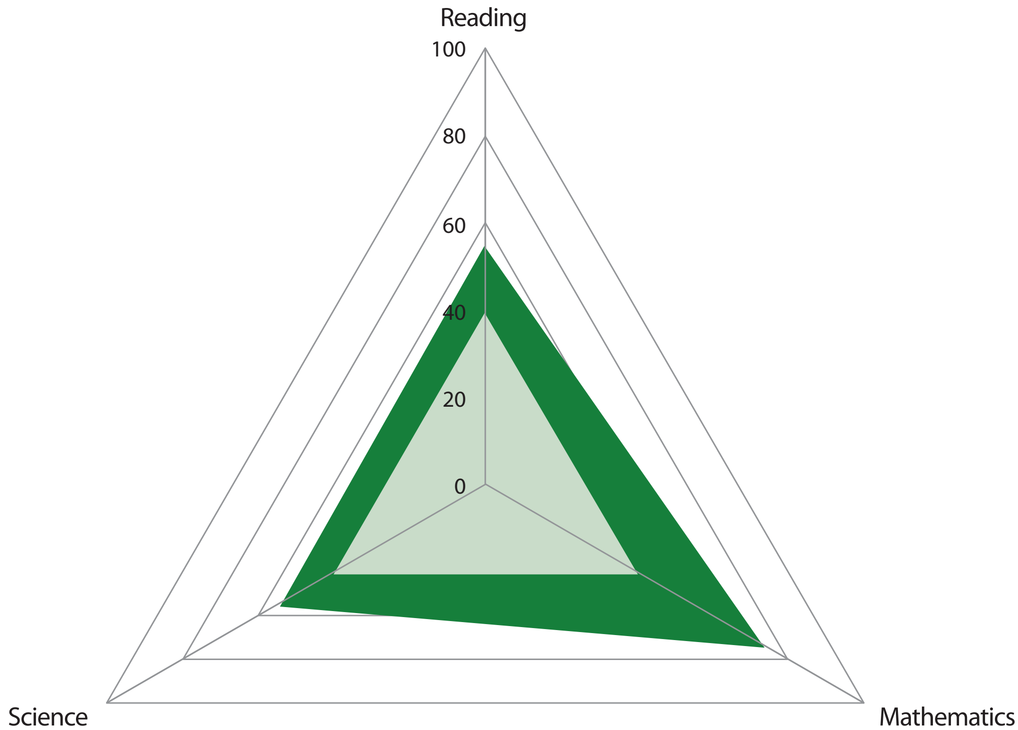
High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	40 (1.3)
Reading	55 (1.3)
Mathematics	74 (1.1)
Science	54 (1.3)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



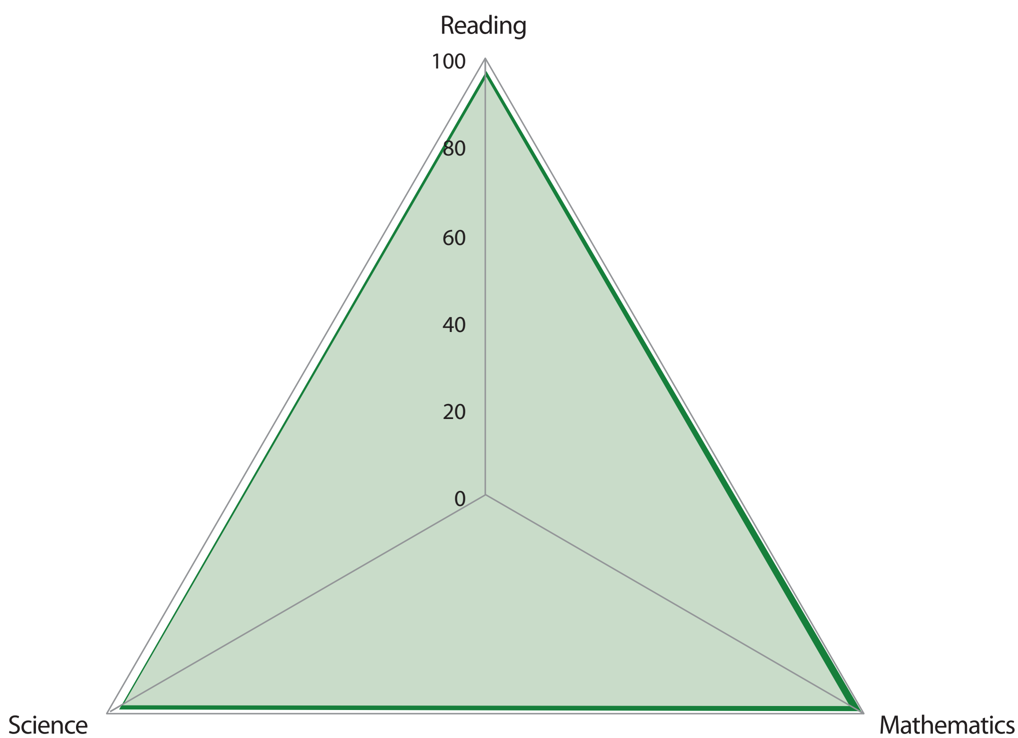
Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	96 (0.4)
Reading	98 (0.4)
Mathematics	99 (0.2)
Science	97 (0.4)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

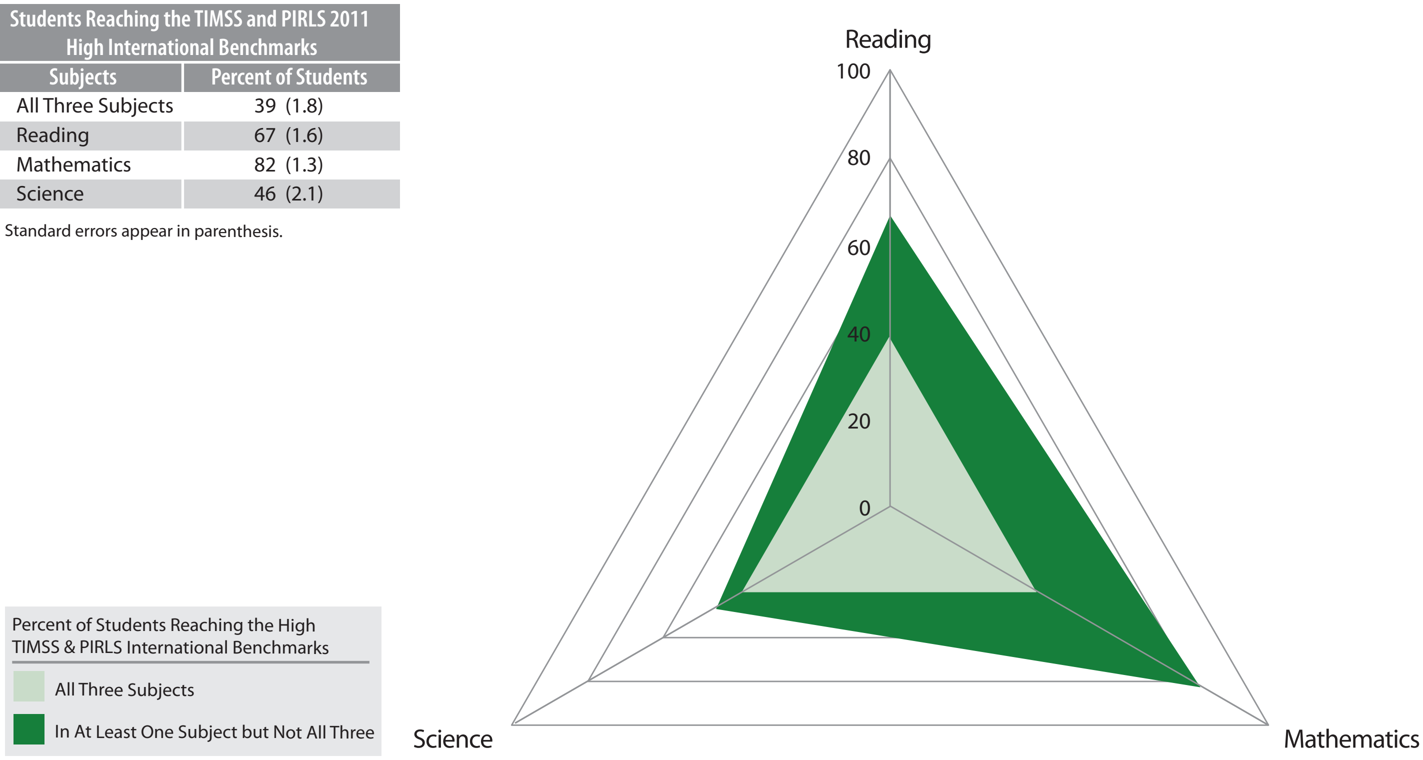
Exhibit 1.5: Hong Kong SAR

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	39 (1.8)
Reading	67 (1.6)
Mathematics	82 (1.3)
Science	46 (2.1)

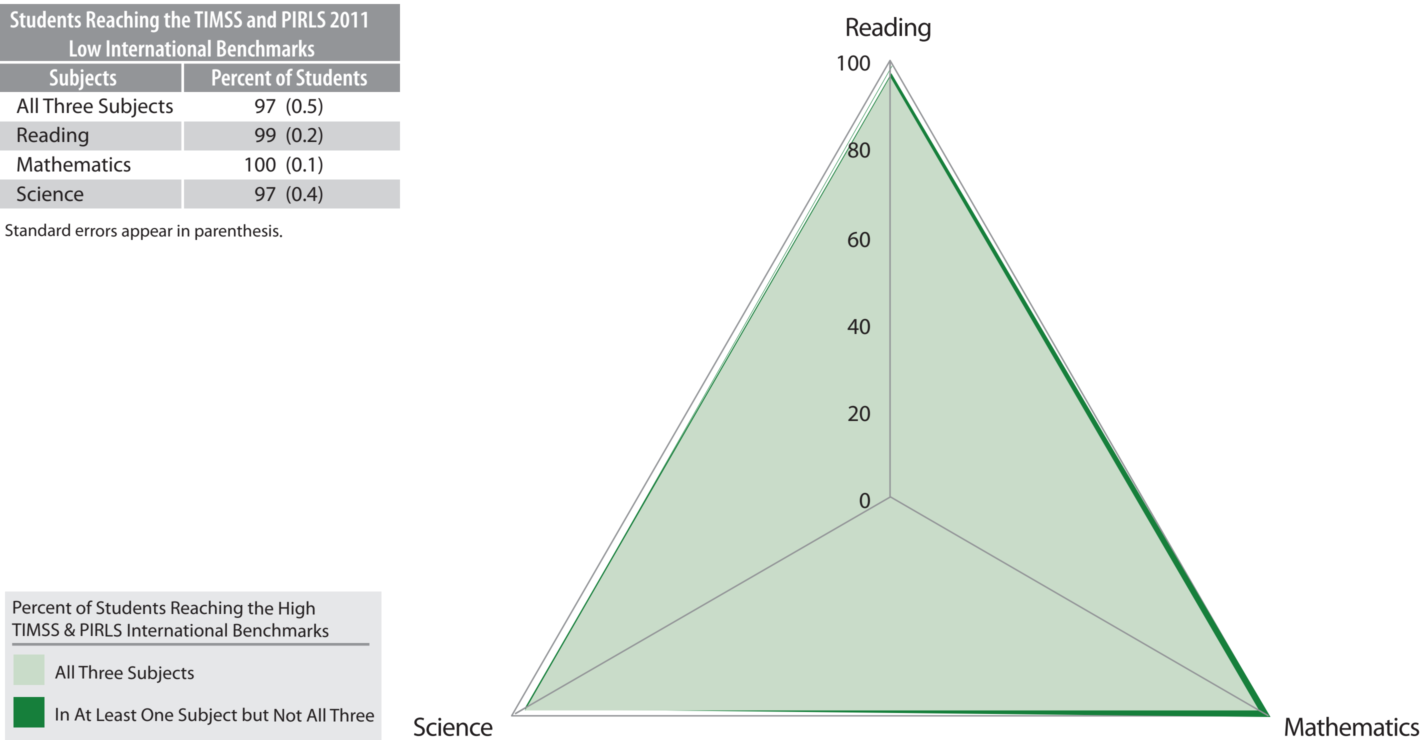
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	97 (0.5)
Reading	99 (0.2)
Mathematics	100 (0.1)
Science	97 (0.4)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.6: Finland

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

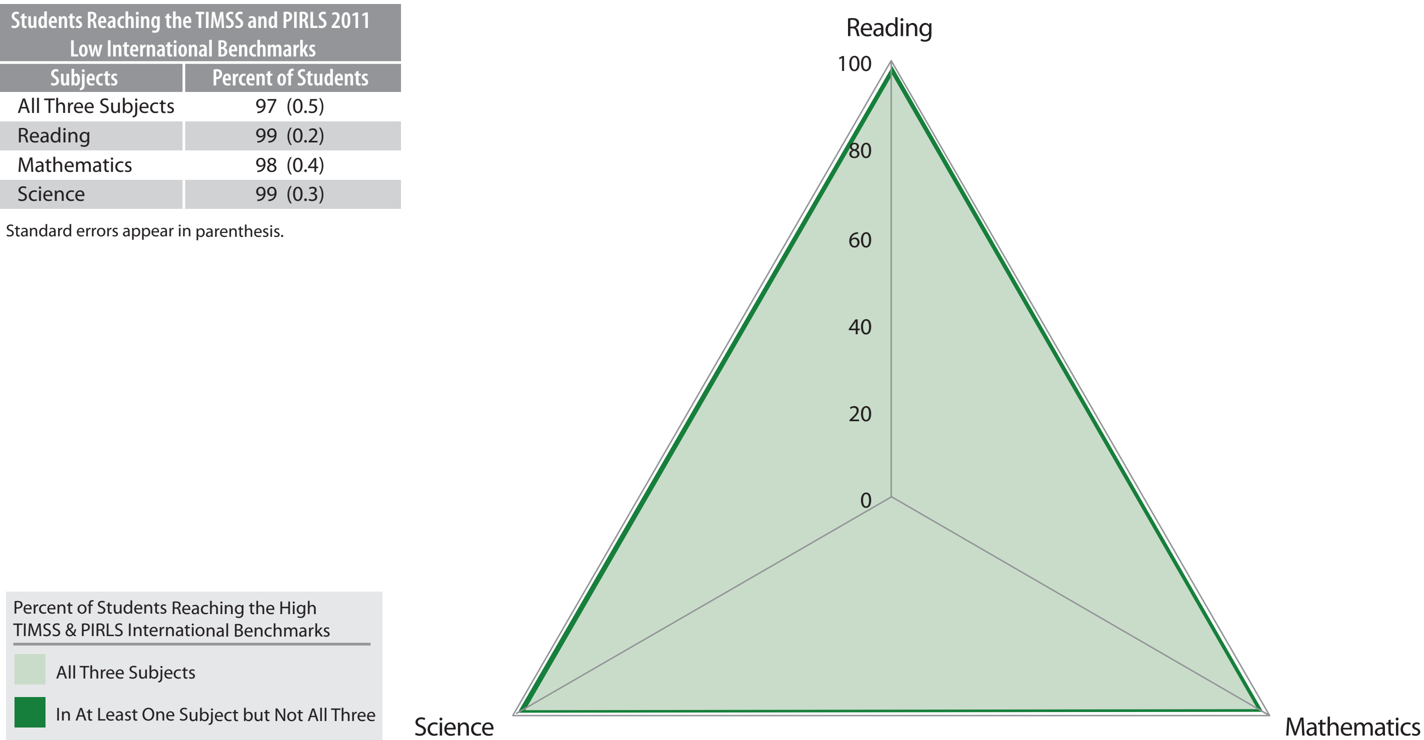
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	39 (1.3)
Reading	63 (1.2)
Mathematics	50 (1.4)
Science	65 (1.7)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	97 (0.5)
Reading	99 (0.2)
Mathematics	98 (0.4)
Science	99 (0.3)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

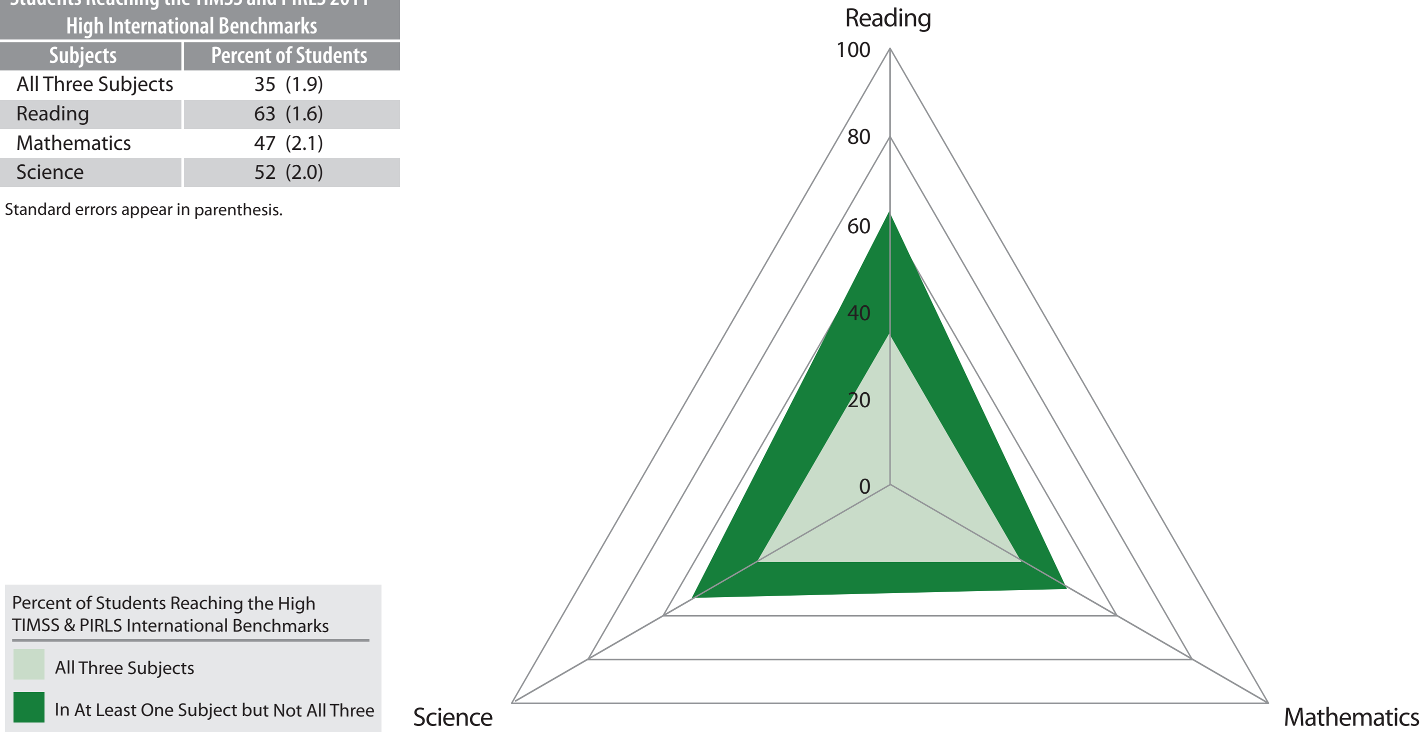
TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	35 (1.9)
Reading	63 (1.6)
Mathematics	47 (2.1)
Science	52 (2.0)

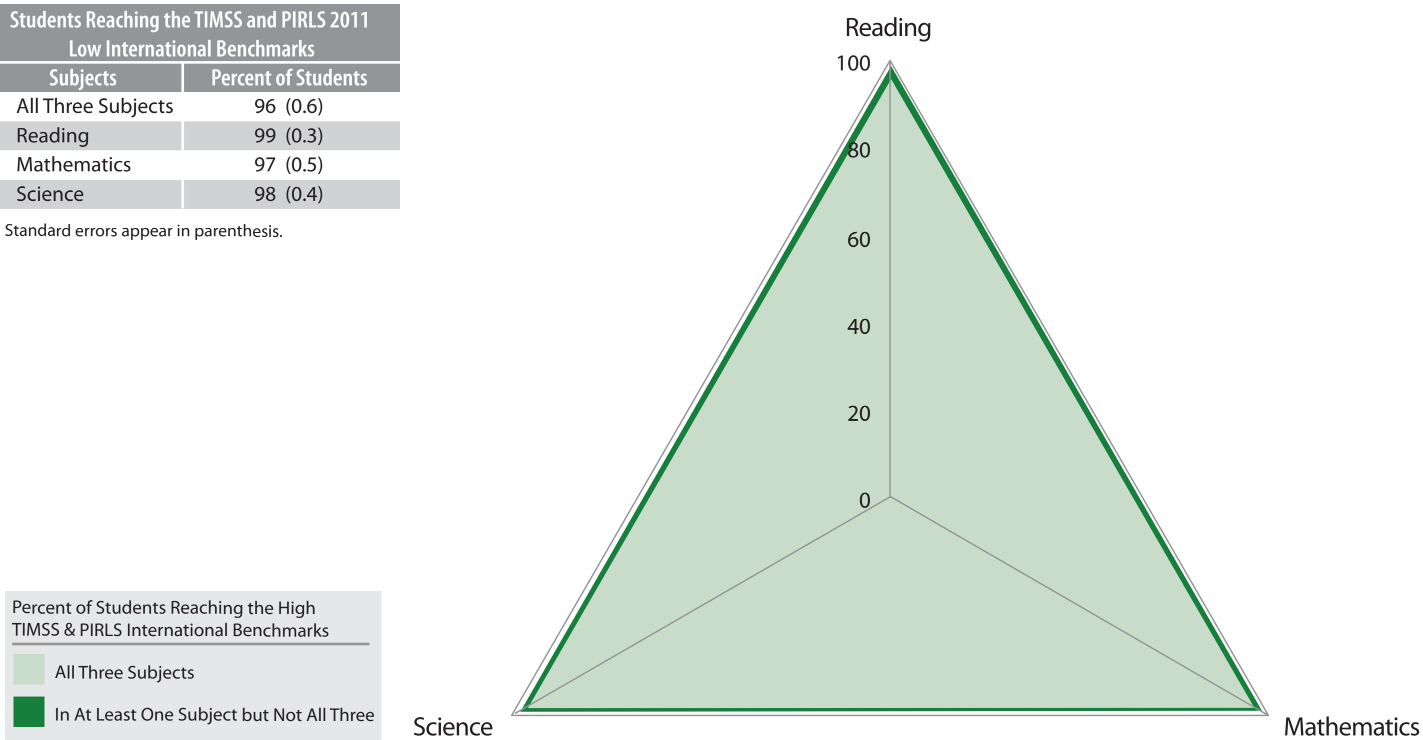
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	96 (0.6)
Reading	99 (0.3)
Mathematics	97 (0.5)
Science	98 (0.4)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

NORTHERN IRELAND These students performed very well in all three subjects, although relatively less so in science. While nearly three-fifths of the students reached the high benchmarks in mathematics (59%) and in reading (58%), one-third did in science (34%). Twenty-nine percent reached the high benchmark in all three subjects, and 92 percent reached the low benchmark in all three subjects.

HUNGARY The Hungarian students performed similarly in all three subjects. Just under half the fourth grade students reached the high benchmark in reading (48%) and science (46%), while 37 percent did so in mathematics. Twenty-eight percent reached the high benchmark in all three subjects. Ninety percent or more reached the low benchmark in each of the three subjects, and 88 percent reached this level in all three subjects.

IRELAND In Ireland, the fourth grade students demonstrated a particular strength in reading, with 54 percent reaching the high benchmark, compared to 41 percent in mathematics and 35 percent in science. One-fourth of the students reached the high benchmark in all three subjects, and 90 percent reached the low benchmark in all three subjects.

GERMANY The German fourth grade students performed similarly across the three subjects, with 46 percent reaching the high benchmark in reading, 39 percent in science, and 37 percent in mathematics. Nearly one-fourth (23%) of the students reached the High International benchmark in all three subjects, and most students (94%) reached the Low International Benchmark in all three subjects.

PORTUGAL In Portugal, there were achievement differences across the subjects, but no large gaps. Forty-seven percent of the students reached the high benchmark in reading, 40 percent in mathematics, and 36 percent in science. Similar to Germany, nearly one-fourth (23%) of the students reached the high benchmark in all three subjects, and most students (93%) reached the low benchmark in all three subjects.

Exhibit 1.8: Northern Ireland

Profiles of High and Low Performance in Reading, Mathematics, and Science

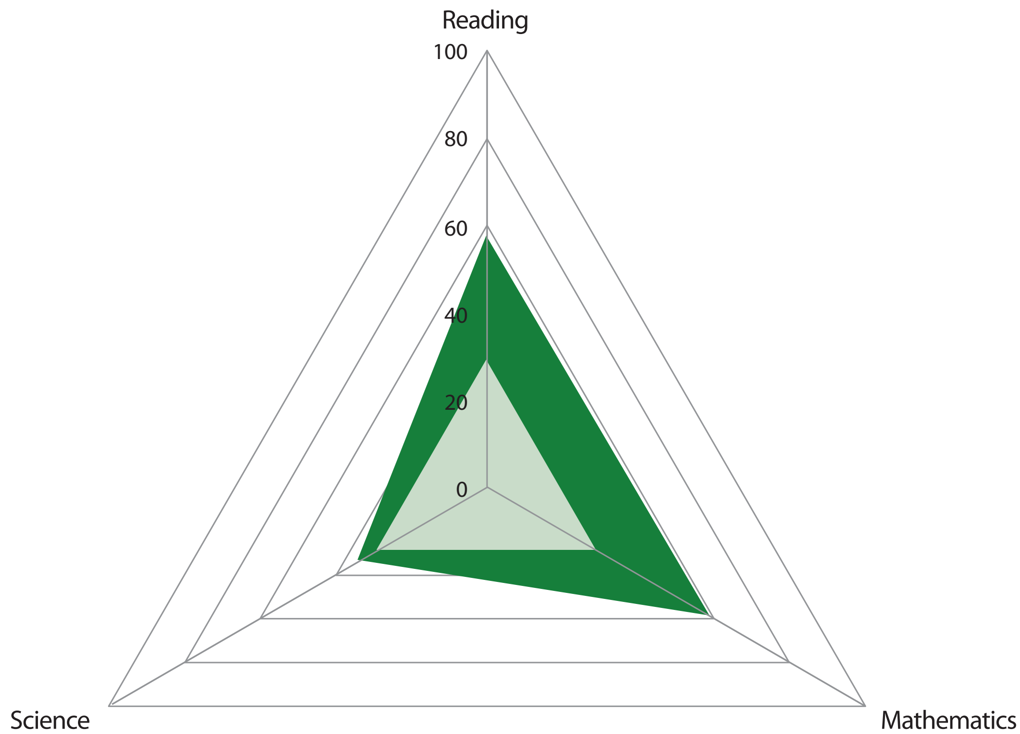
High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	29 (1.4)
Reading	58 (1.4)
Mathematics	59 (1.4)
Science	34 (1.6)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



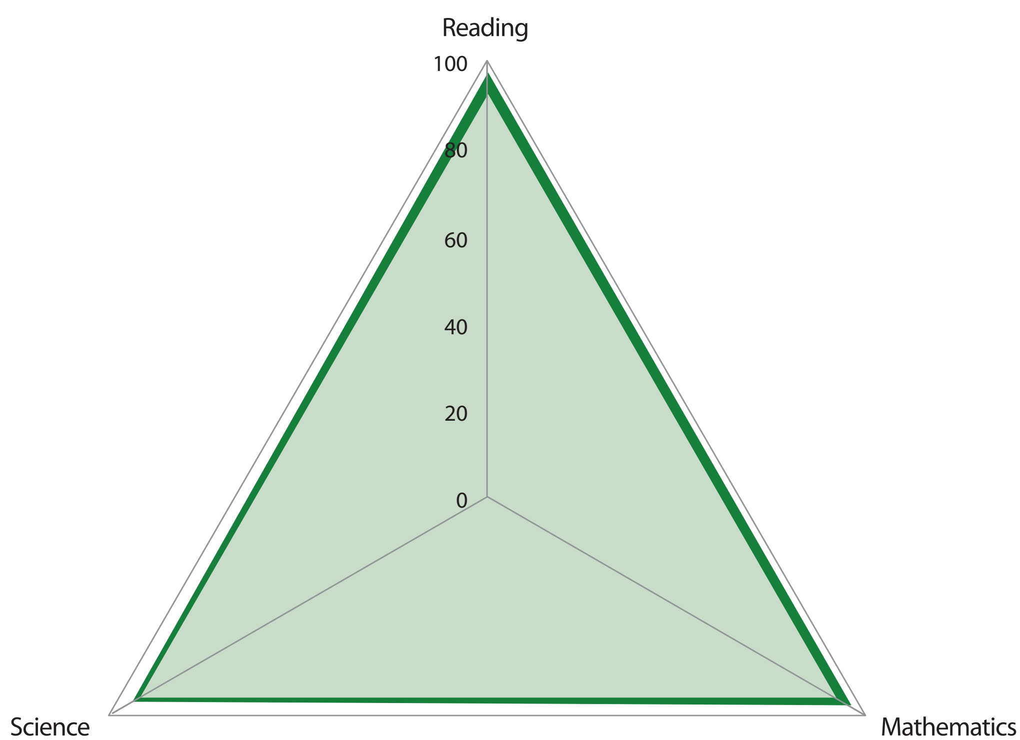
Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	92 (0.8)
Reading	97 (0.5)
Mathematics	96 (0.6)
Science	94 (0.8)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Study – TIMSS and PIRLS 2011

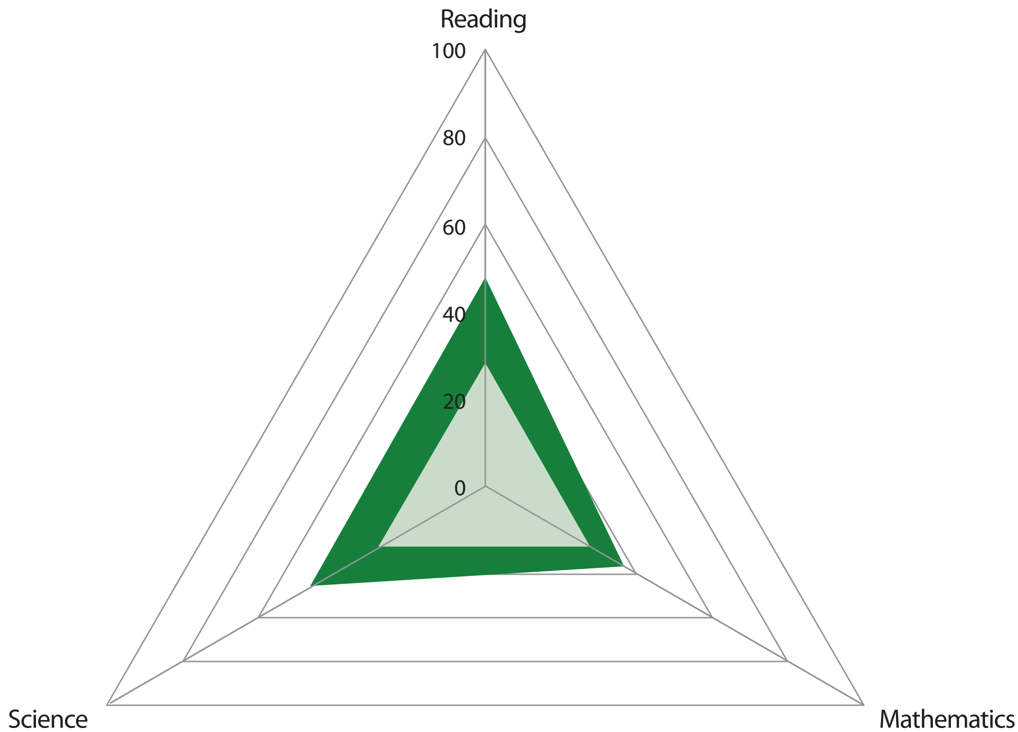
Exhibit 1.9: Hungary

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	28 (13)
Reading	48 (1.5)
Mathematics	37 (1.4)
Science	46 (2.0)

( ) Standard errors appear in parenthesis.



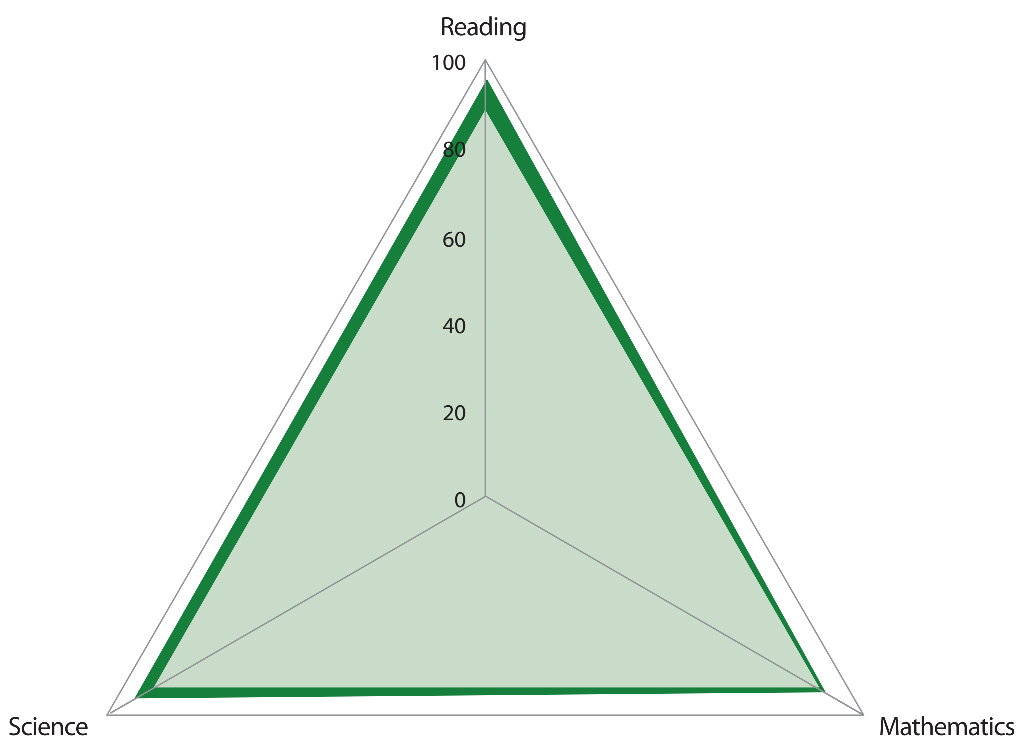
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	88 (1.1)
Reading	95 (0.8)
Mathematics	90 (0.9)
Science	93 (0.9)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

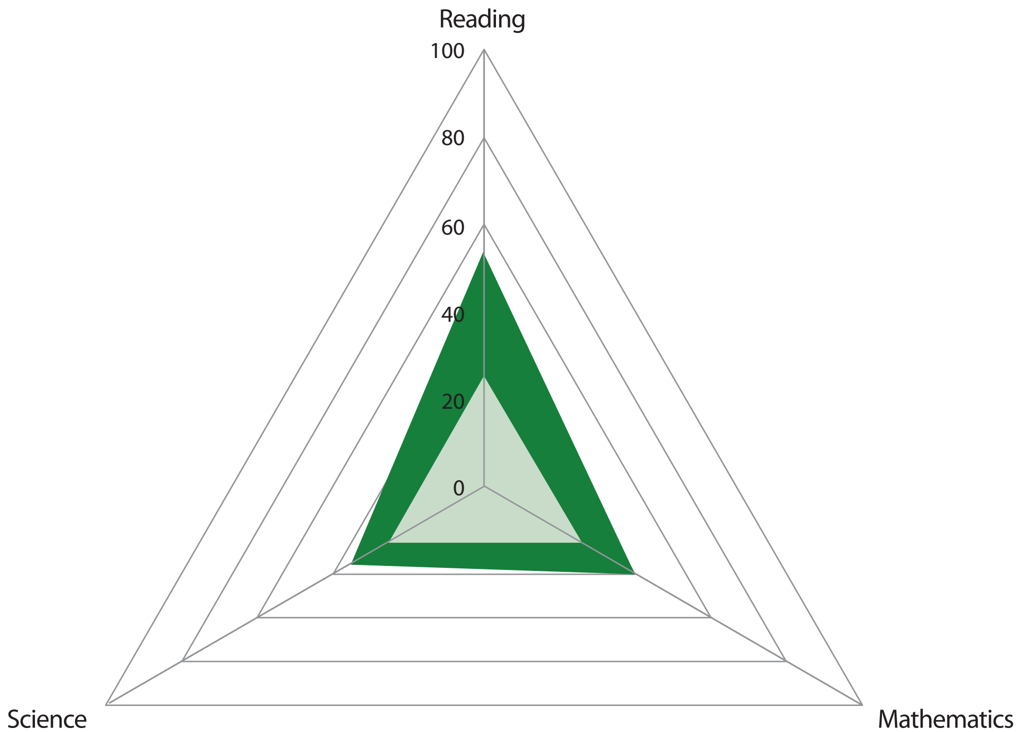
Exhibit 1.10: Ireland

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	25 (1.5)
Reading	54 (1.4)
Mathematics	41 (1.6)
Science	35 (1.7)

( ) Standard errors appear in parenthesis.



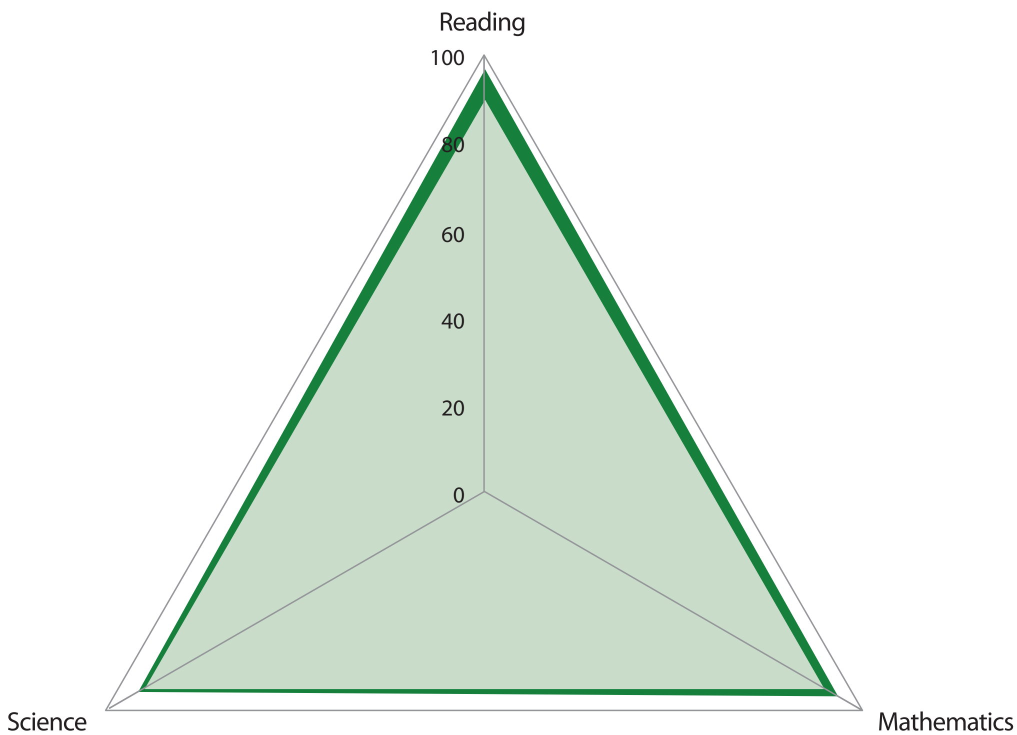
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	90 (0.9)
Reading	97 (0.5)
Mathematics	94 (0.6)
Science	92 (0.8)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

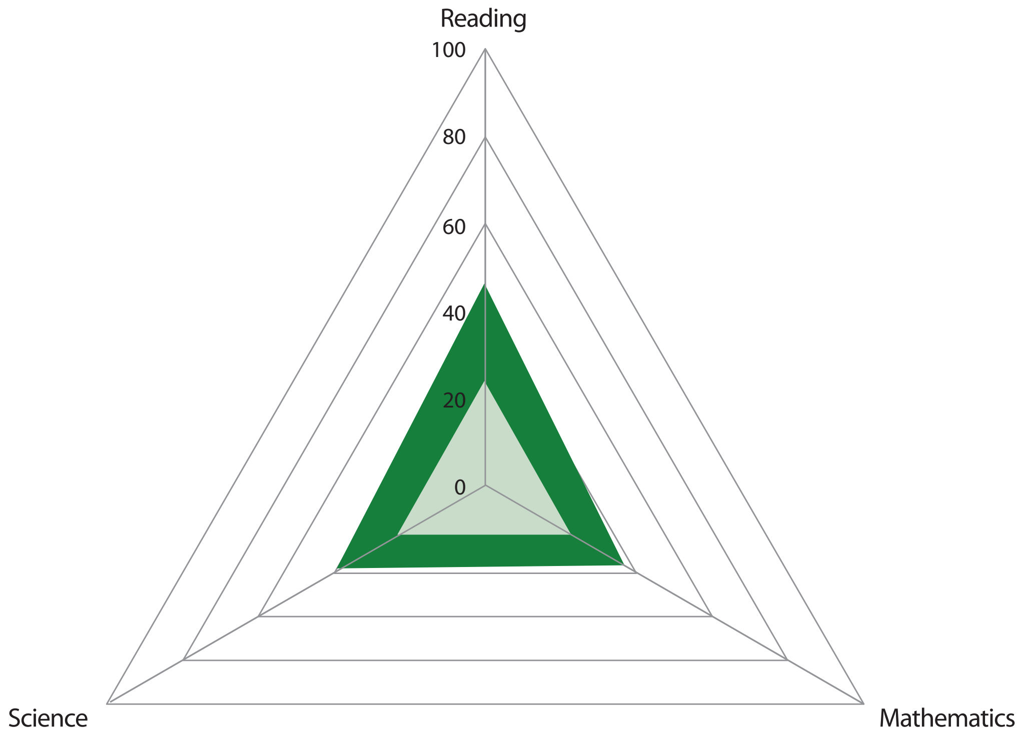
Exhibit 1.11: Germany

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	23 (1.3)
Reading	46 (1.3)
Mathematics	37 (1.4)
Science	39 (1.5)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

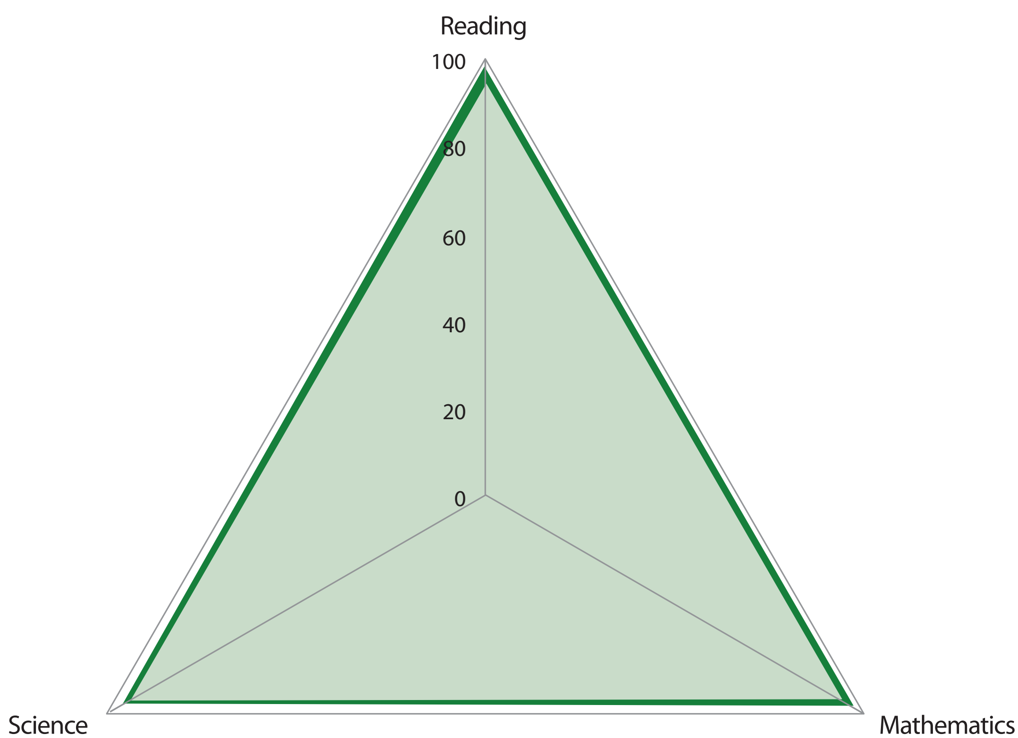
All Three Subjects

In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	94 (0.8)
Reading	98 (0.4)
Mathematics	97 (0.5)
Science	96 (0.8)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

All Three Subjects

In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

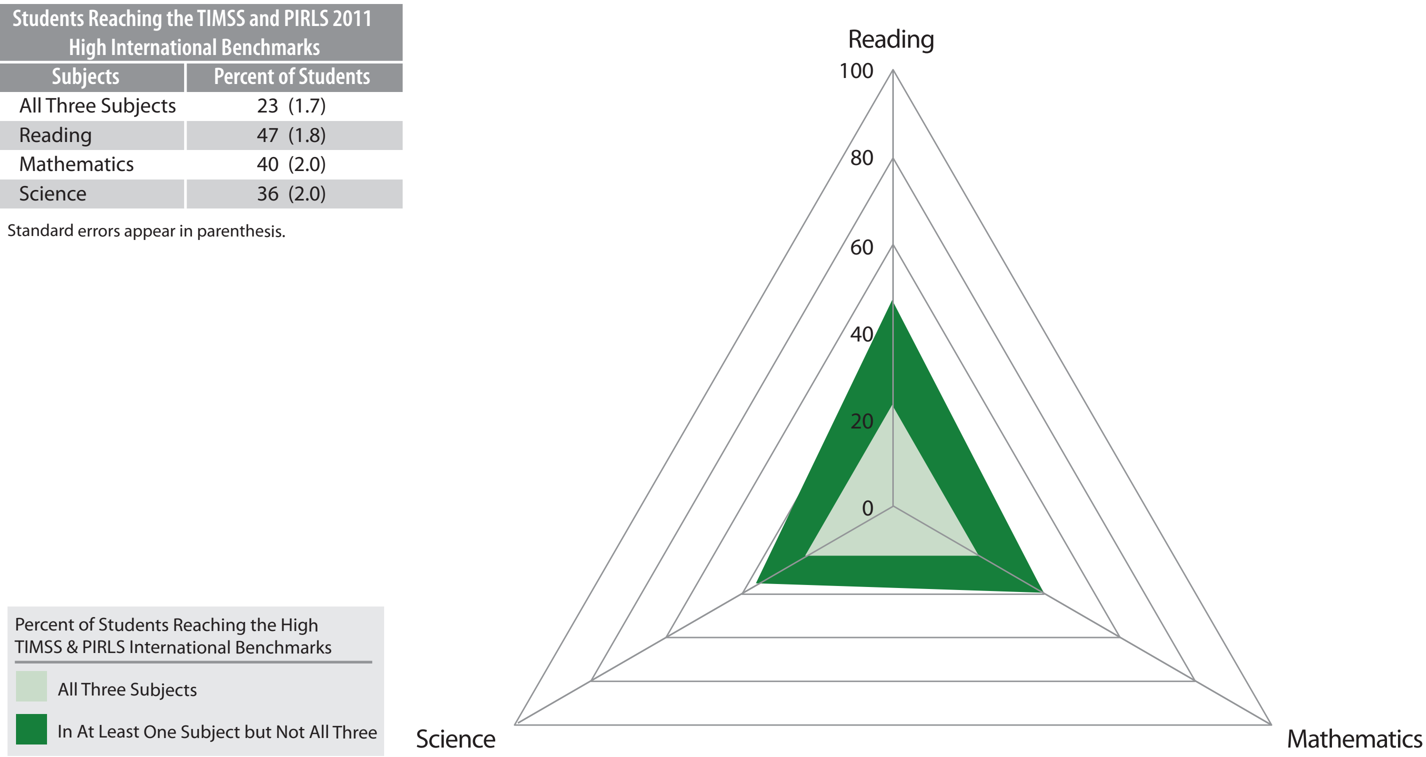
Exhibit 1.12: **Portugal**

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	23 (1.7)
Reading	47 (1.8)
Mathematics	40 (2.0)
Science	36 (2.0)

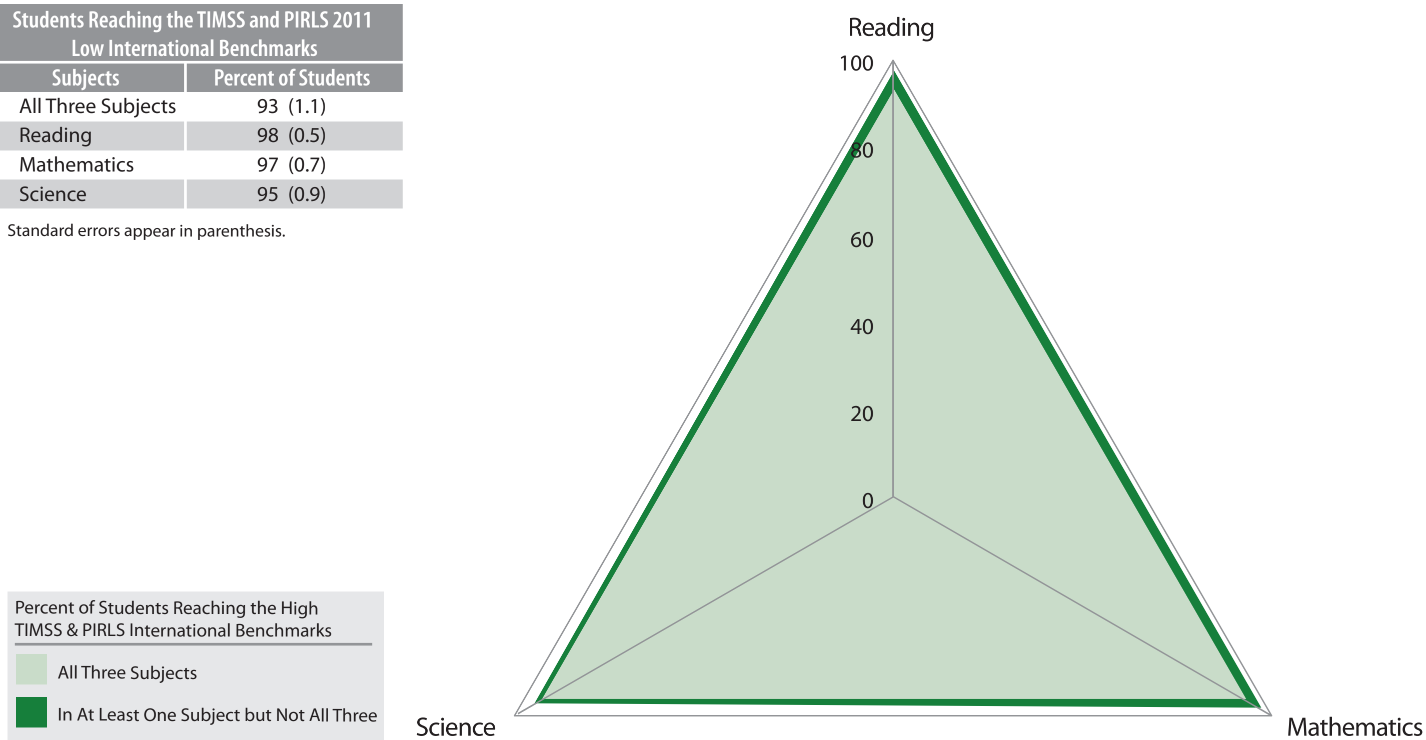
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	93 (1.1)
Reading	98 (0.5)
Mathematics	97 (0.7)
Science	95 (0.9)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

AUSTRALIA In reading, 42 percent of the Australian students reached the high benchmark and 35-36% reached this level in mathematics and science. Twenty-two percent reached the high benchmark in all three subjects. Although more than 90 percent reached the low level in each of three subjects separately, somewhat less (86%) reached the low benchmark in all three subjects.

CZECH REPUBLIC The fourth grade students in the Czech Republic demonstrated a relative weakness in mathematics. Although half reached the high benchmark in reading and 45 percent in science, a comparative smaller percent (30%) reached this level in mathematics. Twenty-one percent of the students reached the high benchmark in all three subjects, and most (92%) reached the low level in all three subjects.

SLOVAK REPUBLIC Similar to the Czech students, the Slovak fourth graders also demonstrated a relative weakness in mathematics, with 44 percent reaching the high benchmark in both reading and science but only 30 percent in mathematics. Also, like the Czech students, 21 percent reached the high benchmark in all three subjects. Although more than 90 percent of the Slovak students reached the low benchmark in each of the subjects, slightly fewer (89%) reached it all three subjects.

LITHUANIA Similar to both the Czech Republic and the Slovak Republic, 21 percent of the Lithuanian students reached the high benchmark in all three subjects. However, the Lithuanian students showed their relative weakness in science. Forty-three percent reached the high benchmark in mathematics and 39 percent in reading, but somewhat fewer (31%) in science. Most students (92%) reached the low benchmark in all three subjects.

SLOVENIA The Slovenian students had the highest percentage of students (42%) reaching the high benchmark in reading, the next highest in science (36%), and the lowest in mathematics (31%). One-fifth the students reached the high benchmark in all three subjects, 90 percent reached the low benchmark in all three subjects.

Exhibit 1.13: Australia

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

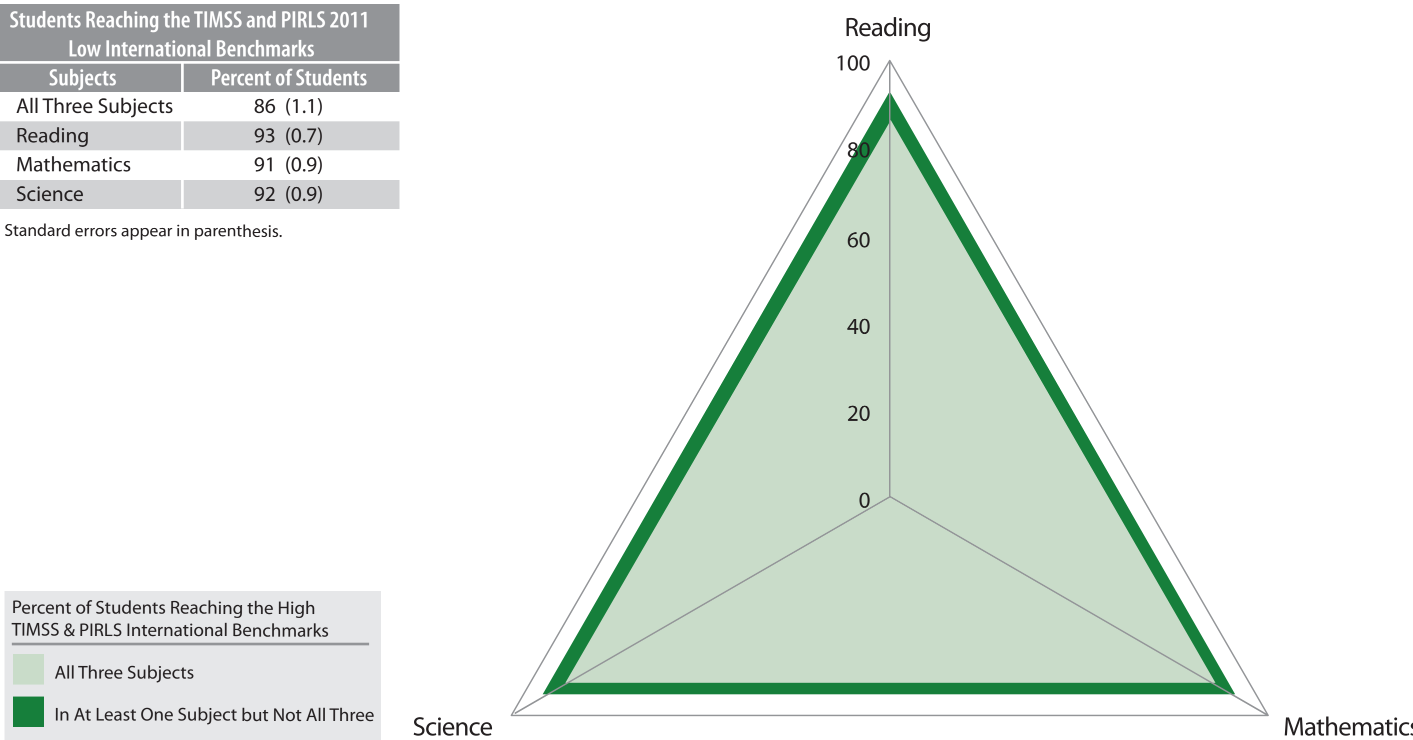
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	22 (1.2)
Reading	42 (1.2)
Mathematics	35 (1.4)
Science	36 (1.4)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	86 (1.1)
Reading	93 (0.7)
Mathematics	91 (0.9)
Science	92 (0.9)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

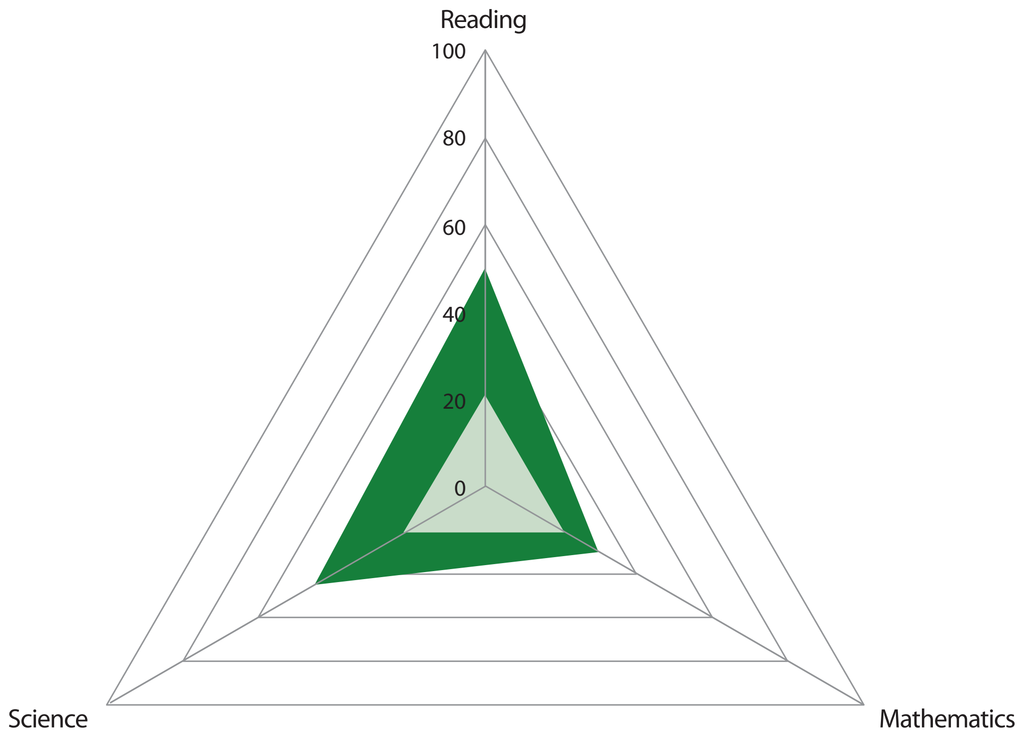
Exhibit 1.14: Czech Republic

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	21 (1.1)
Reading	50 (1.4)
Mathematics	30 (1.6)
Science	45 (1.5)

( ) Standard errors appear in parenthesis.



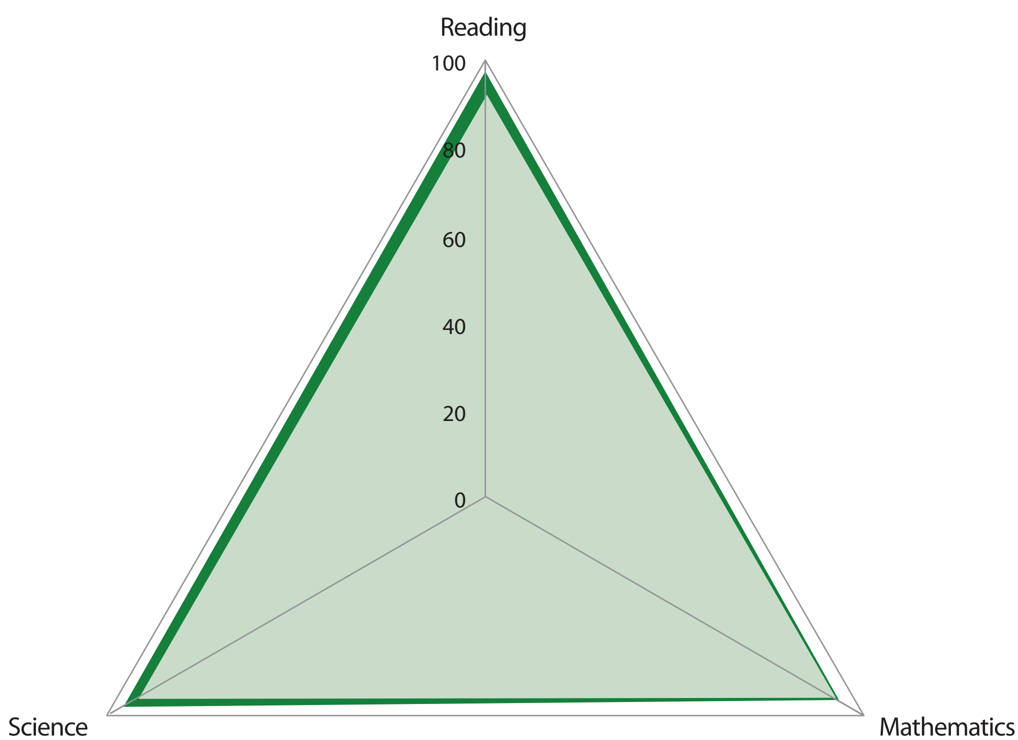
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	92 (0.8)
Reading	98 (0.5)
Mathematics	93 (0.8)
Science	96 (0.7)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 1.15: Slovak Republic

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

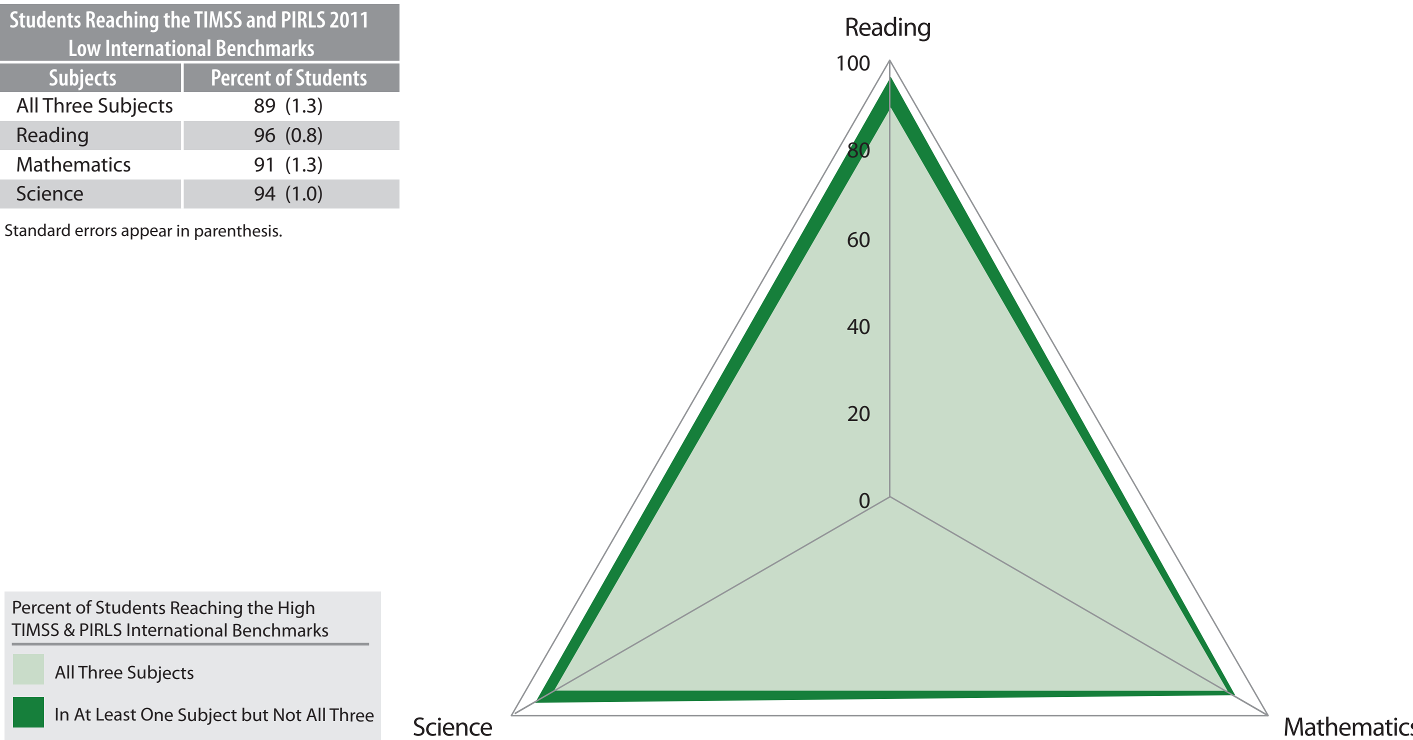
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	21 (1.3)
Reading	44 (1.4)
Mathematics	30 (1.6)
Science	44 (1.6)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	89 (1.3)
Reading	96 (0.8)
Mathematics	91 (1.3)
Science	94 (1.0)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.16: **Lithuania**

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

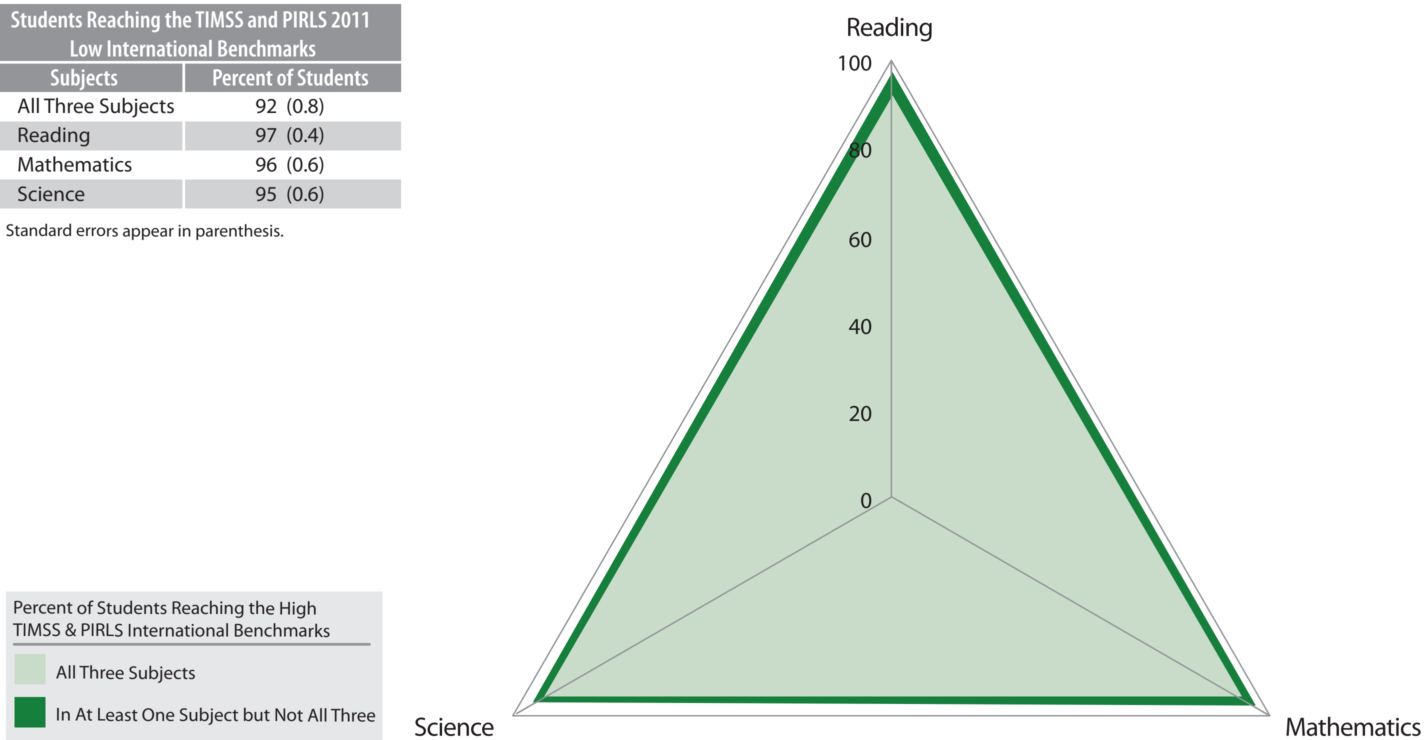
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	21 (1.3)
Reading	39 (1.3)
Mathematics	43 (1.6)
Science	31 (1.6)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	92 (0.8)
Reading	97 (0.4)
Mathematics	96 (0.6)
Science	95 (0.6)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

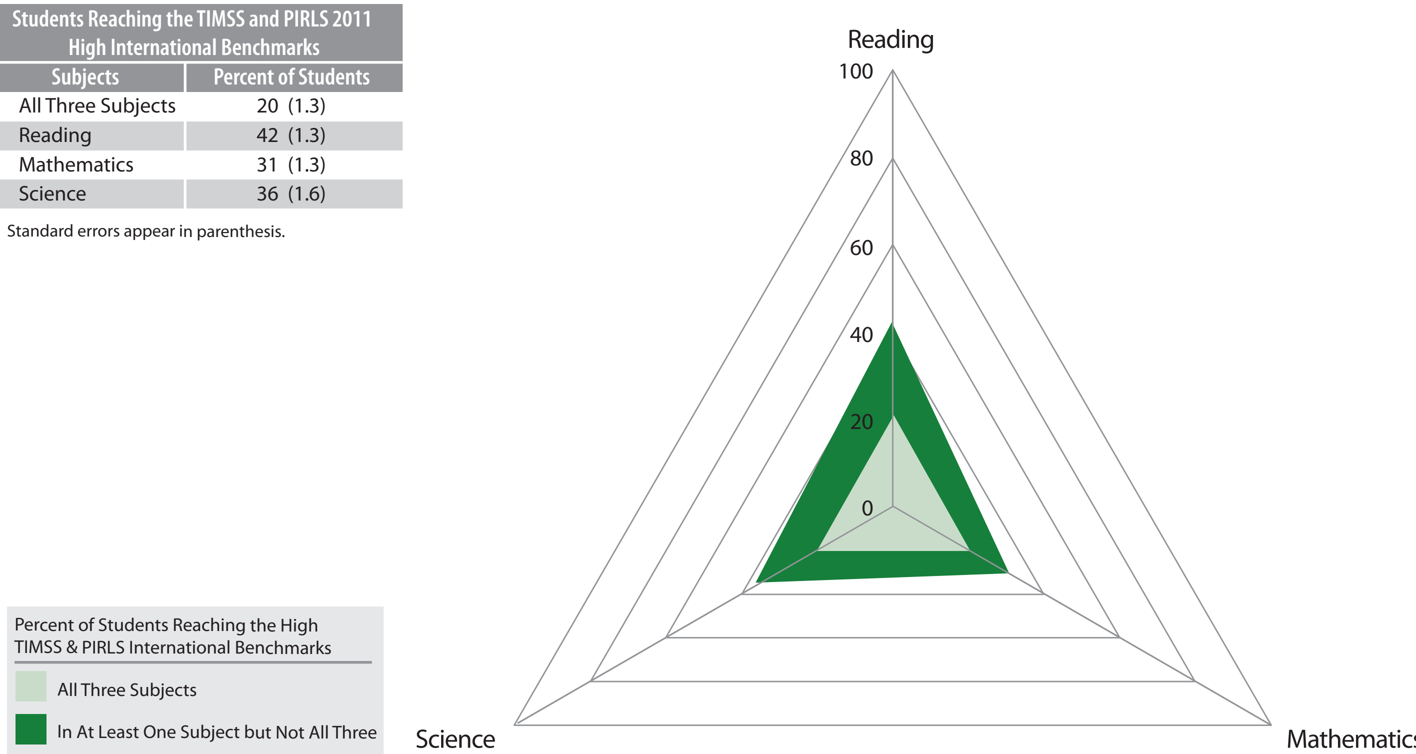
Exhibit 1.17: Slovenia

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	20 (1.3)
Reading	42 (1.3)
Mathematics	31 (1.3)
Science	36 (1.6)

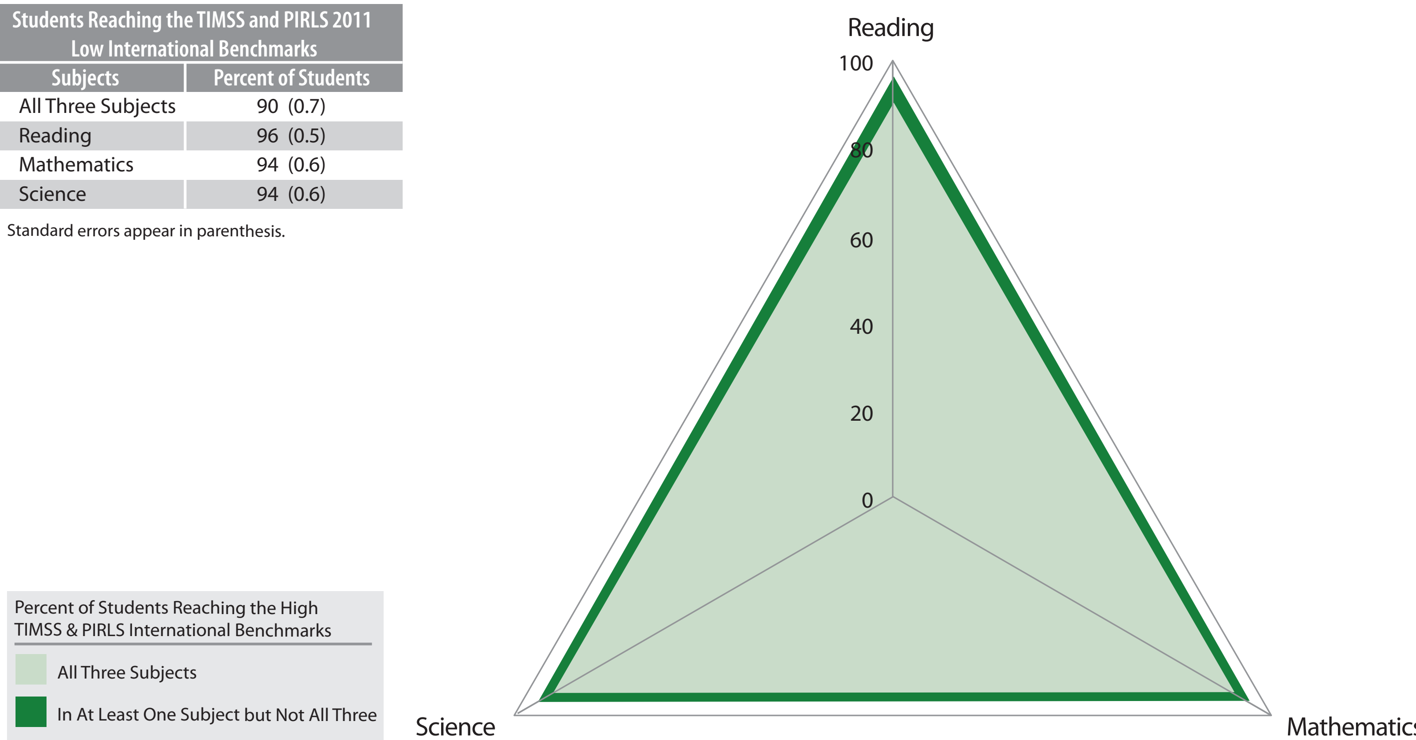
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	90 (0.7)
Reading	96 (0.5)
Mathematics	94 (0.6)
Science	94 (0.6)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

ITALY The Italian fourth grade students show considerable variation in achievement across the three subjects. In reading, 46 percent of the students reached the high benchmark, in science 37 percent, and in mathematics 28 percent. Eighteen percent reached the high benchmark in all three subjects, and 90 percent reached the low benchmark in all three subjects.

SWEDEN The Swedish students showed a relative weakness in mathematics. In reading, 47 percent of the students reached the high benchmark and in science 44 percent did, but in comparison only 25 percent reached that level in mathematics. Similar to Italy, 18 percent reached the high benchmark in all three subjects, and 91 percent reached the low benchmark in all three subjects.

AUSTRIA Very similar to Sweden, the Austrian fourth grade students also showed a relative weakness in mathematics. In science, 42 percent of the students reached the high benchmark and in reading 39 percent did. However, only 26 percent reached that level in mathematics. Eighteen percent reached the high benchmark in all three subjects, and 92 percent reached the low benchmark in all three subjects.

ROMANIA Seventeen percent of the Romanian fourth grade students reached the high benchmark in all three subjects, with 37% reaching that level in science, 32% in reading, and 28% in mathematics. Considering that the percentage of students reaching the high level in all three subjects was similar to a number of the preceding countries, it is interesting that only 73 percent reached the low benchmark in all three subjects.

CROATIA The Croatian fourth grade students showed considerable variation in achievement across the three subjects. They had very good achievement in reading, with more than half the students (54%) reaching the high benchmark. Thirty percent reached the high benchmark in science, but only 19 did in mathematics. While 13 percent reached the high benchmark in all three subjects, 90 percent reached the low benchmark in all three subjects.

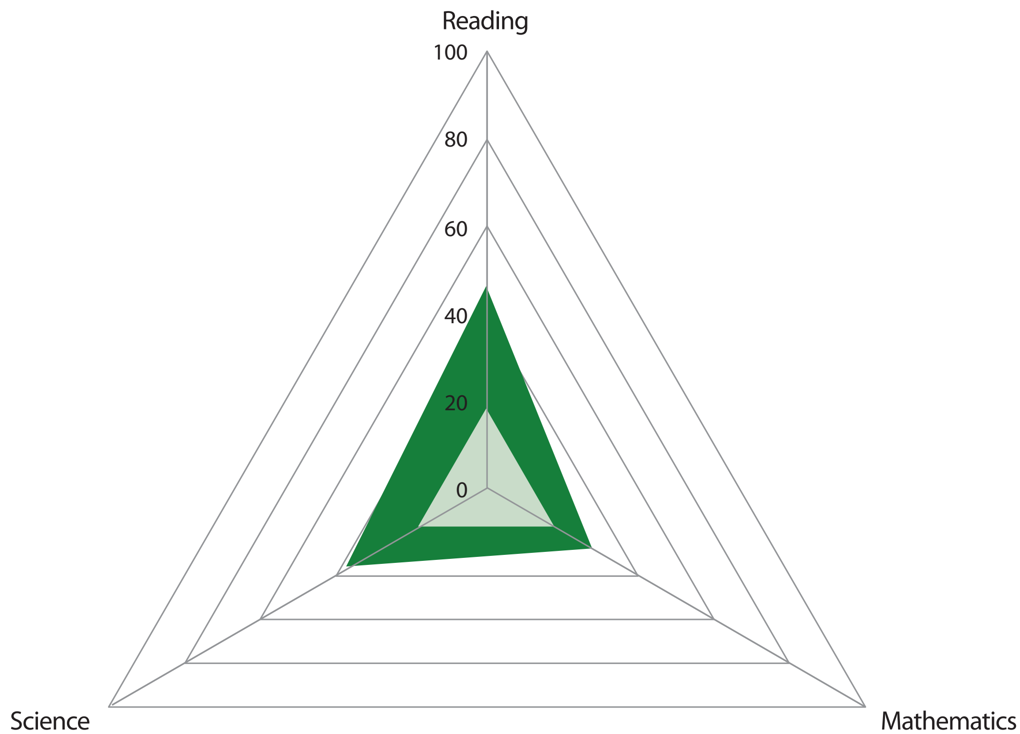
Exhibit 1.18: Italy

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	18 (1.1)
Reading	46 (1.4)
Mathematics	28 (1.6)
Science	37 (1.6)

( ) Standard errors appear in parenthesis.



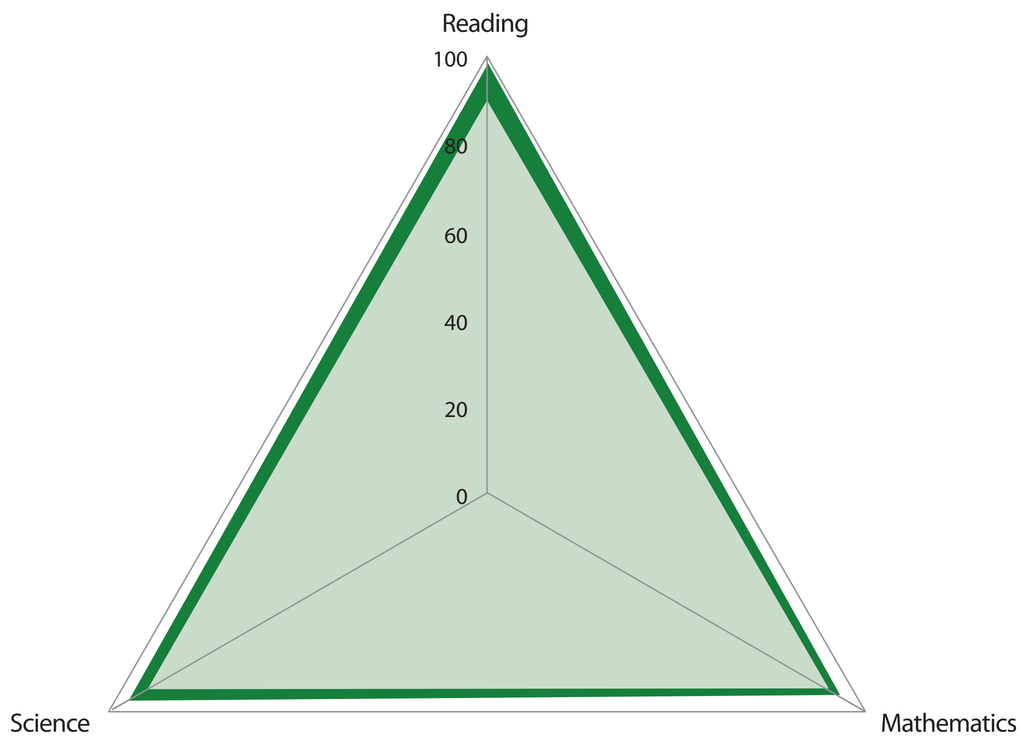
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	90 (0.9)
Reading	98 (0.4)
Mathematics	93 (0.8)
Science	95 (1.0)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.19: Sweden

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

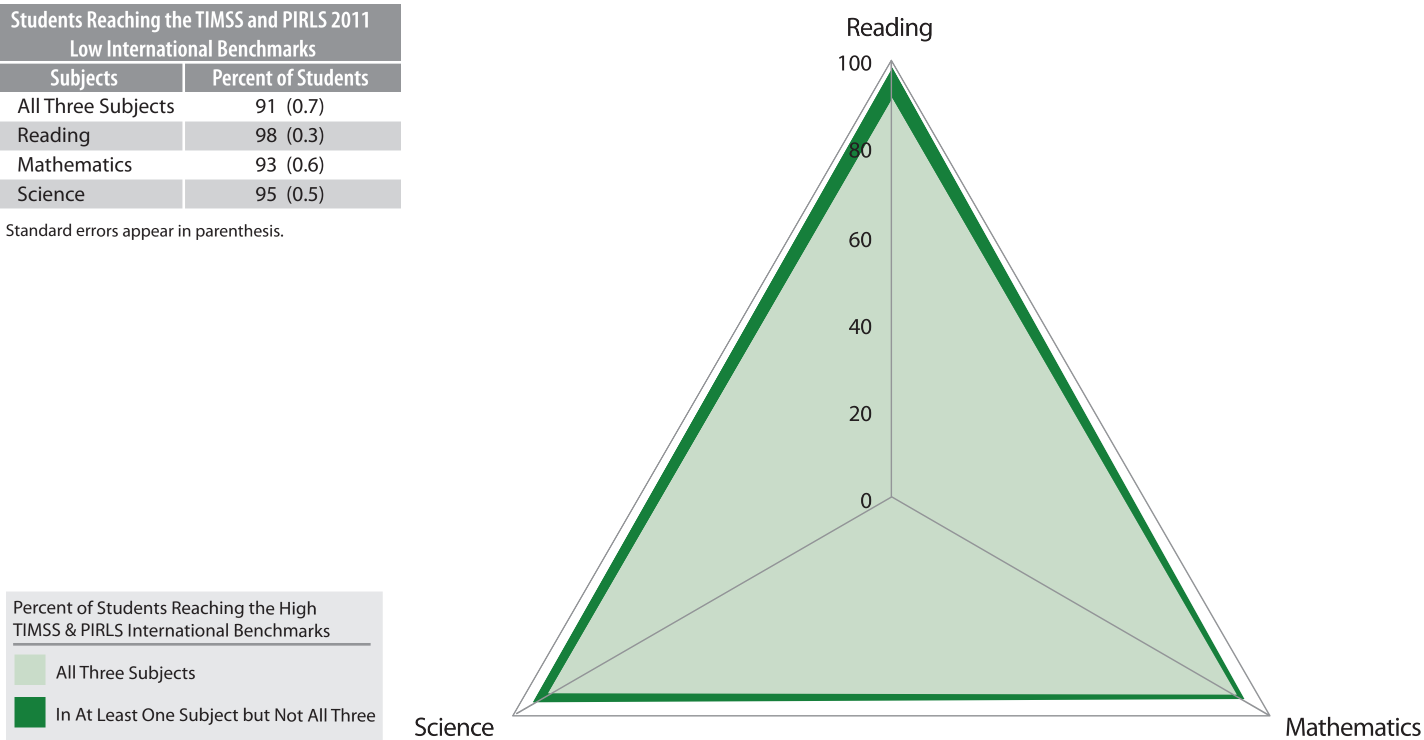
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	18 (1.1)
Reading	47 (1.6)
Mathematics	25 (1.2)
Science	44 (1.5)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	91 (0.7)
Reading	98 (0.3)
Mathematics	93 (0.6)
Science	95 (0.5)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

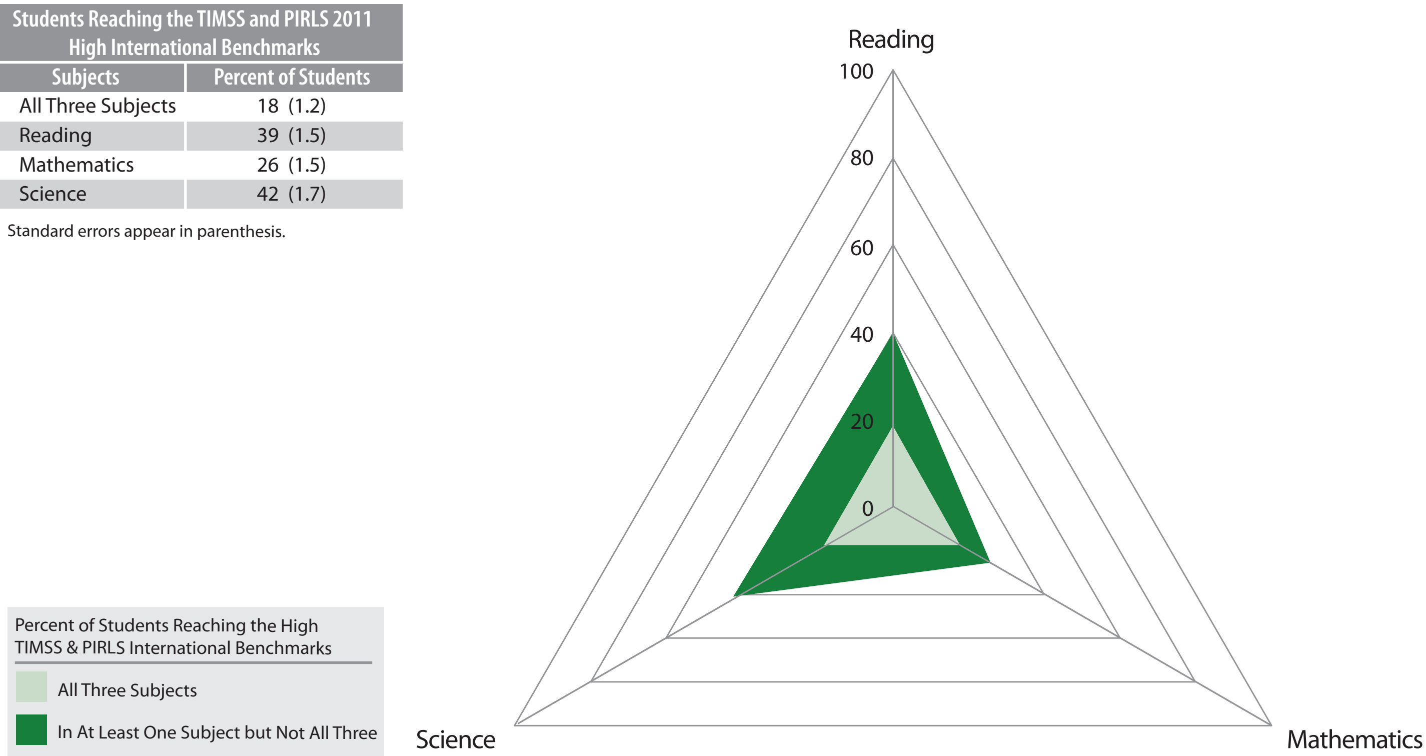
Exhibit 1.20: Austria

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	18 (1.2)
Reading	39 (1.5)
Mathematics	26 (1.5)
Science	42 (1.7)

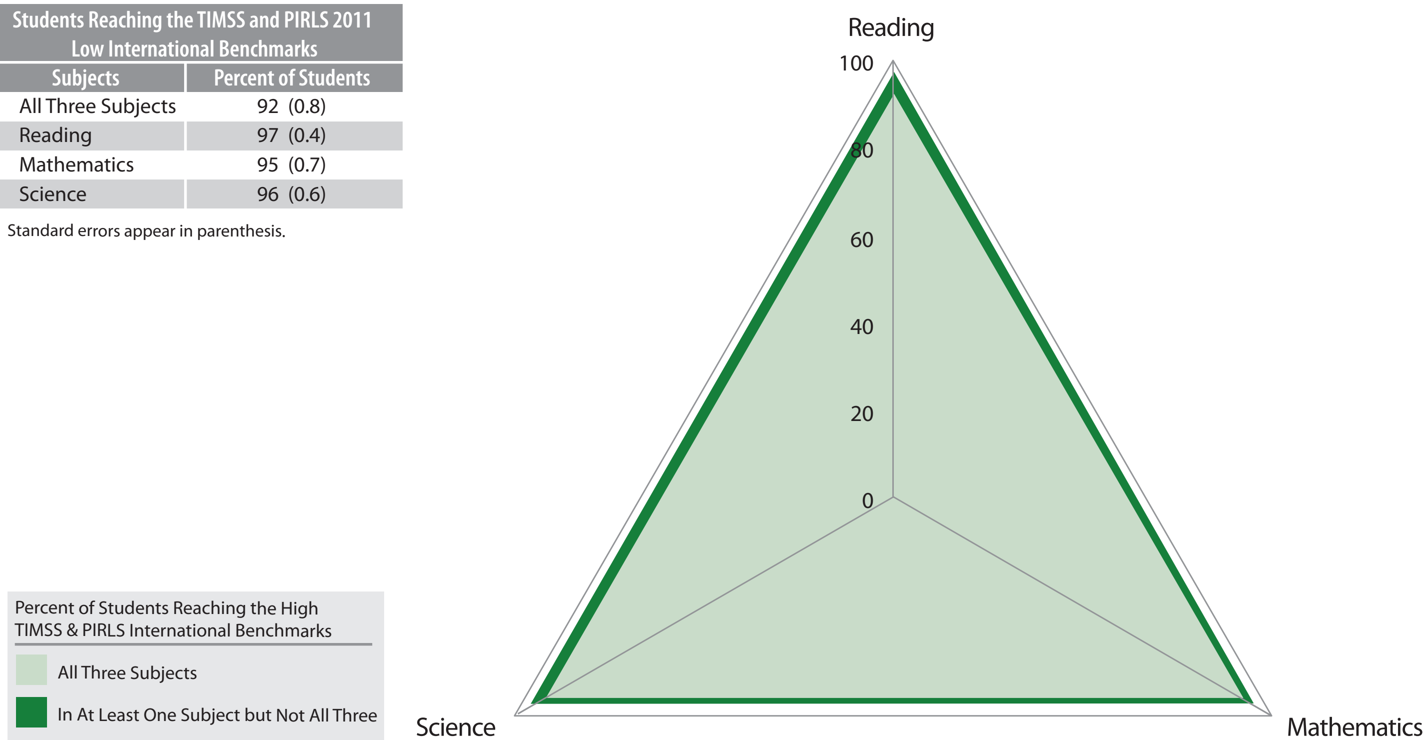
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	92 (0.8)
Reading	97 (0.4)
Mathematics	95 (0.7)
Science	96 (0.6)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

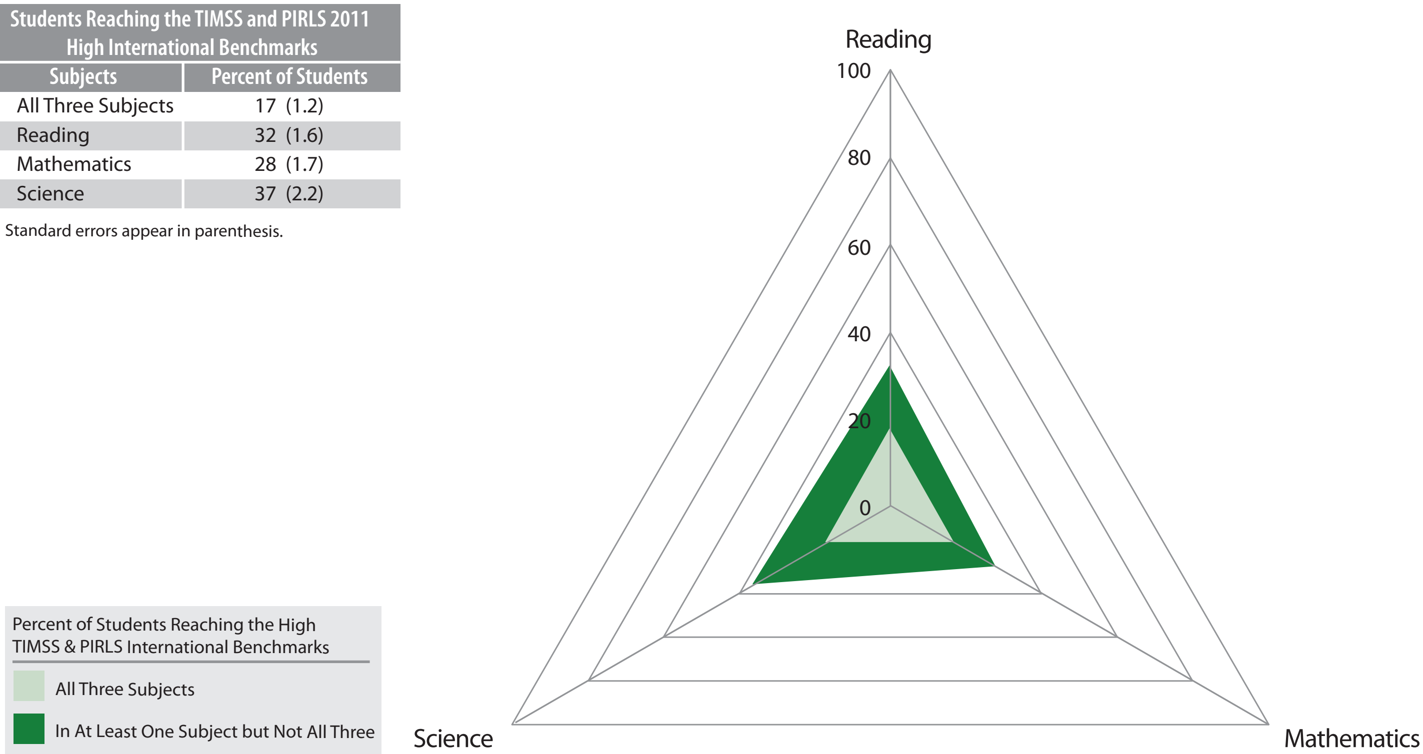
Exhibit 1.21: Romania

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	17 (1.2)
Reading	32 (1.6)
Mathematics	28 (1.7)
Science	37 (2.2)

( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	73 (2.1)
Reading	86 (1.5)
Mathematics	79 (2.0)
Science	84 (1.8)

( ) Standard errors appear in parenthesis.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

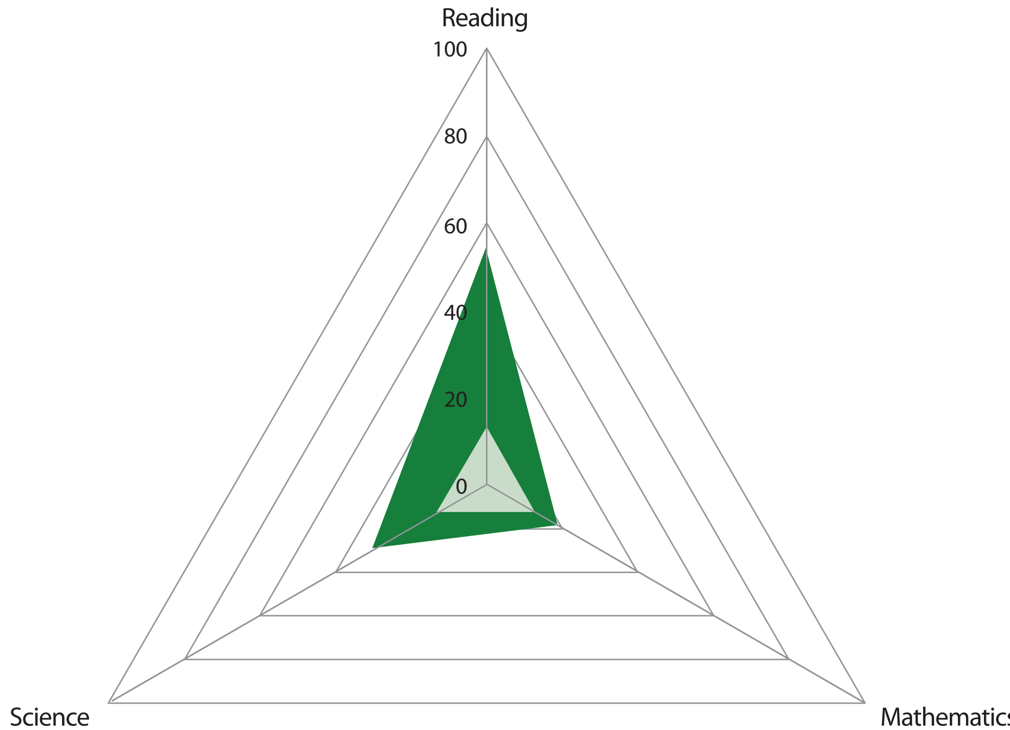
Exhibit 1.22: Croatia

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	13 (0.7)
Reading	54 (1.3)
Mathematics	19 (1.0)
Science	30 (1.1)

( ) Standard errors appear in parenthesis.



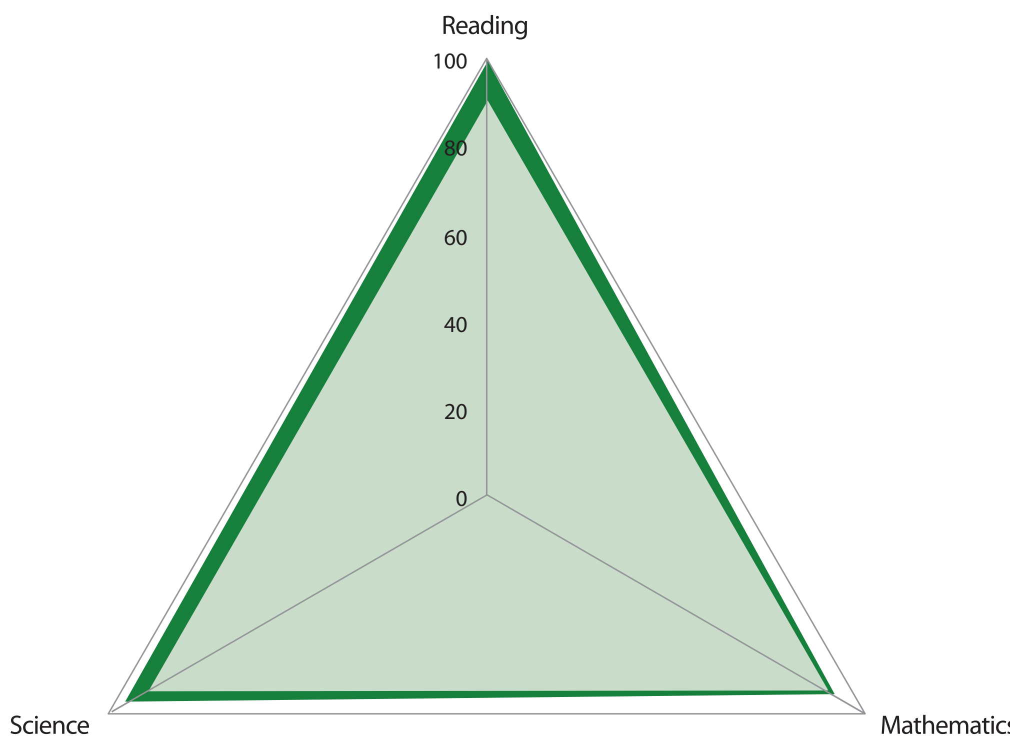
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	90 (1.0)
Reading	99 (0.2)
Mathematics	91 (0.9)
Science	96 (0.5)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

POLAND There also was considerable variation in achievement in Poland. In reading, 39 percent reached the high benchmark and 29 percent did in science, while only 17 percent reached that level in mathematics. Twelve percent reached the high benchmark in all three subjects, and 83 percent reached the low level in all three subjects. The relative weakness in mathematics also was emerging at the low benchmark. While 95 and 91 percent of the students reached the low level in reading and science, respectively, 87 percent did in mathematics.

SPAIN Similar to the pattern in Croatia and Poland, the Spanish students also showed a relative weakness in mathematics. Similar percentages of students reached the high benchmark in reading (30%) and in science (28%), while only 17 percent did in mathematics. Nine percent reached the high benchmark in all three subjects, and 82 percent reached the low benchmark in all three subjects. The relative weakness in mathematics was noticeable at the low benchmark, with 94 and 92 percent of the students reaching the low benchmark in reading and science, but 87 percent in mathematics.

NORWAY Norway had relatively similar percentages of students reaching the high benchmark in reading (25%), mathematics (21%), and science (19%). Interestingly, only 8 percent of those were the same students reaching the high benchmark in all three subjects. Also, high percentages of students reached the low benchmarks, more than 90 percent in each of the subjects. However, again somewhat fewer (86%) reached the low benchmark in all three subjects.

MALTA The Maltese fourth grade students showed a relative weakness in science. One-fourth of the students reached the high benchmark in mathematics and reading, but only 14 percent in science. Seven percent reached the high benchmark in all three subjects, and 64 percent reached the low benchmark in all three subjects. At the low benchmark, the percentages indicated a relative strength in mathematics (88%), compared to 78 percent in reading and 70 percent in science.

UNITED ARAB EMIRATES Fourteen percent of the students reached the high benchmarks in reading and science, and 12 percent did in mathematics. Six percent reached the high benchmark in all three subjects, and about half (48%) reached the low benchmark in all three subjects. Achievement also was similar across the three subjects at the Low Benchmark (61-64%).

Exhibit 1.23: Poland

Profiles of High and Low Performance in Reading, Mathematics, and Science

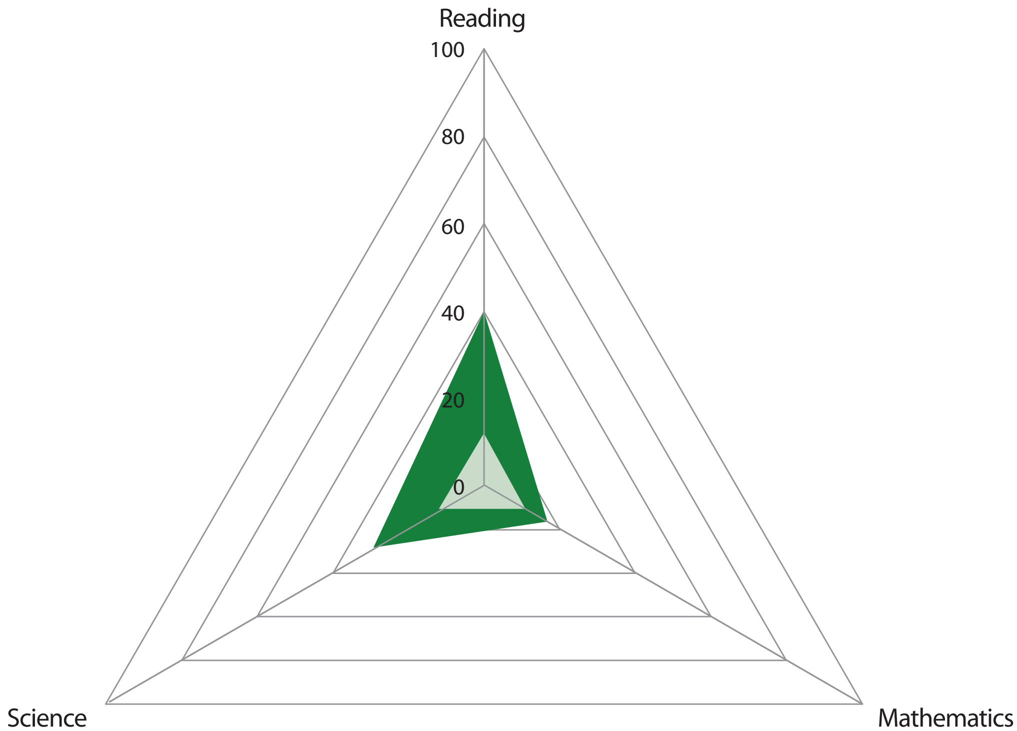
High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	12 (0.8)
Reading	39 (1.2)
Mathematics	17 (1.0)
Science	29 (1.5)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



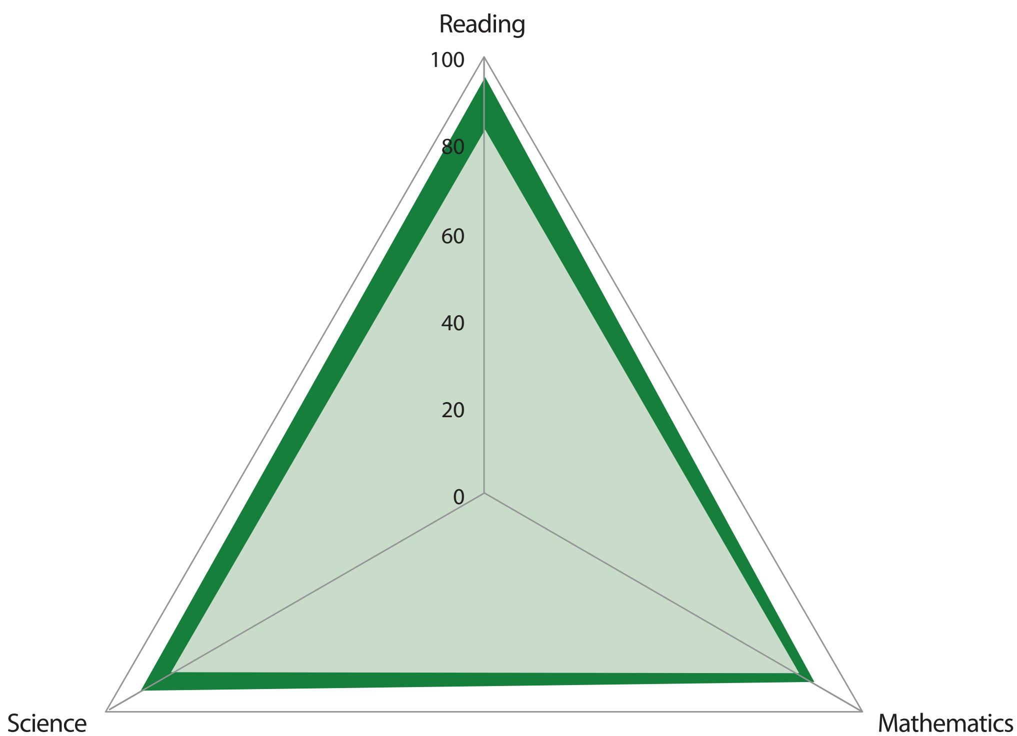
Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	83 (1.0)
Reading	95 (0.5)
Mathematics	87 (0.9)
Science	91 (0.8)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

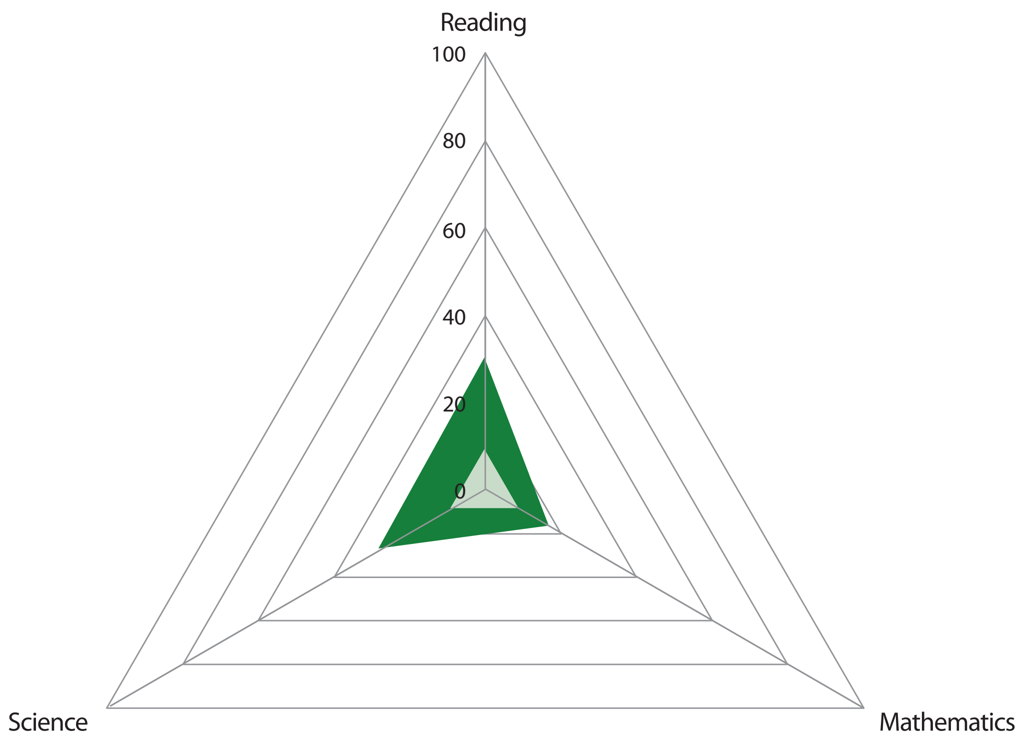
Exhibit 1.24: Spain

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	9 (0.8)
Reading	30 (1.7)
Mathematics	17 (1.1)
Science	28 (1.5)

( ) Standard errors appear in parenthesis.



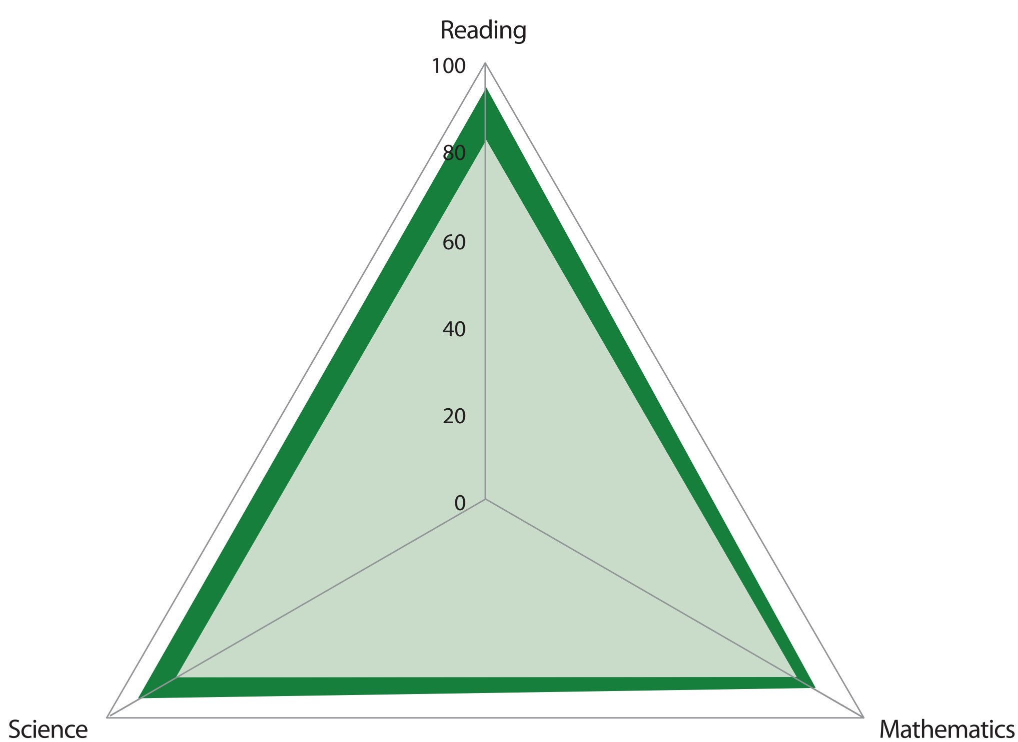
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	82 (1.4)
Reading	94 (0.9)
Mathematics	87 (1.2)
Science	92 (1.2)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.25: Norway

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

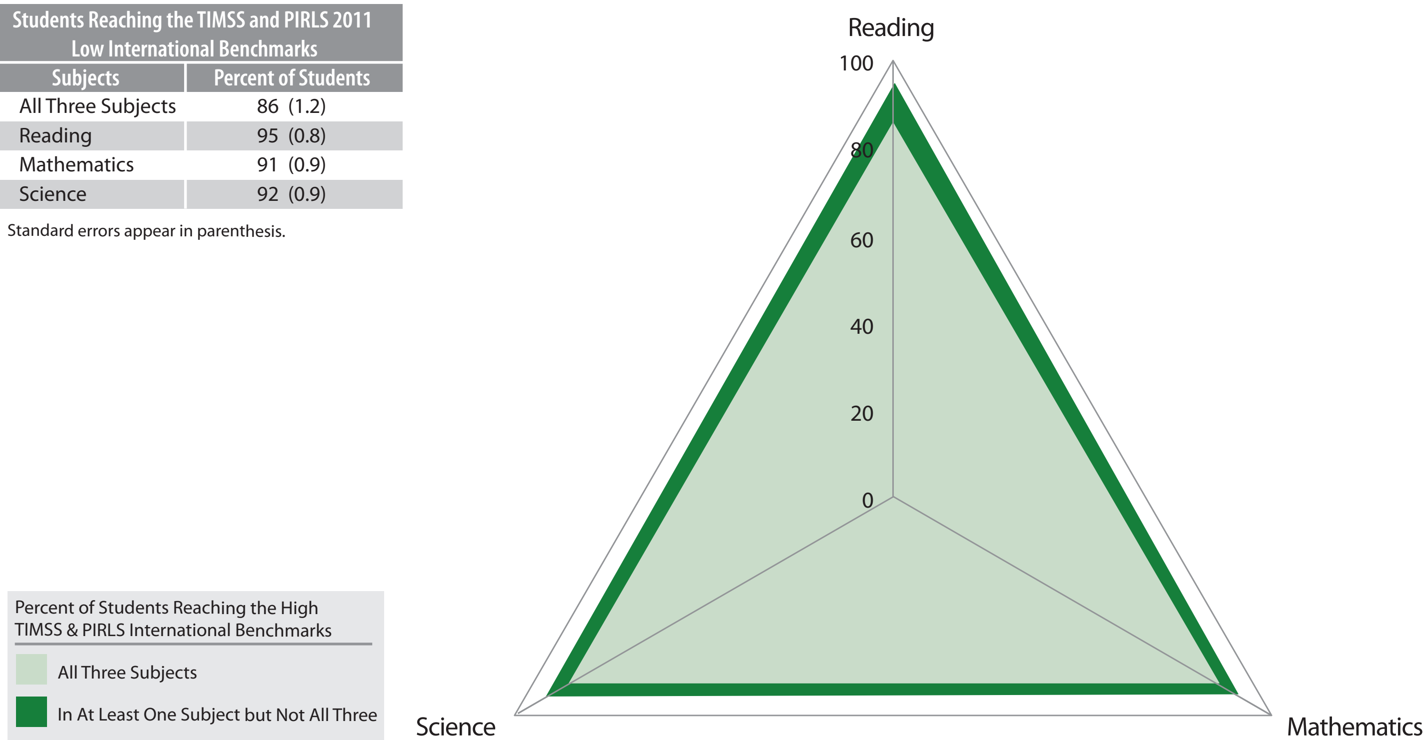
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	8 (0.9)
Reading	25 (1.6)
Mathematics	21 (1.6)
Science	19 (1.3)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	86 (1.2)
Reading	95 (0.8)
Mathematics	91 (0.9)
Science	92 (0.9)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

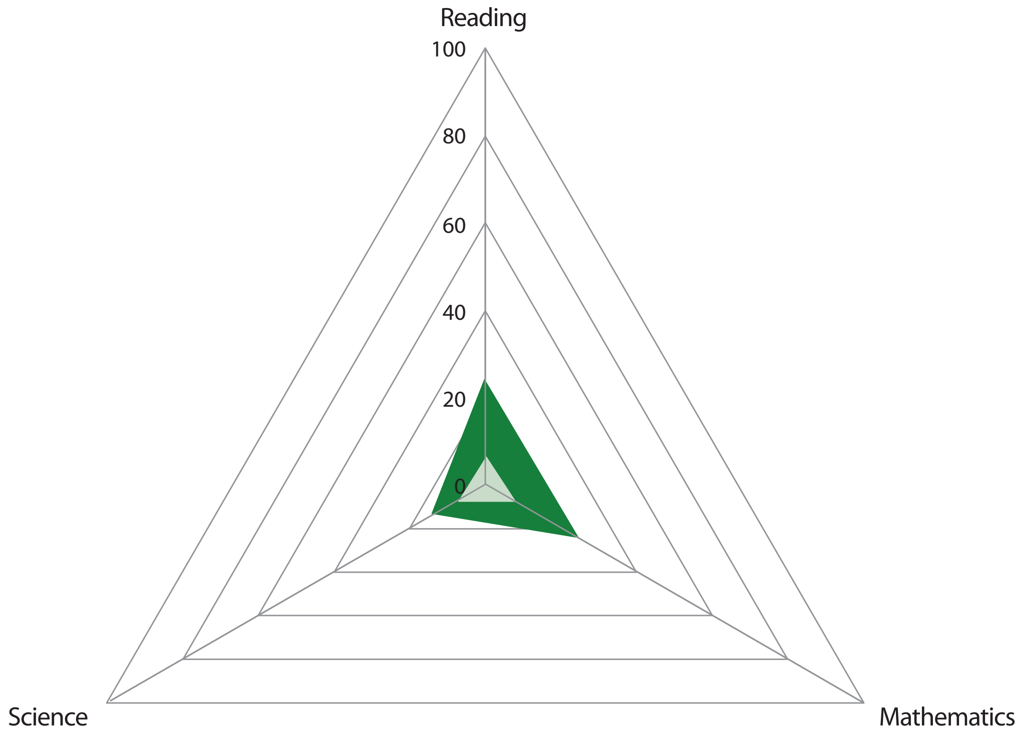
Exhibit 1.26: Malta

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	7 (0.4)
Reading	24 (0.7)
Mathematics	25 (0.9)
Science	14 (0.6)

( ) Standard errors appear in parenthesis.

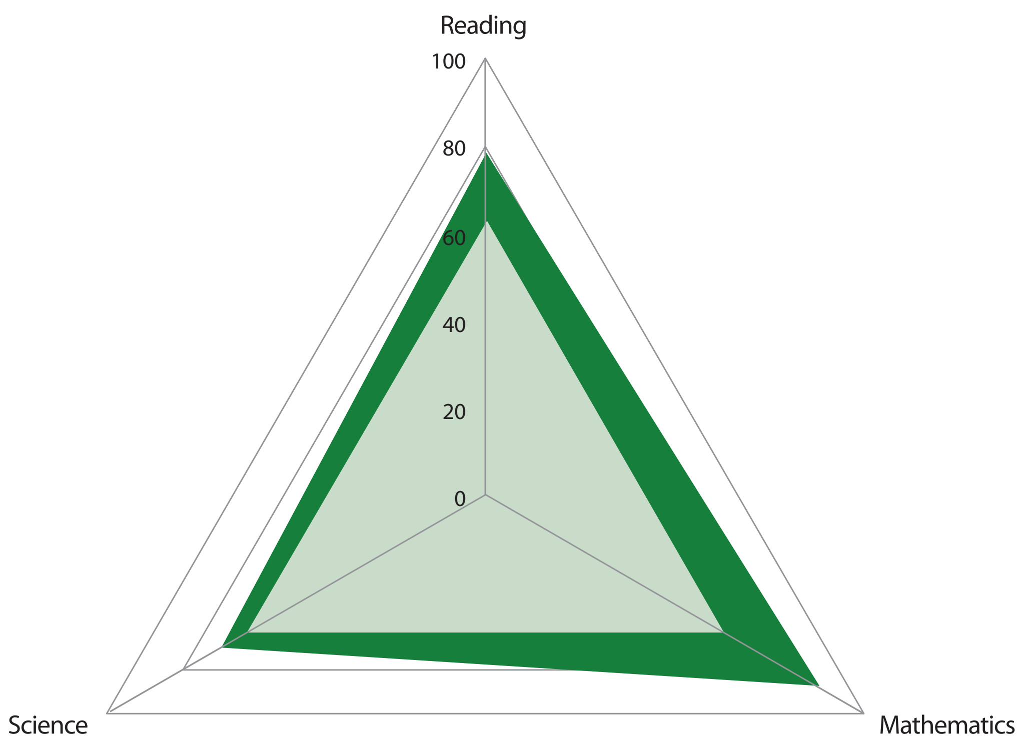


Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks
- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	64 (0.9)
Reading	78 (0.7)
Mathematics	88 (0.7)
Science	70 (1.0)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks
- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

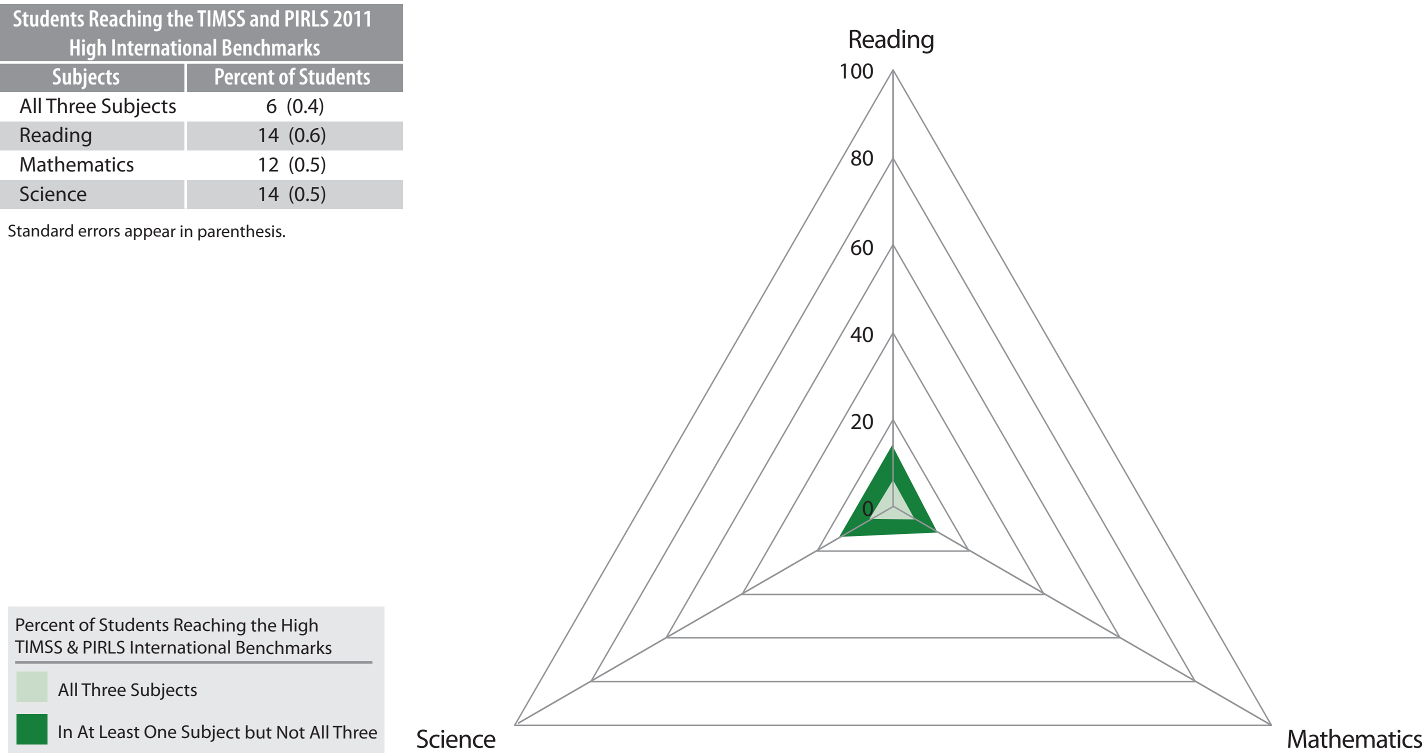
Exhibit 1.27: United Arab Emirates

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	6 (0.4)
Reading	14 (0.6)
Mathematics	12 (0.5)
Science	14 (0.5)

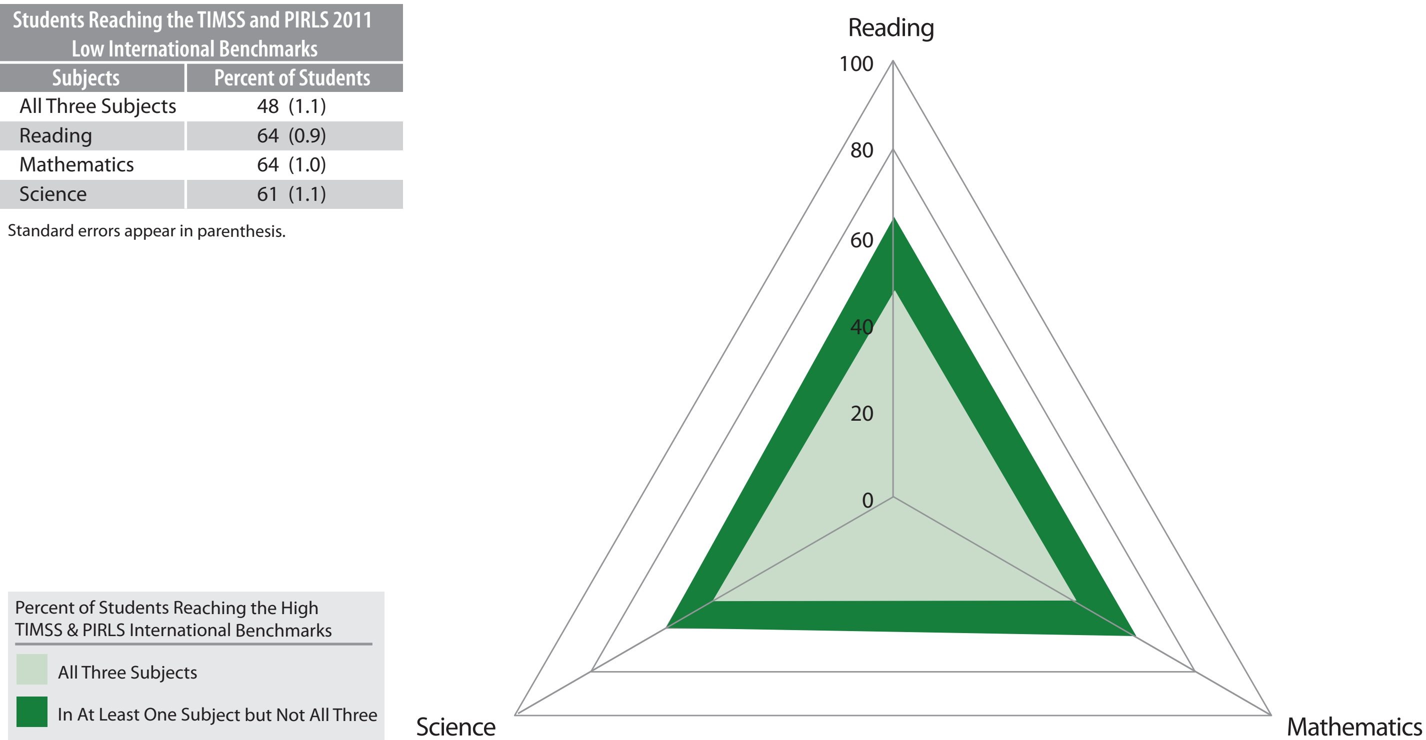
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	48 (1.1)
Reading	64 (0.9)
Mathematics	64 (1.0)
Science	61 (1.1)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

GEORGIA The Georgian students found the assessments difficult, but showed a relative strength in reading. While 21 percent of the fourth grade students reached the high benchmark in reading, only 12-13 percent did in mathematics and science. Similarly, 87 percent reached the low benchmark in reading, compared with 72 percent in mathematics and 75 percent in science. Five percent reached the high benchmark in all three subjects and 65 percent reached the low benchmark in all three subjects.

IRAN In Iran, students showed a slight comparative weakness in mathematics. Sixteen percent of the students reached the high benchmark in science and 13 percent in reading, compared to 9 percent in mathematics. Four percent reached the high benchmark in all three subjects, and 57 percent reached the low benchmark in all three subjects. The pattern of mathematics being a relative weakness was noticeable at the low benchmark, 76 and 72 percent reaching this level in reading and science, respectively, but 64 percent in mathematics.

QATAR Similar percentages (10-12%) reached the High International Benchmark in each of the three subjects, and 4 percent reached the high benchmark in all three subjects. Forty percent reached the Low International Benchmark in all three subjects, with 60 percent reaching this level in reading, 55 percent in mathematics, and 50 percent in science.

AZERBAIJAN Interestingly, students in Azerbaijan showed a relative strength in mathematics at the high benchmark, and relative strength in reading at the low benchmark. The percentages of students reaching the high benchmark were 21 percent in mathematics, but only 13 percent in science and 9 percent in mathematics. Three percent reached the high benchmark in all three subjects, and 55 percent reached the low benchmark in all three subjects. However, 82 percent of the students reached the low benchmark in reading, compared to 72 percent in mathematics and 65 percent in science.

SAUDI ARABIA Twelve percent of the students reached the high benchmark in science, 8 percent in reading, and 7 percent in mathematics. Two percent reached the high benchmark in all three subjects and 43 percent reached the low benchmark in all three subjects, with performance in reading and science (63-65%) at the low benchmark relatively stronger than in mathematics (55%).

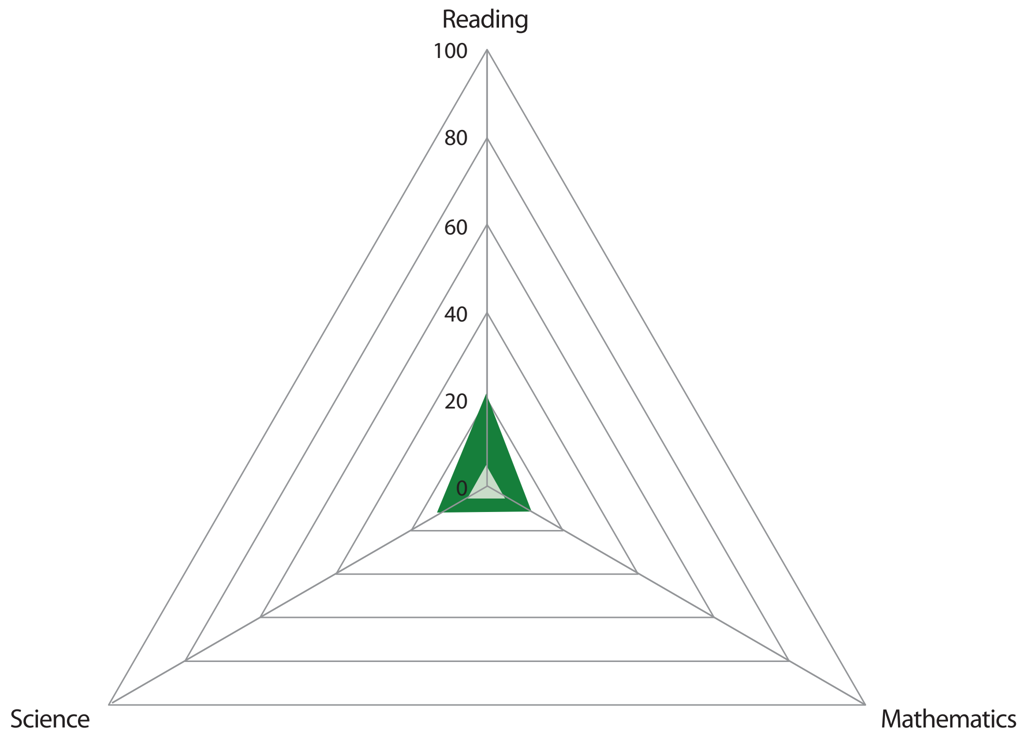
Exhibit 1.28: Georgia

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	5 (0.7)
Reading	21 (1.2)
Mathematics	12 (1.0)
Science	13 (1.2)

( ) Standard errors appear in parenthesis.



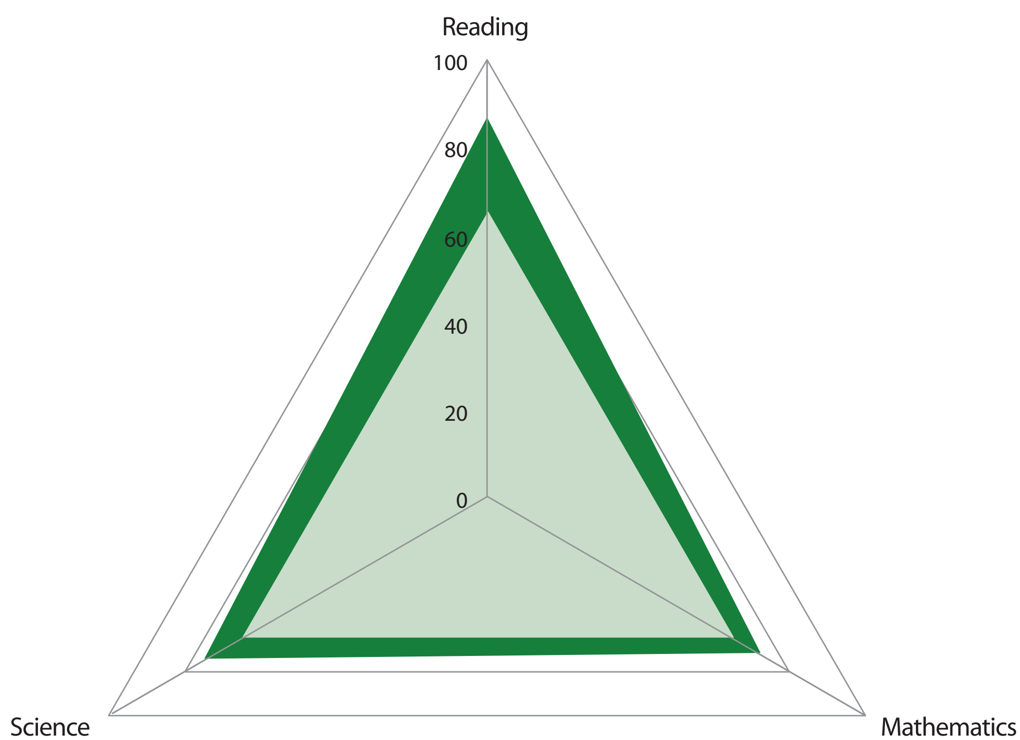
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	65 (1.6)
Reading	87 (1.4)
Mathematics	72 (1.7)
Science	75 (1.6)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

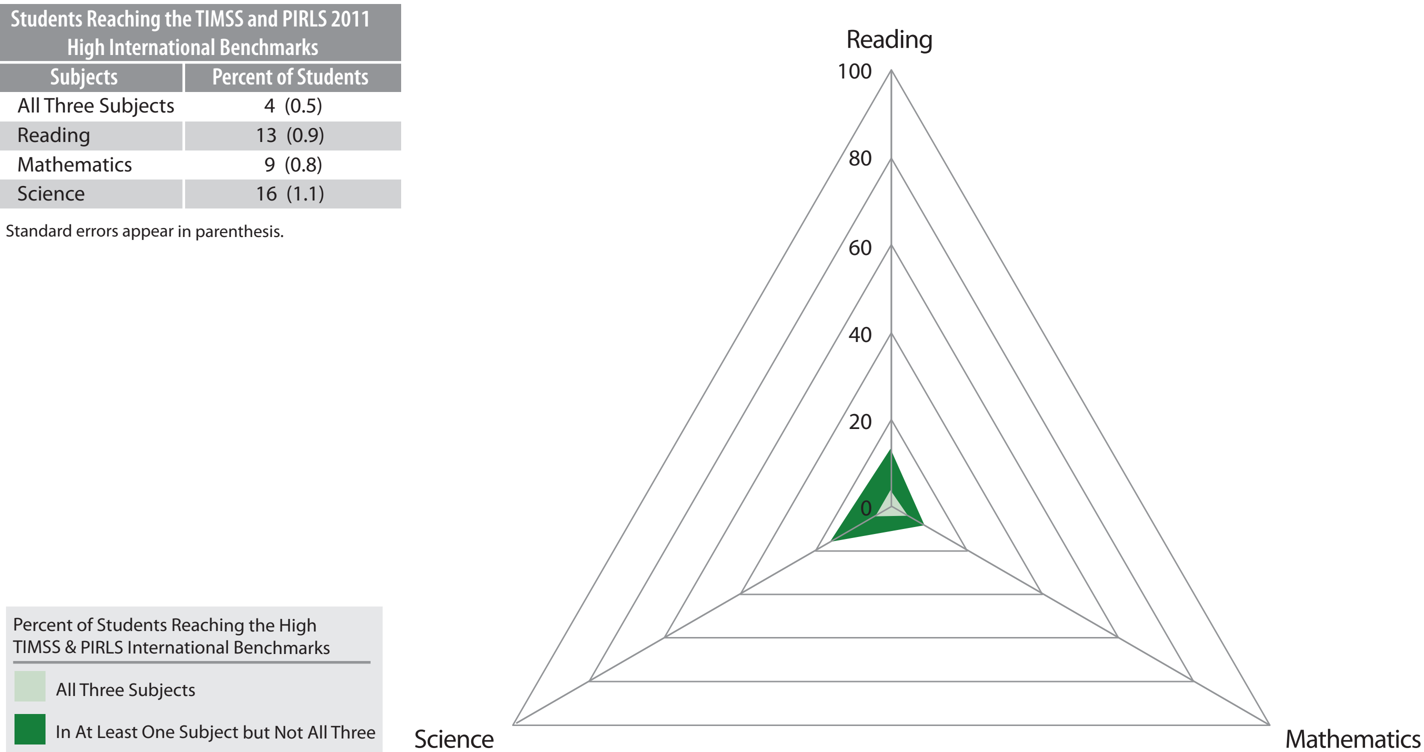
Exhibit 1.29: Iran, Islamic Republic of

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	4 (0.5)
Reading	13 (0.9)
Mathematics	9 (0.8)
Science	16 (1.1)

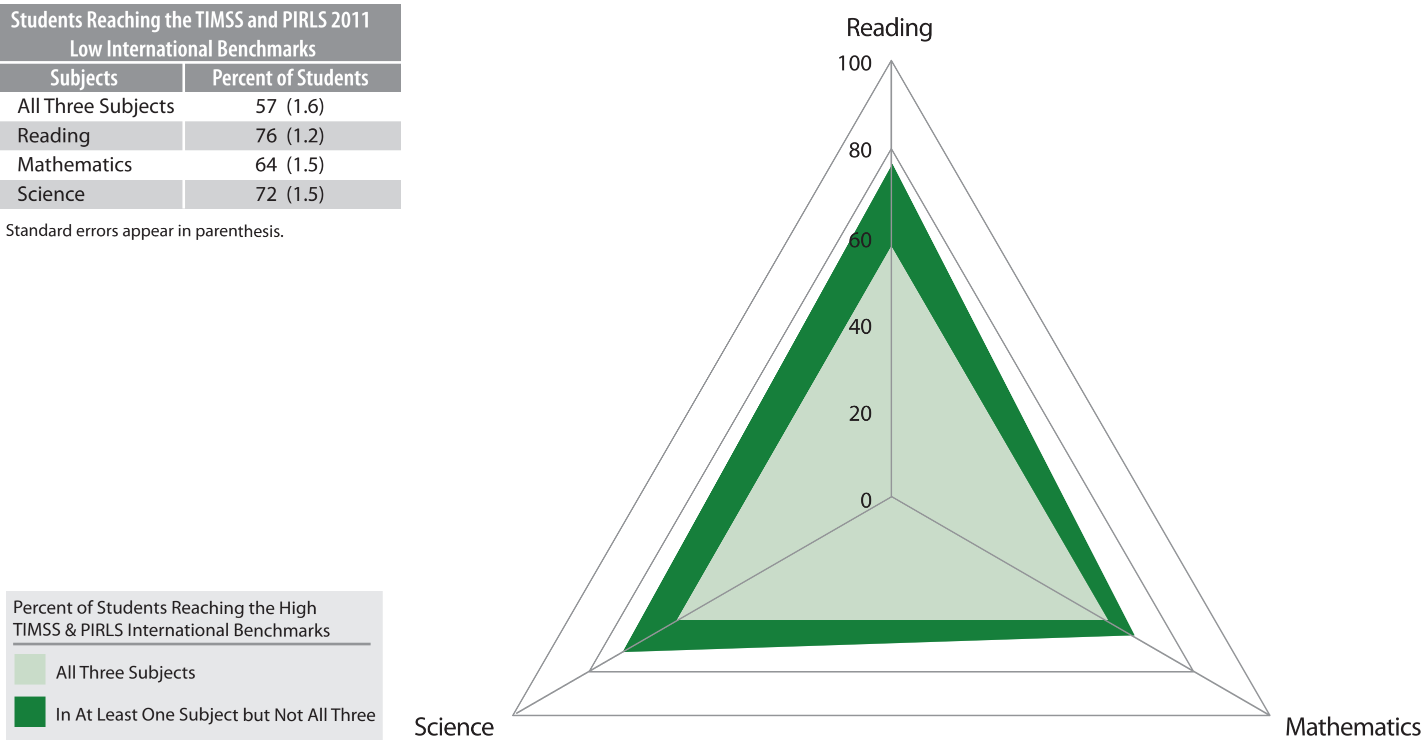
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	57 (1.6)
Reading	76 (1.2)
Mathematics	64 (1.5)
Science	72 (1.5)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.30: Qatar

Profiles of High and Low Performance in Reading, Mathematics, and Science

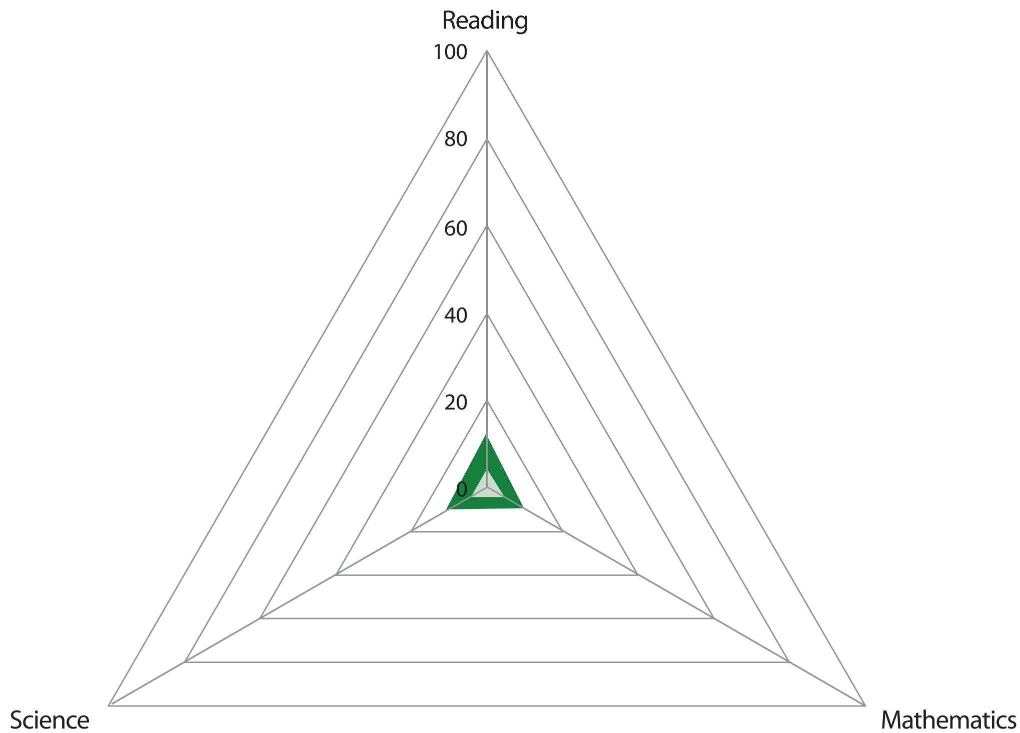
High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	4 (0.7)
Reading	12 (1.1)
Mathematics	10 (0.9)
Science	11 (1.0)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



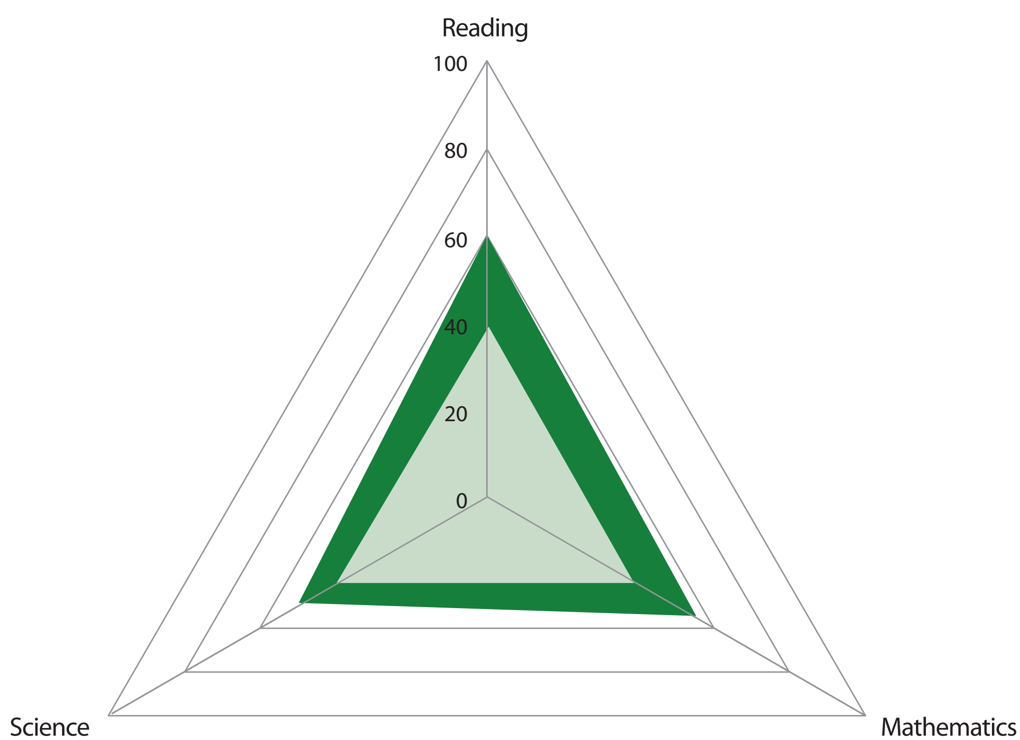
Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	40 (1.6)
Reading	60 (1.5)
Mathematics	55 (1.5)
Science	50 (1.5)

( ) Standard errors appear in parenthesis.

Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

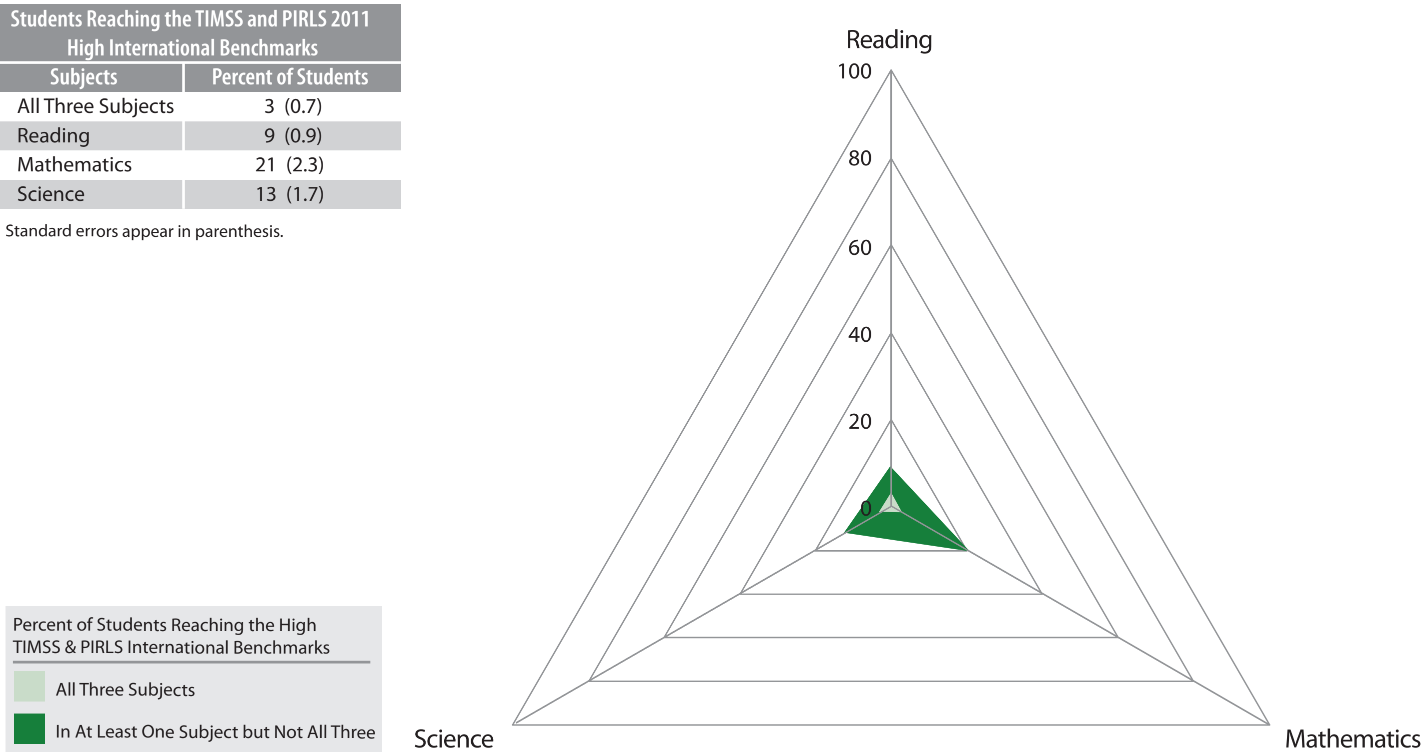
Exhibit 1.31: **Azerbaijan**

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	3 (0.7)
Reading	9 (0.9)
Mathematics	21 (2.3)
Science	13 (1.7)

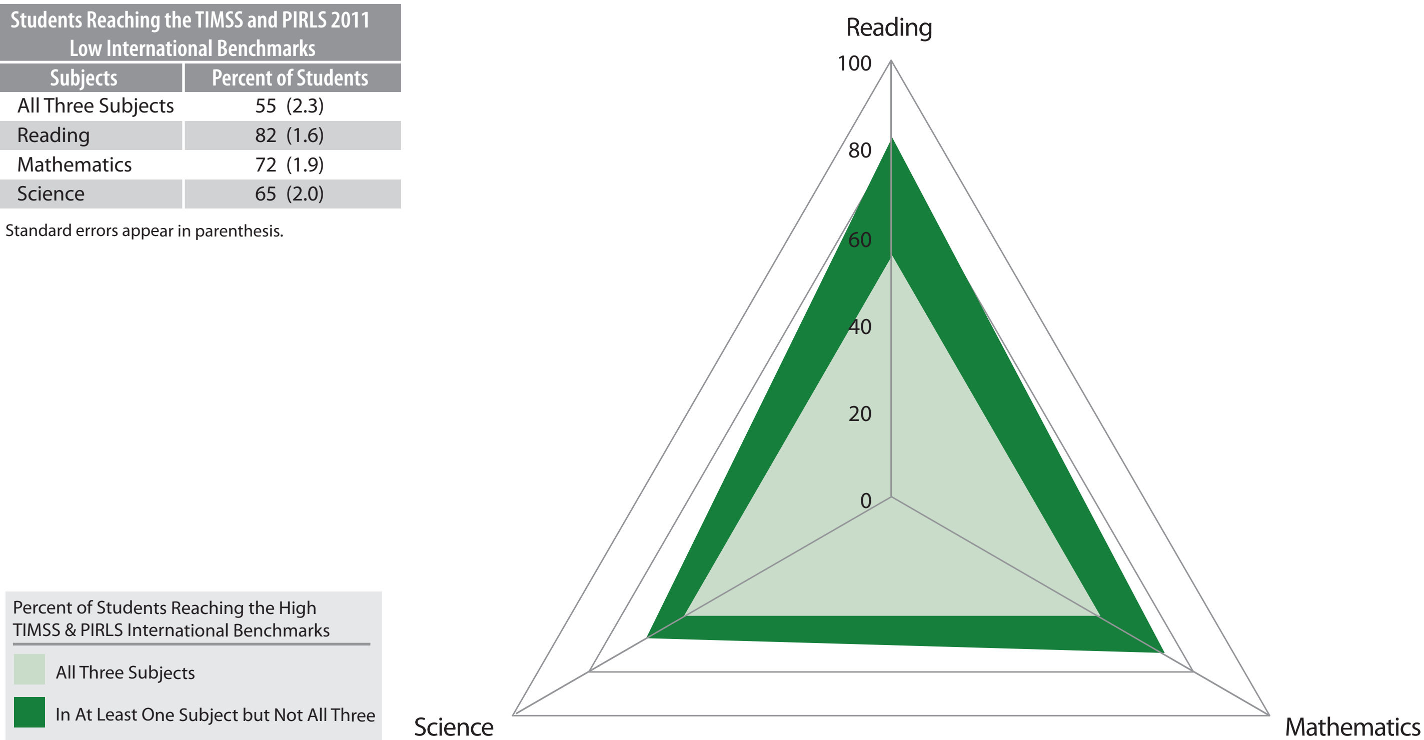
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	55 (2.3)
Reading	82 (1.6)
Mathematics	72 (1.9)
Science	65 (2.0)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.32: Saudi Arabia

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	2 (0.7)
Reading	8 (1.0)
Mathematics	7 (1.2)
Science	12 (1.4)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	43 (1.8)
Reading	65 (1.8)
Mathematics	55 (1.8)
Science	63 (1.9)

( ) Standard errors appear in parenthesis.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

OMAN Performance was similar across the three subjects in Oman. Relatively small percentages (5-7%) of students reached the High International Benchmark in each of the three subjects, with 1 percent reaching the high level in all three subjects. Thirty percent reached the low benchmark in all three subjects, although nearly half (45-48%) reached the low level in each subject.

MOROCCO Performance was also similar across the three subjects in Morocco. Few students (1-2%) reached the high benchmarks in reading, mathematics, and science, but about one-fourth reached the low benchmark in mathematics, 21 percent in reading, and 15 percent in science.

Countries at the Sixth Grade

BOTSWANA At the high benchmark, performance in Botswana was similar across the three subjects. Nine percent of the sixth grade students reached the high benchmark in reading, while 7 percent did so in mathematics and science. Three percent reached the high benchmark in all three subjects. At the Low International Benchmark, students showed a relative weakness in science. Thirty-seven percent reached the low benchmark in all three subjects, with 60 percent reaching that level in reading and 56 percent in mathematics, but only 43 percent in science.

HONDURAS In Honduras, students showed a relative weakness in mathematics at both the high and the low benchmark. At the high benchmark, 11 percent of the sixth grade students reached the benchmark in reading and 8 percent did so in science, but only 3 percent reached this level in mathematics. Because the students performing well in mathematics mostly also did well in the other two subjects, 2 percent reached the high benchmark in all three subjects. Forty-three percent reached the low benchmark in all three subjects, with considerable variation across the subjects. Approximately three-fourths of the students (74%) reached that level in reading, two-thirds (66%) in science, and half (49%) in mathematics.

Benchmarking Participants

QUEBEC, CANADA The students in Quebec showed relative weakness in science, with 43 percent of students reaching the High International Benchmark in reading and 40 percent in mathematics, compared to 29 percent in science. Seventeen percent reached the high benchmark in all three subject and essentially all students (95%) reached the low benchmark in all three subjects.

Exhibit 1.33: Oman

Profiles of High and Low Performance in Reading, Mathematics, and Science

High International Benchmarks

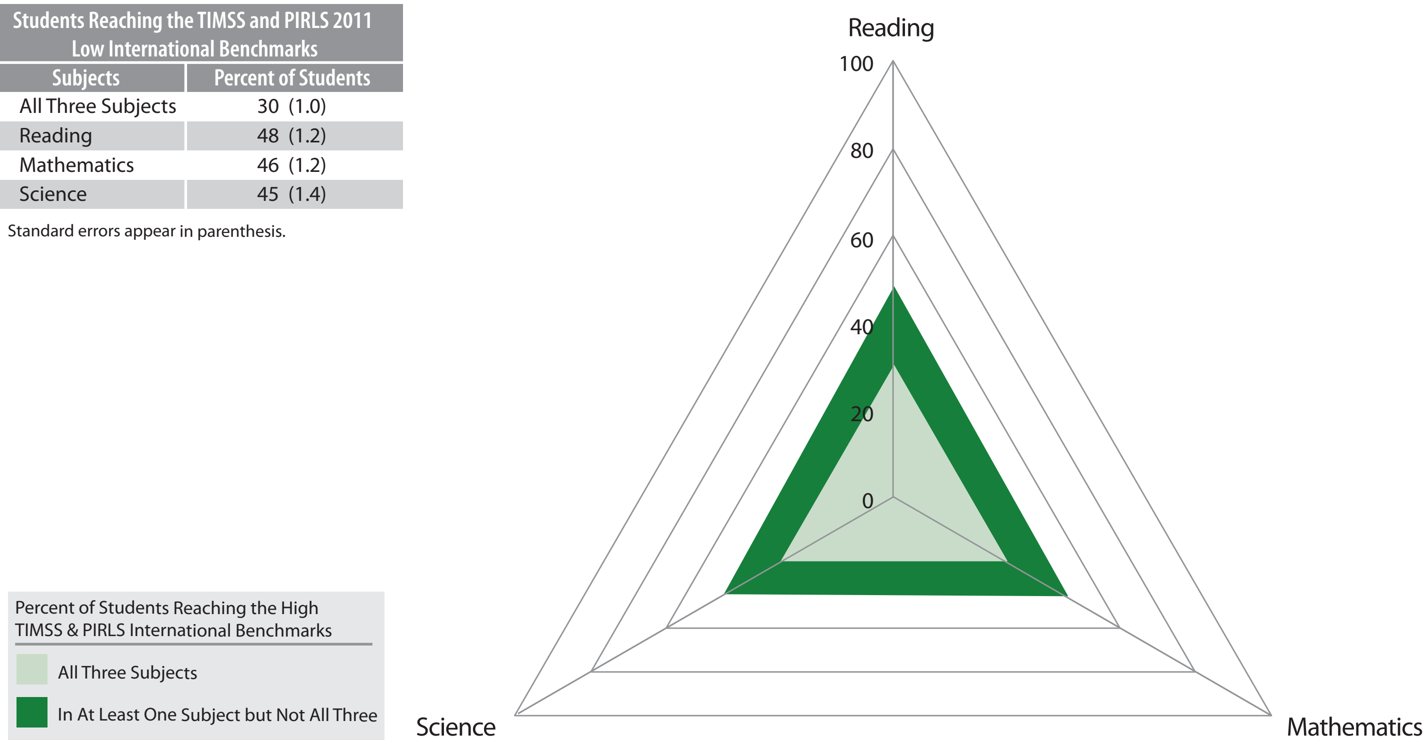
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	1 (0.2)
Reading	5 (0.4)
Mathematics	5 (0.3)
Science	7 (0.7)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	30 (1.0)
Reading	48 (1.2)
Mathematics	46 (1.2)
Science	45 (1.4)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

DUBAI, UNITED ARAB EMIRATES Performance was very similar across the three subjects. Approximately one-fourth of the students reached the High International Benchmark in each subject—26 percent in reading, 23 percent in science, and 22 percent in mathematics. Twelve percent of the students reached the high benchmark in all three subjects, and 63 percent reached the low benchmark in all three subjects. Approximately three-fourths of the students reached the Low International Benchmark in each subject—75 percent in both reading and mathematics, and 72 percent in science.

ABU DHABI, UNITED ARAB EMIRATES Performance in Abu Dhabi also was very similar across the three subjects. Ten percent of the students reached the high benchmark in reading and science, and 8 percent did in mathematics. Three percent reached the high benchmark in all three subjects and 43 percent reached the low benchmark in all three subjects. At the low benchmark, 60 percent reached this level in reading, 58 percent in mathematics, and 55 percent in science.

Summary

Students performing at the High International Benchmarks in all three subjects are very accomplished fourth grade students—able to read relatively complex materials with in-depth understanding, solve a variety of mathematics problems, and show familiarity with a range of scientific information. These students have developed a solid basis for further learning and are well positioned to take advantage of future educational opportunities. However, the TIMSS and PIRLS 2011 data provide evidence that it is a very challenging task to educate students to the level of the high benchmarks at the fourth grade. Only Singapore had more than half its students reach the high benchmarks in all three subjects, and only two more countries, Chinese Taipei and Finland, had at least half their fourth grade students reach the high benchmark in each subject separately. Chinese Taipei had 40 percent of its students reach the high benchmark in all three subjects and Finland had 39 percent, as did Hong Kong SAR. The Russian Federation had 35 percent reach the high benchmark in all three subjects, and the remaining participants had less than 30 percent.

More than half the countries, however, were successful in educating 90 percent of more of their students to the Low International Benchmark in all three subjects. These students showed that they can read and comprehend facts, read a variety of simple graphs and tables, know simple mathematics (such as adding, subtracting, and basic geometric figures), and know science

Exhibit 1.34: Morocco

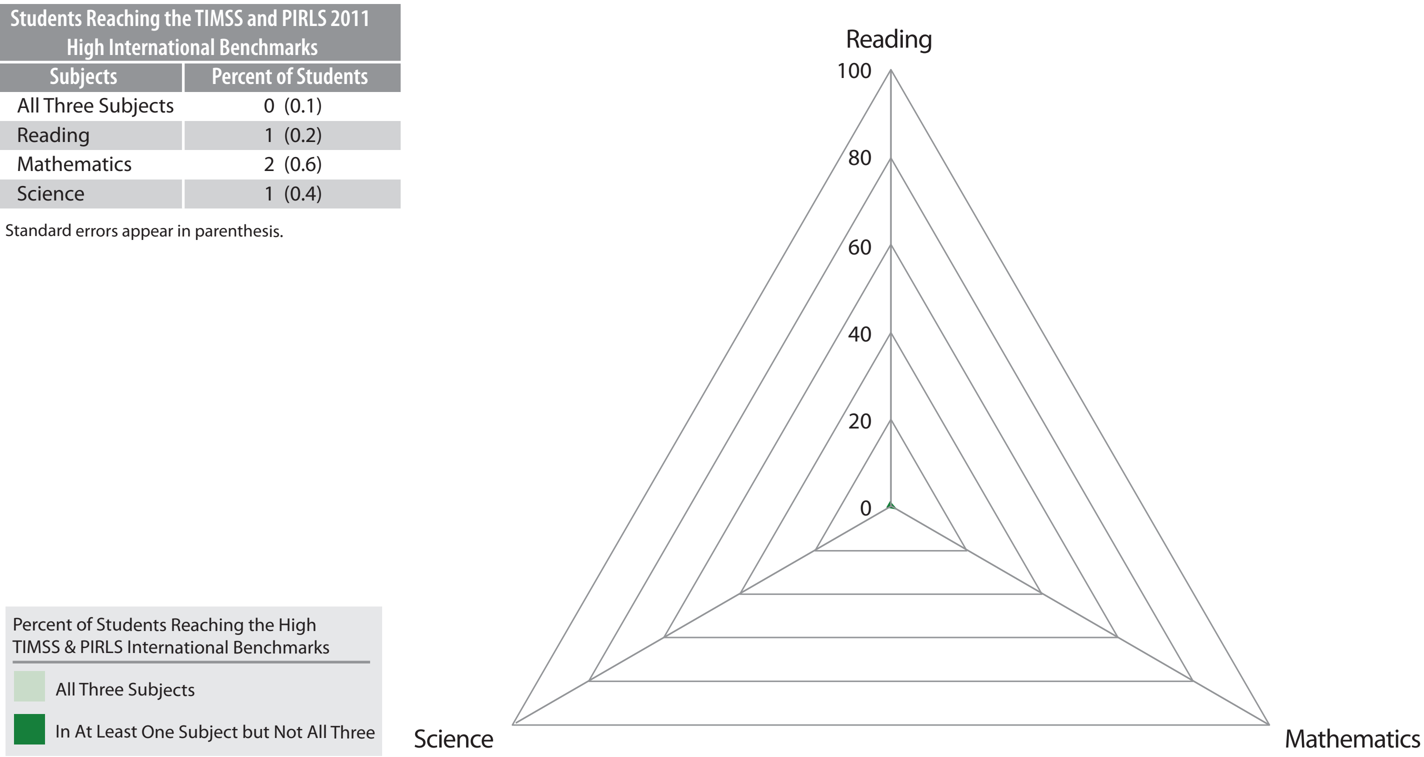
Profiles of High and Low Performance in Reading, Mathematics, and Science

Sixth Grade Participant

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	0 (0.1)
Reading	1 (0.2)
Mathematics	2 (0.6)
Science	1 (0.4)

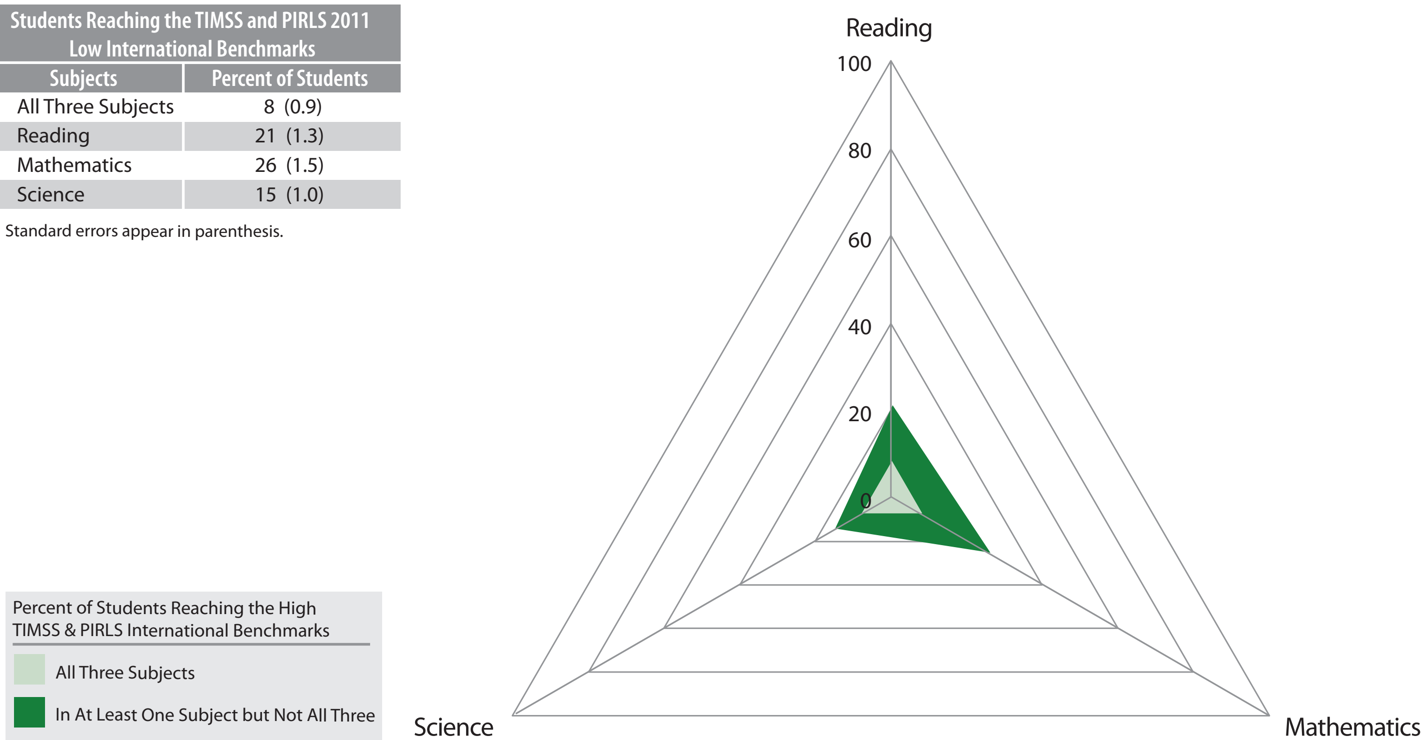
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	8 (0.9)
Reading	21 (1.3)
Mathematics	26 (1.5)
Science	15 (1.0)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.35: Botswana

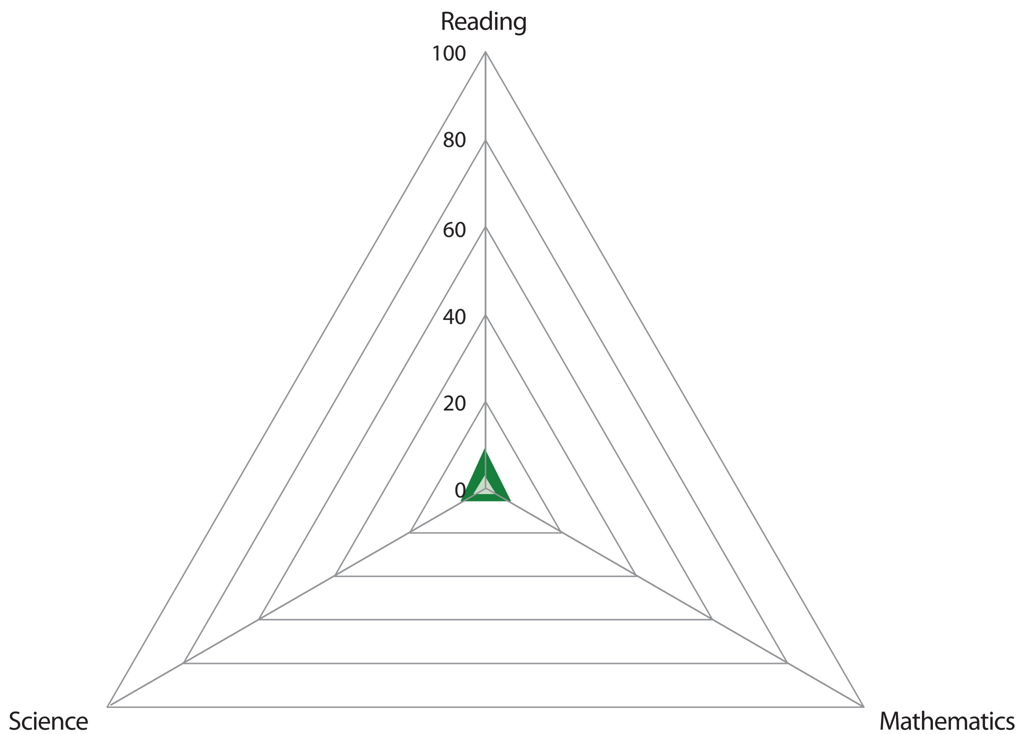
Profiles of High and Low Performance in Reading, Mathematics, and Science

Sixth Grade Participant

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	3 (0.7)
Reading	9 (1.3)
Mathematics	7 (1.0)
Science	7 (1.1)

( ) Standard errors appear in parenthesis.



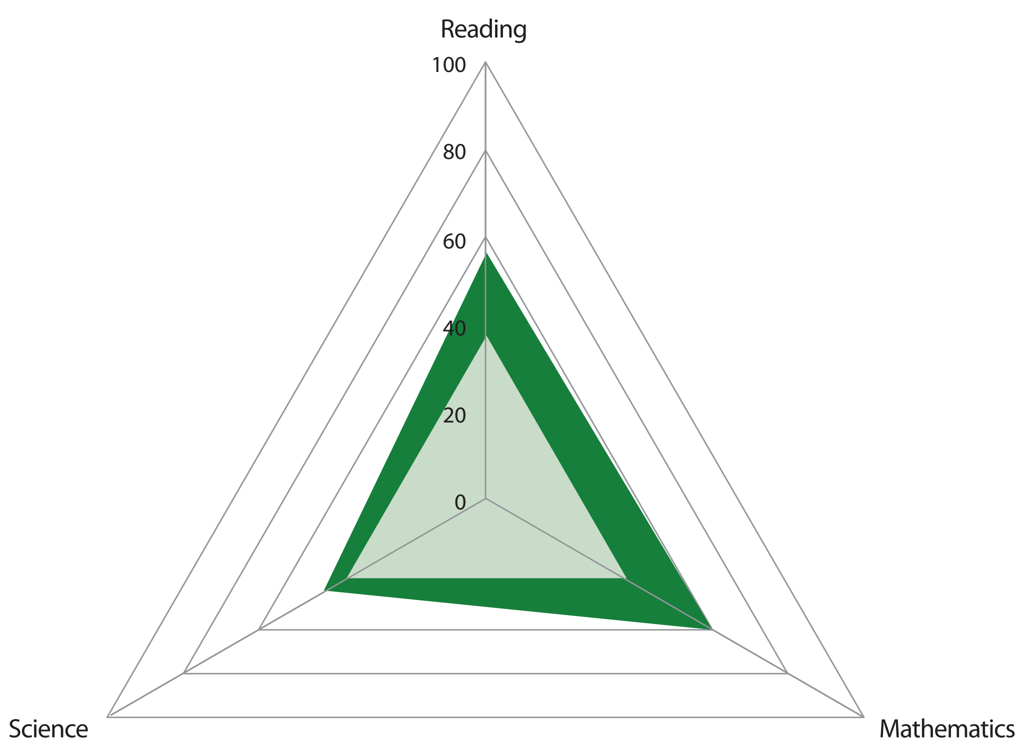
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	37 (1.8)
Reading	56 (1.8)
Mathematics	60 (1.6)
Science	43 (1.8)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.36: Honduras

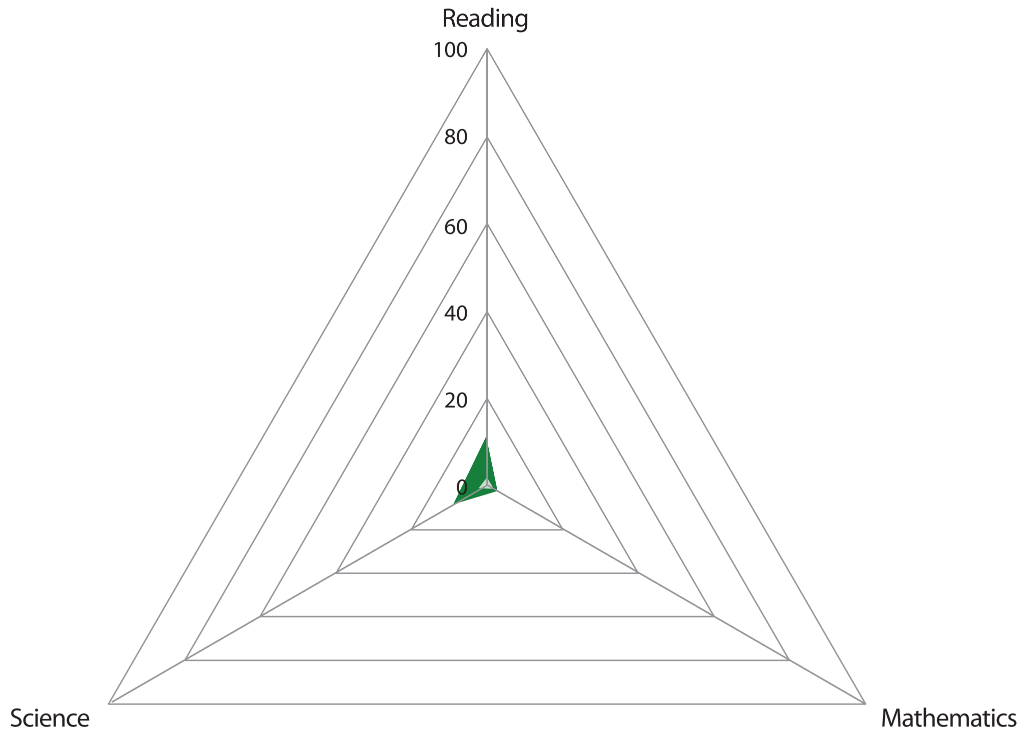
Profiles of High and Low Performance in Reading, Mathematics, and Science

Sixth Grade Participant

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	2 (0.6)
Reading	11 (1.5)
Mathematics	3 (0.9)
Science	8 (1.4)

( ) Standard errors appear in parenthesis.



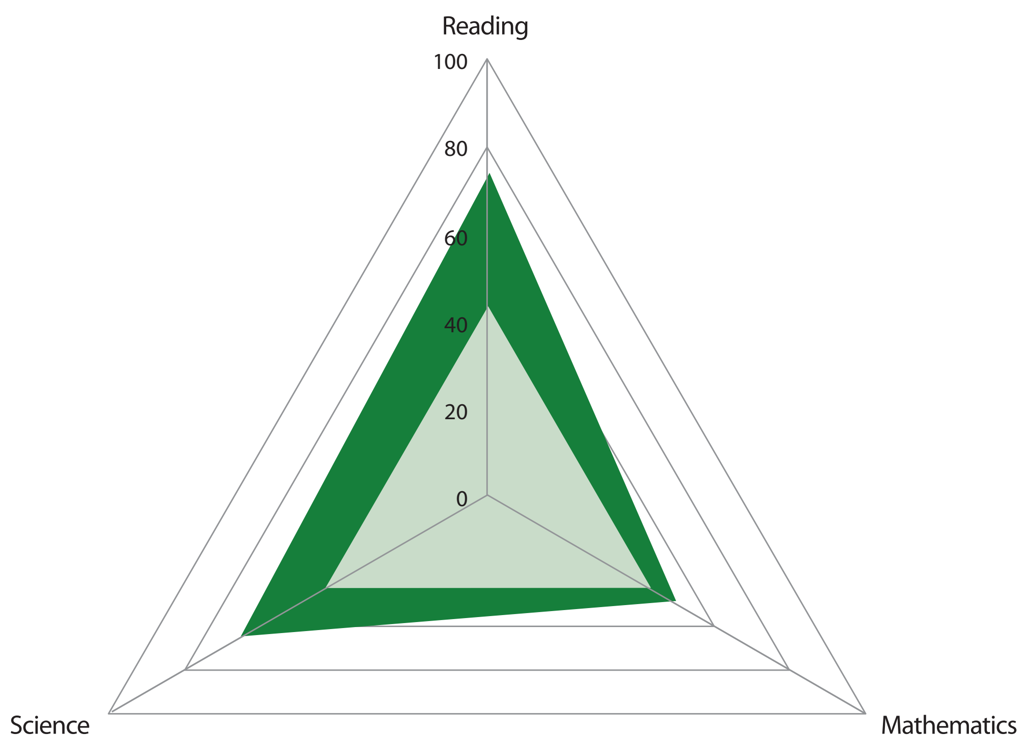
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	43 (2.5)
Reading	74 (2.2)
Mathematics	49 (2.5)
Science	66 (2.5)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.37: Quebec, Canada

Profiles of High and Low Performance in Reading, Mathematics, and Science

Benchmarking Participant

High International Benchmarks

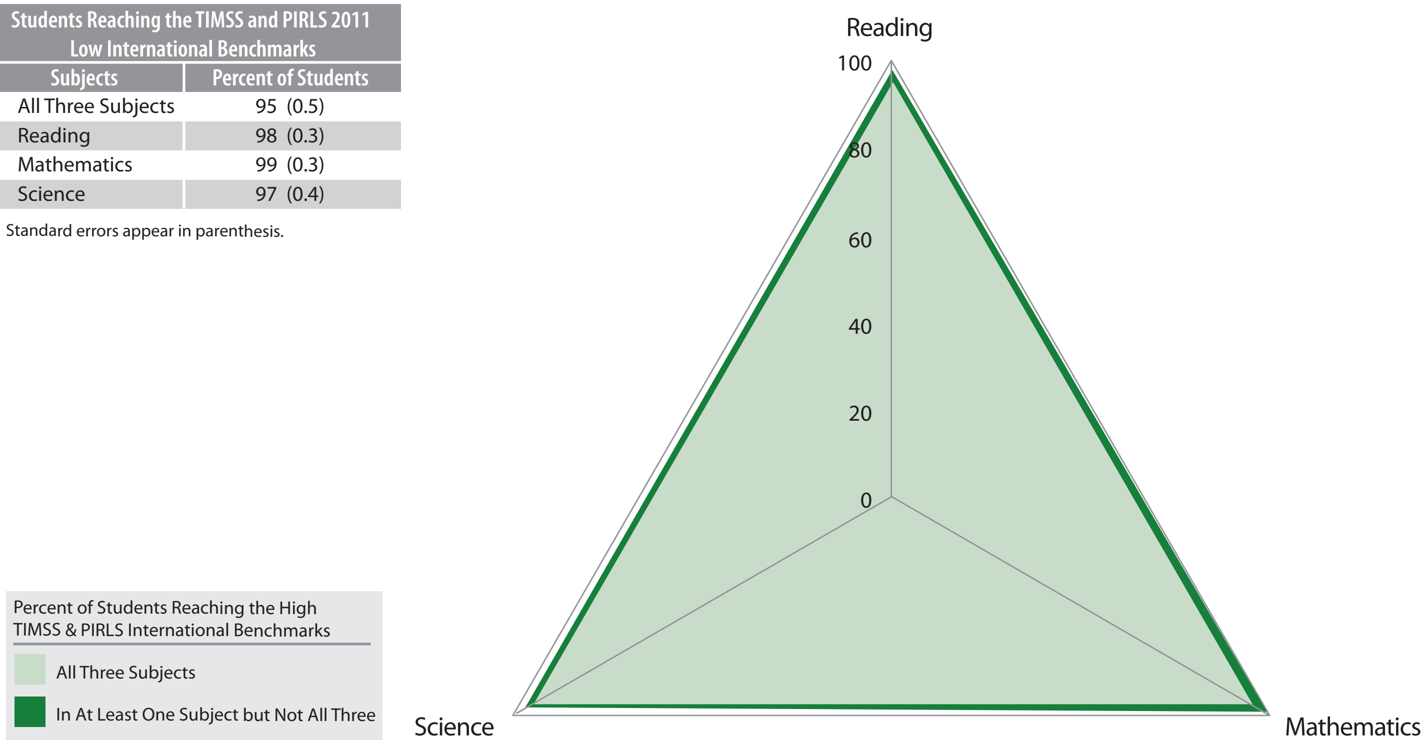
Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	17 (1.2)
Reading	43 (1.8)
Mathematics	40 (1.7)
Science	29 (1.5)

( ) Standard errors appear in parenthesis.

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	**Percent of Students**
All Three Subjects	95 (0.5)
Reading	98 (0.3)
Mathematics	99 (0.3)
Science	97 (0.4)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 1.38: Dubai, UAE

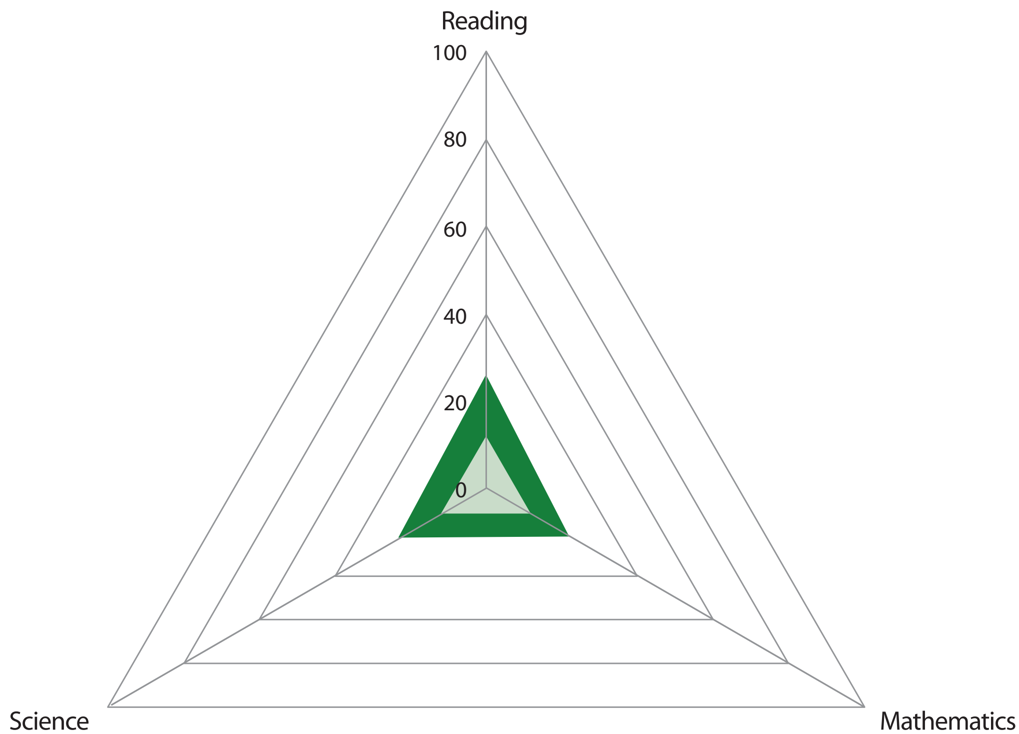
Profiles of High and Low Performance in Reading, Mathematics, and Science

Benchmarking Participant

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	12 (0.7)
Reading	26 (0.8)
Mathematics	22 (0.8)
Science	23 (0.9)

( ) Standard errors appear in parenthesis.



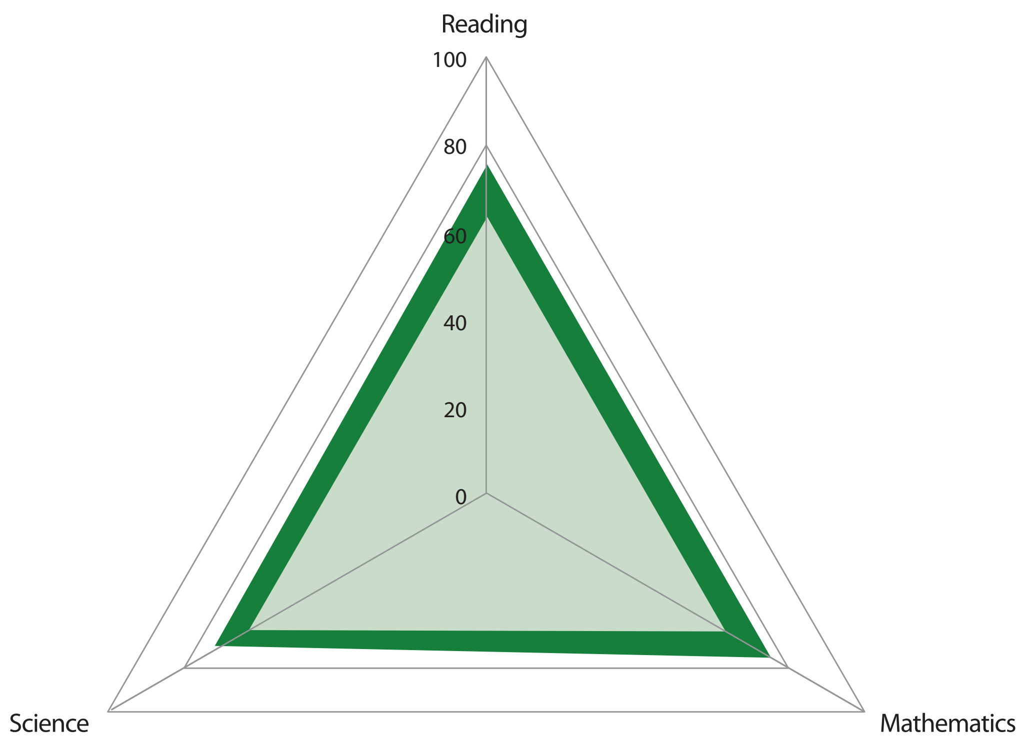
Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	63 (1.2)
Reading	75 (0.8)
Mathematics	75 (0.8)
Science	72 (1.1)

( ) Standard errors appear in parenthesis.



Percent of Students Reaching the High TIMSS & PIRLS International Benchmarks

- All Three Subjects
- In At Least One Subject but Not All Three

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 1.39: Abu Dhabi, UAE

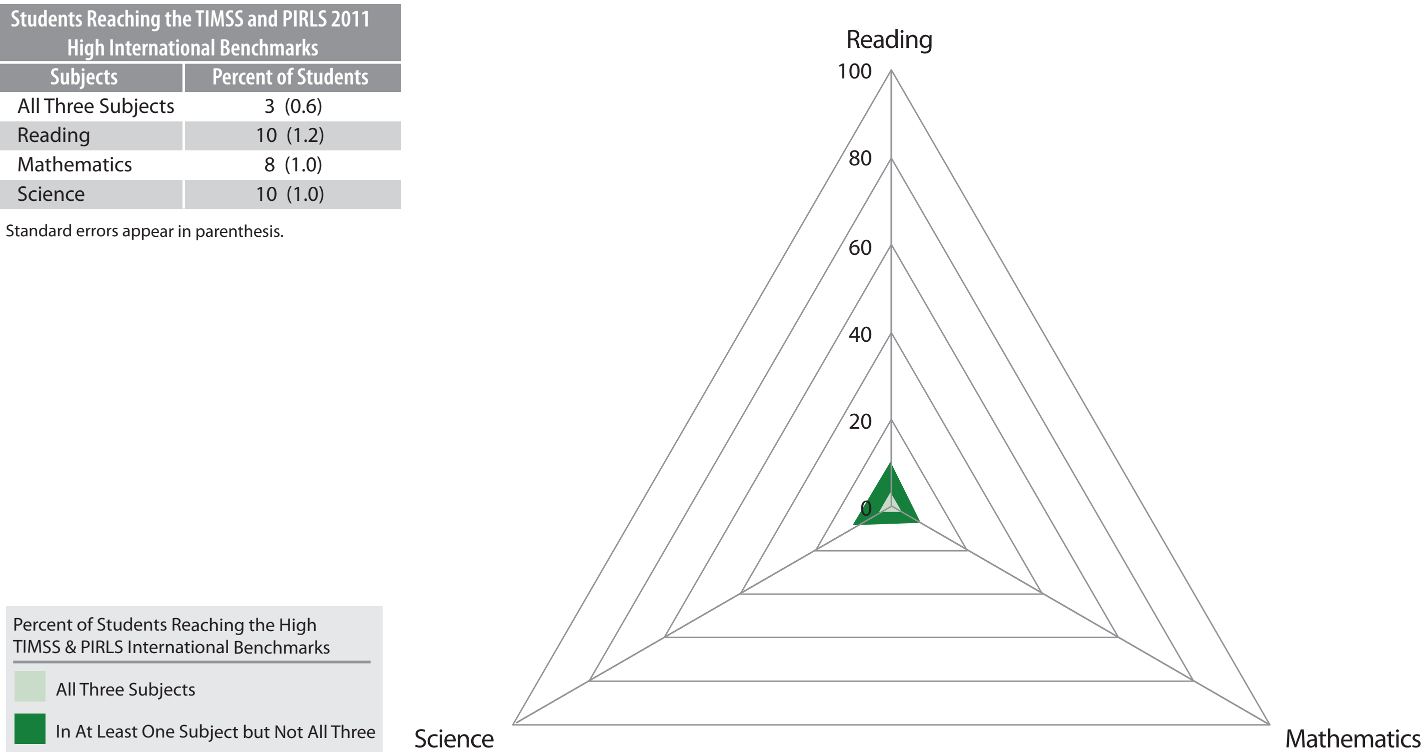
Profiles of High and Low Performance in Reading, Mathematics, and Science

Benchmarking Participant

High International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 High International Benchmarks	
Subjects	Percent of Students
All Three Subjects	3 (0.6)
Reading	10 (1.2)
Mathematics	8 (1.0)
Science	10 (1.0)

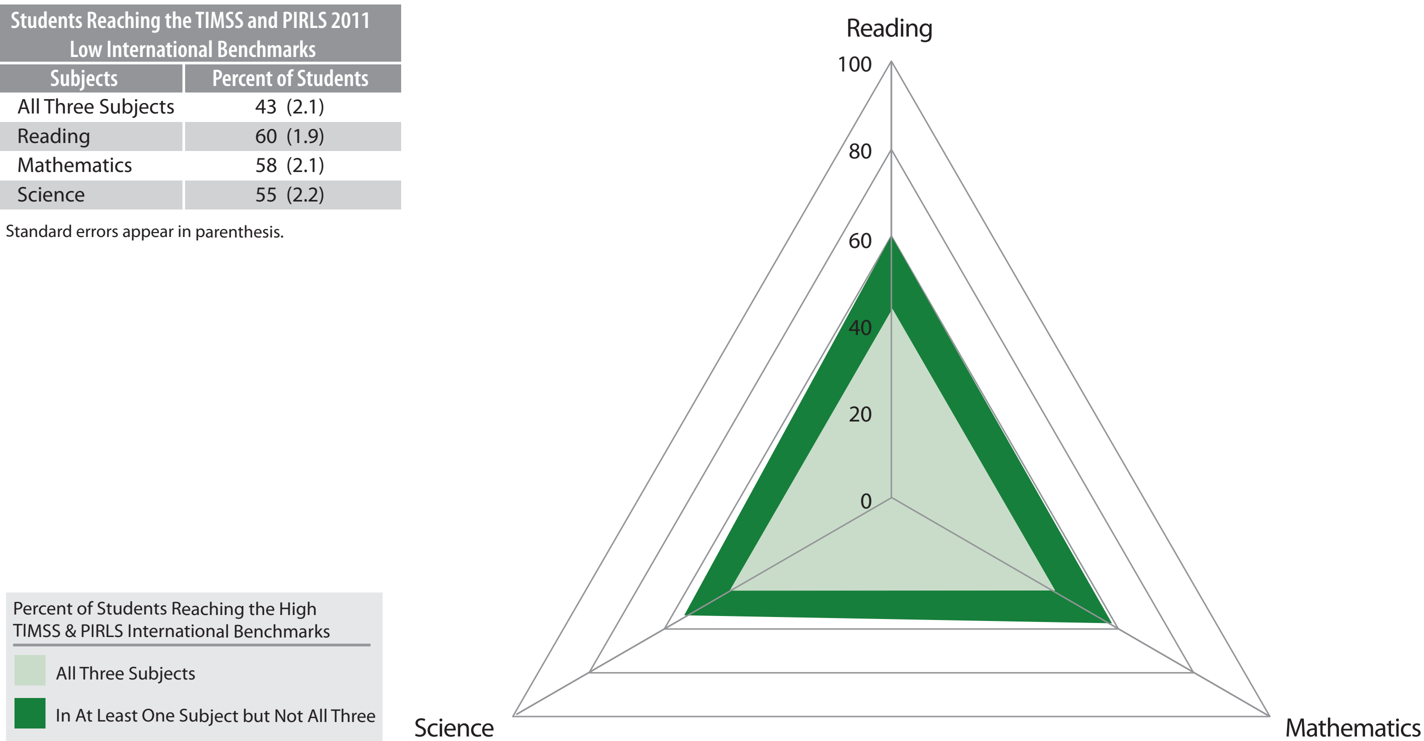
( ) Standard errors appear in parenthesis.



Low International Benchmarks

Students Reaching the TIMSS and PIRLS 2011 Low International Benchmarks	
Subjects	Percent of Students
All Three Subjects	43 (2.1)
Reading	60 (1.9)
Mathematics	58 (2.1)
Science	55 (2.2)

( ) Standard errors appear in parenthesis.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

facts about health, ecosystems, and animals. Although these students have lower achievement than those at the high level, they do have a well-rounded foundation in core concepts and skills that provides a good basis for further learning. In comparison, students who have not learned the basic fundamentals of reading, mathematics, and science by the end of their fourth year of schooling may be at some risk for future academic success.

Interestingly, most countries were more successful in educating their students in one or two of the subjects than in the others, especially when it comes to educating substantial percentages of students to high levels. For example, among the five countries with the highest percentages of students reaching the High International Benchmark, the three East Asian countries had a particular strength in mathematics—Singapore, Chinese Taipei, and Hong Kong SAR. In contrast, Finland had relative weakness in mathematics compared to its relative strengths in reading and science. The Russian Federation showed a particular strength in reading. Relatively few countries had similar percentages of students reach the benchmarks across all three subjects.

Chapter 2

The Impact of Reading Ability on TIMSS Mathematics and Science Achievement at the Fourth Grade: An Analysis by Item Reading Demands

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Boston College

Introduction

In the past several decades, schools have seen increasing integration across subject areas in teaching and learning, including greater emphasis on reading within subject areas. Today mathematics and science curricula around the world, as well as standards for proficiency in these subjects, commonly include reading and communication skills, and the *TIMSS 2011 Assessment Frameworks* (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009) reflect this situation. At the fourth grade in mathematics, for example, topics in the TIMSS framework content domains of number, measurement, and data display specify that students should be able to solve routine and non-routine problems set in everyday contexts. Understanding the description of the everyday situations for these types of problems necessarily involves reading. Also, the data display area is based on "reading and interpreting" tables, pictographs, bar graphs, and pie charts as well as creating such data displays. Similarly, the science framework requires students to comprehend descriptions of experiments and investigations as well as to read and interpret a variety of models and diagrams of science systems and phenomena.

Given that reading has been incorporated into the mathematics and science assessment frameworks, the TIMSS 2011 fourth grade achievement items encompass a range of reading comprehension demands. Of course, the reading demands vary across items, from quite minimal, as in items requiring students to complete a calculation, to somewhat more substantial, as in items requiring students to understand a description of a science experiment or phenomenon and then apply their knowledge or explain their reasoning. Additionally, it should be emphasized that all TIMSS items undergo extensive review for clarity, straightforward vocabulary, and syntax, and that any extraneous or irrelevant information is removed. Developing clearly written items that are equally accessible to all students is fundamental to all item development, but especially pertinent to TIMSS which needs to be translated into 30 or so languages. Multiple reviews by representatives of the participating countries ensure that the TIMSS item development approach prioritizes clarity and brevity, such that none of the TIMSS fourth grade items involve reading of any length or complexity (although some do at the eighth grade).

Still, fourth grade students are likely to be at a disadvantage in learning mathematics and science as well as demonstrating high performance on the TIMSS assessment if they lack reading skills. The availability of PIRLS data on reading achievement at the fourth grade provides an ideal opportunity to investigate the relationship between reading ability and the reading demands of the TIMSS mathematics and science assessment items. This study capitalized on the unique availability of PIRLS and TIMSS achievement scores for the same fourth grade students across reading, mathematics, and science for 34 countries and three benchmarking participants to examine the following overarching question:

> How does reading ability impact TIMSS mathematics and science achievement at the fourth grade?

Overview of Study

The basic approach used in the analysis presented in this chapter was to examine, for each participating country and benchmarking entity, the relationship between fourth grade students' reading ability as measured by PIRLS and their performance on TIMSS items with increasing levels of reading demands.

The hypotheses were as follows:

1. Students with high reading ability would not be impacted by the level of reading demand in the items. That is, the best readers would score similarly on TIMSS items regardless of the degree of reading demands.
2. Students with lower reading ability would perform relatively better on items with less reading. That is, poorer readers would score better on the items with the lowest reading demands than on the items with the highest reading demands.

The study was conducted separately for mathematics and for science, with the initial steps involving sorting the 175 TIMSS fourth grade mathematics items and 168 science items according to degree of reading demands. To maintain robustness of measurement while at the same time preserving differentiation, each set of fourth grade TIMSS items (mathematics and science) was separated into three relatively equal sized categories from relatively low to relatively high reading demands (low, medium, and high). Students' mathematics and science achievement was examined for each of the groups of mathematics and science items categorized as having low, medium, and high reading demands, for students at three different levels of reading ability on PIRLS 2011 (upper, middle, and lower terciles). The hypotheses were supported in general, but more so in mathematics than in science, and more so in some countries than in others. The results differed across countries, and sometimes between mathematics and science within countries.

Categorizing the TIMSS Fourth Grade Mathematics and Science Items According to Reading Demands

It was fundamental to this study to be able rank the TIMSS fourth grade mathematics and science items by level of reading demand in a manner that would be reliable and appropriate for further analysis. To have enough categories to discriminate between items, but not too many categories such that distinguishing among them would become extremely difficult, it was decided to have three categories of reading demand: low, medium, and high. Furthermore, it was very important to be able to document that the lowest category included items with lower reading demands than the medium category and, in particular, the highest category. Thus, the process of separating the items into the three categories of low, medium, and high reading demands involved several phases, including a review of the literature about the factors influencing reading demand, a holistic evaluation of the items according to selected indicators of reading demand, coding each item according to the reading demand indicators, and validating the holistic item categorizations through discriminant function analysis.

Holistic Evaluation of the Level of Reading Demands in the TIMSS 2011 Fourth Grade Items

As a first step toward holistically rating the TIMSS fourth grade items according to level of reading demand, the TIMSS & PIRLS International Study Center staff conducted a detailed review of the literature concerning dimensions of reading difficulty in the context of evaluating the reading demands presented by the TIMSS 2011 fourth grade mathematics and science items.

Settling on the best set of indicators to capture the reading demand of the TIMSS items was somewhat challenging, because much of the research on factors influencing reading difficulty is based on continuous text of some length, whereas the TIMSS fourth grade items are short. Also, the preponderance of research about reading difficulty in test items highlights how difficulty can be reduced by using clearer, less complicated language; however TIMSS already makes every effort to avoid unnecessary reading and the language used is no more complex than needs to be to frame the question (and responses for multiple-choice items). Additionally, the reading demand indicators used for this study needed to be applicable across the many languages of the TIMSS countries, which imposed further operational and practical constraints. When considering which of the many factors that influence reading difficulty could be used as indicators of reading demand, the following criteria were kept in mind:

- Appropriateness for the TIMSS fourth grade items;
- Generalizability across languages;
- Likelihood of being applied reliably; and
- Feasibility within resource and time constraints.

After a detailed discussion, staff articulated a set of indicators that appeared most applicable to evaluating the reading demands of the TIMSS fourth grade items. These included:

1. **Number of Words—**The number of words one must read is a basic feature of reading difficulty included in many well-known readability formulae (e.g., Dale-Chall and Flesch-Kincaid). While it was recognized that the number of words varies across languages, it was assumed that the items with more words in English would also have more words in other languages; therefore the relative reading demands across items would be maintained.

2. **Vocabulary**—A unique feature of reading in the mathematics and science context is that there are specialized vocabularies one must know for complete comprehension, but the use of particular vocabulary terms can contribute to reading demand (Adams, 2003; Bernardo, 2005; Justenson & Katz, 1995; Kane, Bryne, & Hater, 1974). Although there is some debate, both mathematics and science generally are regarded as having specialized languages with their own technical vocabularies, including everyday language that has specific meaning when used in the mathematics or science context (e.g., "difference" and "more" in mathematics; and "stay alive" instead of "survive" in science).

3. **Symbolic Language**—Similar to the specialized vocabulary component, understanding symbolic language requires reading skills that are particularly important in the mathematics and science context (Matteson, 2006). These can include numerals (e.g., 3, 5, 40) as well as other symbols and abbreviations (e.g., +, =, cm).

4. **Visual Displays—**The TIMSS achievement items contain a range of visual displays that students need to interact with to varying degrees in order to successfully complete the items. The complexity or density of a visual display impacts reading difficulty (Matteson, 2006; Mosenthal & Kirsch, 1998). Visual displays included the following: 1) pictorial representations of real world things, 2) geometric shapes and figures, 3) models and diagrams, 4) tables, and 5) graphs.

The above indicators of reading difficulty were used to holistically rate the TIMSS items according to their reading demands. Taking the specified components into account, ten members of the TIMSS & PIRLS International Study Center with backgrounds in measurement, reading, mathematics, and science used a holistic approach to evaluate the reading demands required by each item as low, medium, or high. According to the holistic scoring approach, the categorization was based on the overall impression of the reading difficulty of the item, with the proviso to assign about the same number of items to each category to ensure stability in the analyses. After independently rating each of the items, the entire team met to reconcile results and reach group consensus on the holistic rating of each item as low, medium, or high.

Empirical Data About the Reading Difficulty Factors Present in Each Item

The next phase of the study involved validating the holistic ratings, by coding each of the items according to the four dimensions of reading difficulty. The TIMSS & PIRLS International Study Center staff developed a draft coding guide to identify and quantify the difficulty factors present in each of the TIMSS fourth grade mathematics and science items. This draft underwent a series of internal reviews. Then, at the June 2012 meeting of TIMSS and PIRLS 2011 National Research Coordinators (NRCs) in Singapore, NRCs were led through the draft coding guide, and they suggested ways in which the coding guide could be further improved.

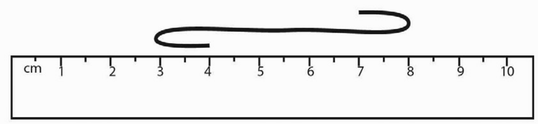
Most importantly, there was a thorough debate among the NRCs about the intersection of reading and mathematics, particularly in the areas of symbolic language and geometric shapes. That is, when students are asked simply to solve an equation for "X," are they reading the language of mathematics or only "doing mathematics" without any reading? Similarly, when asked to analyze the attributes of a triangle, are students engaging in an activity similar to reading a diagram, or is that only "doing mathematics?" Based on the literature review and the discussion, the TIMSS & PIRLS International Study Center decided to code these aspects of reading difficulty with separate codes so that analyses could be done with or without these aspects should researchers be interested.

The major indicators of reading demand in the final coding guide applied to each TIMSS fourth grade item were as follows:

- The number of words (anywhere in the item, including titles of graphics and labels);
- The number of different symbols (e.g., numerals, operators);
- The number of different specialized vocabulary words; and
- The total number of elements (density) in the visual displays (e.g., diagrams, graphs, tables).

Exhibit 2.1: Mathematics Item Coding Example

Mathematics Item Coding Example



If the string in the diagram above is pulled straight, which of these is closest to its length?

Ⓐ 5 cm
Ⓑ 7 cm
Ⓒ 8 cm
Ⓓ 9 cm

Number of Words: 18

Symbolic Language: 11 different symbols (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, cm)

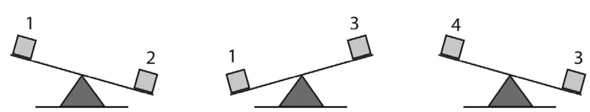
Visual Display: Pictorial Representation with a density of 2 (string, ruler) and a "necessary" level of interaction

Exhibit 2.2: Science Item Coding Example

Science Item Coding Example

Stephanie has a balance and four cubes (1, 2, 3, 4). The cubes are made of different materials.

She puts two cubes at a time on the balance and observes the following results.



What can she conclude about the weight of cube 2?

Ⓐ It is heavier than cubes 1, 3, and 4.
Ⓑ It is heavier than cube 1 but lighter than cubes 3 and 4.
Ⓒ It is heavier than cube 3 but lighter than cubes 1 and 4.
Ⓓ It is heavier than cube 4 but lighter than cubes 1 and 3.

Number of Words: 74

Symbolic Language: 4 different symbols (1, 2, 3, 4)

Vocabulary: 2 different terms (balance, cube)

Visual Display: 3 models, each with a density of 3 (1 balance, 2 cubes) and a "necessary" level of interaction

The coding guide was implemented to document the reading demands of each of the TIMSS fourth grade mathematics and science items (see *Technical Appendix A: Quantifying the Reading Demands of the TIMSS 2011 Fourth Grade Mathematics and Science Items*). In order to ensure that all dimensions of difficulty were correctly coded, each item was coded independently by two TIMSS or PIRLS senior staff members, who then reconciled any discrepancies. Exhibits 2.1 and 2.2 provide examples of the detailed coding applied to each item.

Discriminant Function Analysis

Finally, in order to validate the holistic categorizations of the items according to low, medium, and high reading demands, the data from coding the reading demands were used to conduct a discriminant function analysis (DFA). Group membership according to the holistic ratings was predicted using the four reading demand indicators: number of words, number of different symbols, number of different specialized vocabulary terms, and number and density of visual displays. Exhibit 2.3 presents the results of the DFAs for mathematics and science. For both subjects, the first discriminant function was sufficient to discriminate between the item groups, and the number of words was the indicator that loaded most heavily on this function.

Exhibit 2.3: Discriminant Function Analysis Results

Mathematics

Loading of Reading Demand Indicators on Discriminant Functions

Reading Demand Indicators	Function 1	Function 2
Total Number of Words	**.897**	-.137
Sum of Visual Display Density and Interaction Values	.327	.360
Number of Unique Symbols	.203	-.376
Number of Unique Technical Words	.016	.806

Science

Loading of Reading Demand Indicators on Discriminant Functions

Reading Demand Indicators	Function 1	Function 2
Total Number of Words	**.889**	-.407
Sum of Visual Display Density and Interaction Values	.489	.807
Number of Unique Symbols	.200	.333
Number of Unique Technical Words	.060	.282

Exhibit 2.4 presents the DFA classification results, which show that the reading demand indicators were effective in recovering the low, medium, and high holistic categorizations. The predicted categories largely matched the holistic categories, with agreement on 82 percent of the items for mathematics and 77 percent of the science items.

Exhibit 2.4: Discriminant Function Analysis Classification Results—Confirmation of Item Classification by Reading Demands Based on Holistic Evaluation and Predicted by Discriminant Function Analysis*

Mathematics

Reading Demand Group—Holistic Evaluation	Reading Demand Group Predicted by DFA		
	Low	Medium	High
Low	**53**	9	0
Medium	11	**46**	2
High	0	9	**45**

Science

Reading Demand Group—Holistic Evaluation	Reading Demand Group Predicted by DFA		
	Low	Medium	High
Low	**41**	12	0
Medium	6	**56**	2
High	0	18	**33**

* Shaded cells show number of holistically evaluated items in agreement with DFA.

Characteristics of Reading Demands in the TIMSS 2011 Fourth Grade Items

As explained earlier, the TIMSS 2011 fourth grade mathematics and science items typically do not have heavy reading demands, although some can be somewhat challenging. Exhibit 2.5 shows the characteristics of the items in terms of the four indicators of reading difficulty used in this study. On average, the total number of words (including all words appearing anywhere in the item) was relatively low, especially for mathematics, which included some items simply asking for computation. The average number of words in the mathematics items was 25 with a maximum of 84 words, and the average for the science items was 41 words with a maximum of 151 words. As would be anticipated, the mathematics items had more symbolic language (e.g., numerals and operators) than the science items, but still averaged only 5 unique symbols per item. Because the language in these items was intended to be at the fourth grade level or lower, occurrences of specialized mathematics and science terms were low (2 to 3 terms per item on average). Finally, the number of visual displays refers to the total density or number of elements in the visual display or displays in the item. Because the TIMSS fourth grade mathematics framework includes geometric shapes as well as data displays (e.g., tables and graphs), the mathematics items more often included visual displays with a number of elements (8 on average) than the science items (3 on average).

Exhibit 2.5: Indicators of Reading Difficulty for the TIMSS 2011 Fourth Grade Items

	Mathematics Items (n=175)		Science Items (n=168)	
Number	**Mean**	**Maximum**	**Mean**	**Maximum**
Total Words*	25	84	41	151
Different Symbols**	5	30	1	15
Different Specialized Terms	2	10	3	13
Density Visual Displays***	8	46	3	27

* Includes all words appearing anywhere in the item—stem, question, response categories, and visual displays (e.g., exhibit titles, labels)

** Includes numerals, signs of operations, units (e.g., abbreviations such as cm), variables (e.g., X), and labels (e.g., A for angle A).

*** Includes all elements in the visual display(s).

Exhibits 2.6a through 2.6f present examples of TIMSS 2011 mathematics and science items with low, medium, and high reading demands, respectively. The items in the low reading demands category typically were very straightforward, including mathematics computation items with hardly any words, short constructed response items where the question asked for the answer in a word or phrase, and basic multiple choice items with a question and short options. The items in the medium category had more words, and also often had diagrams or geometric figures especially for mathematics. In comparison, the items in the high category usually had both more words and more complex visual displays.

Exhibit 2.6: Examples of TIMSS Fourth Grade Mathematics and Science Items Categorized as Having Low, Medium, and High Reading Demands

Exhibit 2.6a: Example TIMSS Fourth Grade Mathematics Item Categorized as Having Low Reading Demands

M051203

$23 \times 19 =$

Answer: ________________

Exhibit 2.6b: Example TIMSS Fourth Grade Science Item Categorized as Having Low Reading Demands

S031254

Which of these animals has a young form that looks the most like the adult form?

Ⓐ moth

Ⓑ human

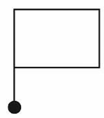
Ⓒ frog

Ⓓ butterfly

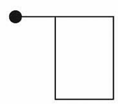
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

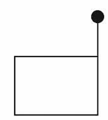
Exhibit 2.6: Examples of TIMSS Fourth Grade Mathematics and Science Items Categorized as Having Low, Medium, and High Reading Demands (Continued)

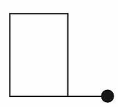
Exhibit 2.6c: Example TIMSS Fourth Grade Mathematics Item Categorized as Having Medium Reading Demands

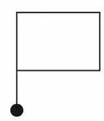


Which of the following shows the position of the shape above after a half turn or 180° rotation?

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

M031071

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.6: Examples of TIMSS Fourth Grade Mathematics and Science Items Categorized as Having Low, Medium, and High Reading Demands (Continued)

Exhibit 2.6d: Example TIMSS Fourth Grade Science Item Categorized as Having Medium Reading Demands

S031421

Some of the materials below will burn and some will not.
Put an X in the box next to the materials that will burn.

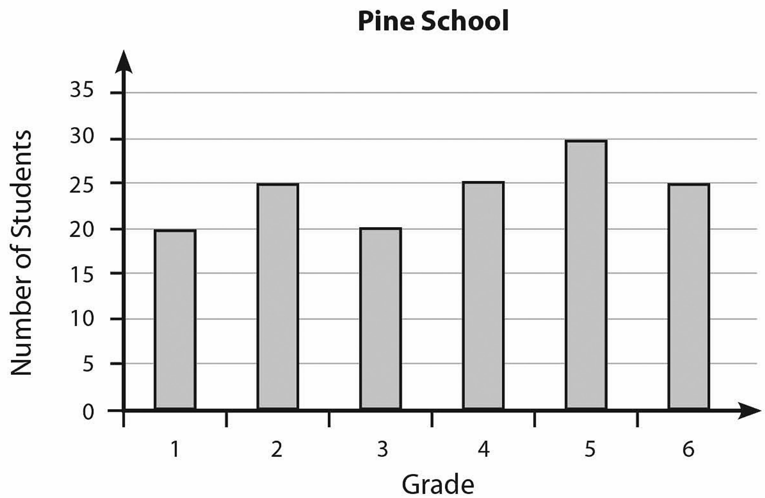
(You may put an X in more than one box.)

- ☐ water
- ☐ wood
- ☐ sand
- ☐ gasoline
- ☐ air

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.6e: Example TIMSS Fourth Grade Mathematics Item Categorized as Having High Reading Demands

The graph shows the number of students at each grade in the Pine School.



In the Pine School there is room in each grade for 30 students.
How many more students could be in the school?

Ⓐ 20

Ⓑ 25

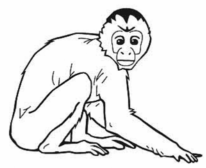
Ⓒ 30

Ⓓ 35

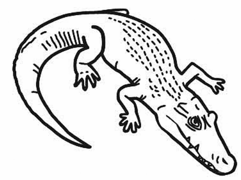
M051117

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.6f: Example TIMSS Fourth Grade Science Item Categorized as Having High Reading Demands

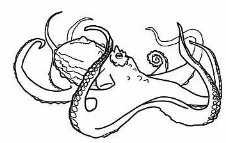


Monkey



Crocodile

Grasshopper



Octopus

Answer the following questions using the animals shown above. Write the name for the correct animal in the spaces below.

Which animal has an internal skeleton and produces milk for its young?

____

Which animal has an external skeleton and three pairs of legs?

____

Which animal has a soft body and no skeleton?

____

S031233

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Interaction Between the Levels of Reading Demands and the TIMSS 2011 Content and Cognitive Domains at the Fourth Grade

It should be recognized that the nature of the content and cognitive domains in TIMSS frameworks can heavily influence the reading demands required by the items. Exhibit 2.7 shows the content and cognitive domains for the TIMSS 2011 mathematics and science items at the fourth grade. Of these two dimensions of the mathematics and science assessments, the content domains describe in some detail the major content to be assessed and the cognitive domains describe the thinking skills the students should be using within the content domains. The TIMSS 2011 mathematics and science assessments each encompassed three content domains and three cognitive domains. The cognitive domains were the same for mathematics and science and at the fourth grade and they had the same amount of emphasis.

Exhibit 2.7: TIMSS 2011 Content and Cognitive Domains at the Fourth Grade Percentages Devoted to Each Domain

Mathematics		Science		Mathematics and Science	
Content Domains	Percentage of Assessment	Content Domains	Percentage of Assessment	Cognitive Domains	Percentage of Assessment
Number	50%	Life Science	45%	Knowing	40%
Geometric Shapes and Measures	35%	Physical Science	35%	Applying	40%
Data Display	15%	Earth Science	20%	Reasoning	20%

Exhibit 2.8 presents the distributions by content domain of the TIMSS 2011 mathematics and science fourth grade items categorized as having low, medium, and high reading demands. For mathematics, there is a clear interaction between the content domain and the reading demands of the items. Half of the assessment is devoted to assessing the number domain, with 50 percent of the number items being classified as having low reading demands because many ask only for computation or familiarity with basic number concepts. The geometry and measurement items (about a third of the assessment) often were categorized as medium (49%), because the framework calls for assessing a variety of understandings related to points, lines, and angles as well as two- and

three-dimensional shapes. Therefore, the typical item in this content domain includes a figure with an associated question, with some items being very straightforward and others more complicated, but primarily the items were in-between. Finally, although only a small part of the assessment is devoted to data display, most of these items (85%) were categorized as having high reading demands because, consistent with the framework topics, these items typically involved reading and interpreting data from relatively dense visual displays, including tables, pictographs, bar graphs, and pie charts.

Exhibit 2.8: TIMSS Fourth Grade Mathematics and Science Items by Content Domains and Low, Medium, and High Reading Demands

	Mathematics Content Domains				Science Content Domains			
Reading Demands	Number	Geometric Shapes and Measures	Data Display	Total Math	Life Science	Physical Science	Earth Science	Total Science
Low	50%	28%	4%	35%	36%	26%	30%	32%
Medium	30%	49%	12%	34%	35%	33%	55%	38%
High	20%	23%	85%	31%	28%	41%	15%	30%
Total	**88**	**61**	**26**	**175**	**74**	**61**	**33**	**168**

Interestingly, the degree of difficulty of the TIMSS mathematics items across content domains may be unexpected in light of the relative levels of reading demands. As shown in the report containing the *TIMSS 2011 International Results in Mathematics* (Mullis, Martin, Foy, & Arora, 2012), the average percent correct across the mathematics items overall was 50 percent, with 47 percent correct, on average, for the number items, 49 percent for the geometric shapes and measures items, and 58 percent for the data display items. On other hand, the degree of reading demands in the mathematics items by content domains has some relationship with the emphasis on the topics in these three content domains in the curricula across countries. According to data published in the *TIMSS 2011 International Results in Mathematics,* across countries, National Research Coordinators reported that of the eight number topics, on average, six (75%) were included in the curriculum; of the seven geometry topics, five (71%) were included, and of the three data display topics, two (67%) were included. According to their teachers, the percentage of students that had been taught the TIMSS topics, averaged across each content domain, was lower for geometric shapes and measures (65%) than for both number and for data display (76%). The NRC and teacher data indicate less curricular emphasis on the TIMSS topics in geometric shapes and measures than in number, whereas the TIMSS items in geometric shapes and measures are more likely than the number items to have medium rather than low reading demands. The situation with data display is more difficult to interpret because it receives a small emphasis in the assessment (15%) and only has three topics. Although the three data display topics seem to be present in the curricula and classrooms of the TIMSS countries, this probably represents only a small part of students' instruction in mathematics and the TIMSS items in this content domain are likely to have relatively high reading demands.

Looking across the science content domains, the life science items—covering topics about the characteristics, processes, and cycles of living things and comprising nearly half of the assessment (45%)—were relatively well distributed according to reading demand, although with a tendency toward lower or medium rather than high levels of reading difficulty. The opposite was found for the physical science items (35% of the assessment) which often involve physical phenomena that can be presented via models or diagrams. Thus, items in the physical science content domain were more likely to have medium and high reading demands. Finally, the one-fifth of the assessment devoted to earth science was well-balanced with most items categorized as having medium reading demands, but some with low and some with high reading demands.

For science at the fourth grade, as reported in *TIMSS 2011 International Results in Science* (Martin, Mullis, Foy, & Stanco, 2012) the average percent correct across countries was 48 percent overall, and very similar across content domains—life science (48%), earth science (46%), and physical science (49%). However, the content areas more likely to have TIMSS items with high reading demands were the content areas emphasized least in the curricula across countries. The life science items were most likely to have low reading demands, earth science items medium reading demands, and physical science items high reading demands. This corresponds with the curricular emphasis on the science content areas, with life science being emphasized more than earth science, and earth science, in turn, emphasized more the physical science. As presented in the *TIMSS 2011 International Results in Science*, across countries, National Research Coordinators reported, on average, that of the six life science topics, five (84%) were included in the curriculum for all students; of the six earth science topics, four (67%) were included; and of the eight physical science topics, five (63%) were included. Consistent with the country reports, according to their teachers, on average, the percentage of students taught the TIMSS topics was highest for life science (75%), next highest for earth science (63%), and lowest for physical science (57%).

Exhibit 2.9 presents the distributions by cognitive domain of the TIMSS 2011 mathematics and science fourth grade items categorized as having low, medium, and high reading demands. In general, the patterns are similar for mathematics and science. The two-fifths of the items measuring the knowing domain (e.g., recall, recognize, compute, classify/order) were more likely to have low reading demands (61% in mathematics and 56% in science); the two-fifths of the items measuring the applying domain (e.g., represent, model, and solve standard problems) were more likely to have medium reading demands; and the one-fifth of the items measuring reasoning (e.g., analyze, synthesize, justify, and solve problems in unfamiliar or complex contexts) were most likely to have high reading demands (59% in mathematics and 76% in science). Items measuring students' ability to apply their knowledge of content and procedures and, especially those requiring reasoning, need to include some information in the form of words or visual displays as to the problems situation. The items measuring reasoning often were based on scenarios or situations reflecting school or daily experiences.

Exhibit 2.9: Percentage of TIMSS Fourth Grade Mathematics and Science Items by Cognitive Domains and Low, Medium, and High Reading Demands

	Mathematics Cognitive Domains				Science Cognitive Domains			
Reading Demands	Knowing	Applying	Reasoning	Total Math	Knowing	Applying	Reasoning	Total Science
Low	61%	24%	6%	35%	56%	18%	7%	32%
Medium	21%	45%	35%	34%	35%	33%	17%	38%
High	17%	31%	59%	31%	28%	41%	76%	30%
Total	**70**	**71**	**34**	**175**	**74**	**61**	**29**	**168**

For the cognitive domains in mathematics and science, the items were more difficult across the cognitive areas from knowing, to applying, and then reasoning. For mathematics, the average percent correct across countries was

55 percent for the items classified in the knowing domain, 50 percent for items classified in the applying domain, and substantially lower for items in the reasoning domain—40 percent (Mullis, Martin, Foy, & Arora, 2012). In science, the average percent correct across countries was 53 percent for knowing, 46 percent for applying, and 41 percent for reasoning (Martin, Mullis, Foy, & Stanco, 2012). Certainly, it can be considered that both the complexity of the cognitive tasks and the increase in reading demands both contribute to the substantial difficulty of the reasoning items.

Generalizability Across Countries of the Item Categorizations According Low, Medium, and High Reading Demands

Because the study of the impact of item reading demands on TIMSS fourth grade mathematics and science achievement was conducted using the English language version of the items, the question arises about the generalizability of the results to languages other than English. Clearly, the four indicators of reading demands would not be expected to have identical values in all languages. For example, it is well known that after translation the number and length of words in the TIMSS items varies across languages. However, it is likely that the items with the highest reading demands in English also would have the highest reading demands in other languages. Thus, National Research Coordinators of countries that conducted TIMSS 2011 in languages other than English participated in a Reading Demands Matching Analysis (RDMA) which involved categorizing the items in their languages into three categories of reading demand (highest, medium, and lowest). NRCs were instructed to categorize the items in their languages using a holistic rating process based on the same four indicators of reading demand used in the study (number of words, number of different symbols, number of different specialized vocabulary terms, and number/density of visual displays). Seventeen countries and one benchmarking participant (representing 16 different languages in total) submitted their RDMA categorizations to the TIMSS & PIRLS International Study Center. On average, NRCs reported involving four different raters in the RDMA process. The rating teams included members of their TIMSS or PIRLS teams and/or content area experts, including researchers, curriculum experts, and teachers. A number of countries reported that they valued participating in the process and appreciated viewing the TIMSS items from a different perspective.

The categorizations submitted by the NRCs were compared to the categorizations developed by the TIMSS & PIRLS International Study Center, and there was a very a high degree of agreement for both the mathematics and science items. On average, there was 71 percent exact agreement and 98 percent adjacent agreement across countries. Although there were some items (15%) where the level of exact agreement was below 50 percent, these were often items with complicated graphics.

The Impact of Reading Ability on TIMSS Achievement for Items with Low, Medium, and High Reading Demand

Keeping in mind that the level of reading demands in the TIMSS fourth grade mathematics and science items interacts with many other factors, including the difficulty and curriculum coverage of the topics in the content domains as well as the variation in difficulty across the cognitive domains, it is still very interesting to look at performance on the TIMSS mathematics and science items for students of different reading ability and how this relates to the level of reading demands in the items from low to medium to high.

The relationship between level of reading ability and TIMSS mathematics and science achievement by level of reading demand in the items was examined by computing the average percent correct[1] for items in each of the three categorizations of reading demands (low, medium, and high) for students with three levels of reading ability. More specifically, separately for mathematics and for science, the TIMSS & PIRLS International Study Center computed the average percent correct for each group of the fourth grade items classified according to low, medium, and high reading demands for each of three levels of students' reading ability (determined by the lower, middle, and upper terciles of reading achievement on PIRLS 2011 in each country).

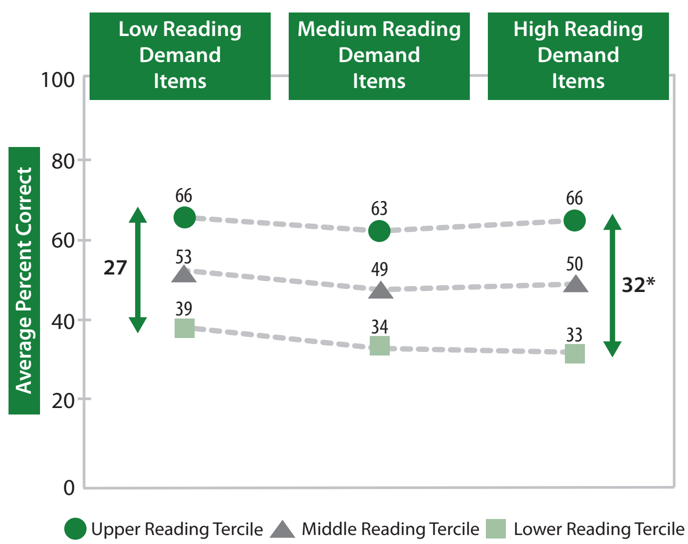
It was expected that the best readers would be unaffected by the reading demands of the items, and therefore would perform similarly on the low, medium, and high demand items, whereas the poorest readers would perform relatively better on low demand items, and less well on high demand items. Some support for these hypotheses was found in the overall and country-by-country results, particularly in mathematics. However, the results varied considerably from country to country and even between mathematics and science within countries.

1 The analyses also were conducted based on achievement scales created for each of the three groups of items using the same scaling approach as used for the TIMSS 2011 content and cognitive domains (i.e., a multi-dimension estimation of performance on high, medium, and low reading demand items using the item parameters from the TIMSS overall concurrent calibration). However, the average percent correct approach used in this paper seemed to provide more easily interpretable results.

Exhibit 2.10 presents line graphs of the international averages across the country-by-country results for TIMSS fourth grade the mathematics items, and Exhibit 2.11 presents the same information for the science items. As would be expected, Exhibit 2.10 for mathematics shows that across the three levels of reading demands (low, medium, and high), the students in the upper reading tercile (top one-third of readers averaged across countries, indicated by **circles**) had higher average mathematics achievement than those in the middle reading tercile (indicated by **triangles**). In turn, the students in the middle reading tercile had higher average mathematics achievement at each level of item reading demand than did those in the lower reading tercile (indicated by **squares**).

Exhibit 2.10: Mathematics Achievement Averaged Across Countries—Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands



Results for each tercile averaged accross countries.

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.

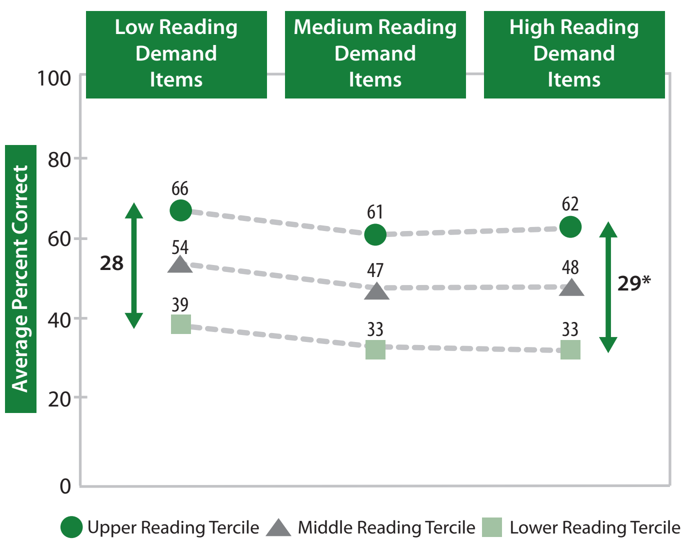
Because of rounding, some results may appear inconsistent.

As hypothesized, the average mathematics achievement of the best readers did not vary much by level of reading demands (66% correct on the low demand items, 63% on the medium items, and 66% on the high items). In comparison, the average mathematics achievement of the least proficient readers was 39 percent correct on the items with low reading demands, but lower on the items of medium (34%) and high reading demands (33%). The difference in average achievement between poor and good readers on the low reading demand items was 27 percentage points. However, this difference increased to 32 percentage points on the high reading demand items. While the poorest readers consistently achieved at a lower level in mathematics than the best readers, they were additionally disadvantaged on the mathematics items that required more reading.

Exhibit 2.11 for science shows results for the poorest readers that are nearly identical to those shown for mathematics, with averages of 39 percent correct on the low demand items and 33 percent correct on both the medium and high demand items. Also, the achievement gaps between the three terciles of readers on the science items with low reading demands are nearly identical to those for

Exhibit 2.11: Science Achievement Averaged Across Countries—Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands



Results for each tercile averaged accross countries.

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.

Because of rounding, some results may appear inconsistent.

mathematics. However, for the science items, similar to the poorest tercile of readers, the upper and middle terciles of readers also had lower achievement on the medium and high reading demand items. Interestingly for science, there was little difference in the results between the medium and high reading demand items, which may reflect a small difference in reading demands between the medium and high demand items. Because all three terciles of readers were similarly disadvantaged by more reading demands, the gaps in achievement between the upper tercile of readers compared to the lower tercile of readers was similar at all three levels of reading demand (28% on the low demand and medium demand items, and 29% on the high demand items).

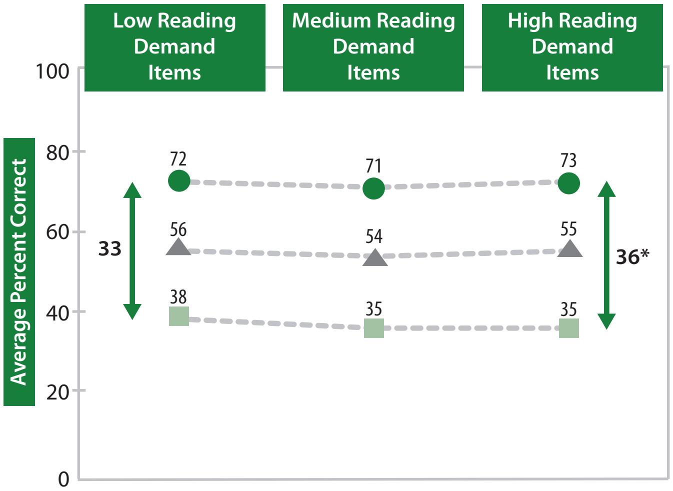
Exhibit 2.12 presents the TIMSS fourth grade mathematics achievement results by level of reading demand and tercile of PIRLS reading achievement for each of the 34 countries and 3 benchmarking entities that assessed the same fourth grade students with TIMSS and PIRLS in 2011. Looking across countries, in most instances there is a significant difference in average percent correct between the upper and lower reading achievement terciles on the low reading demand items (left side of graphs) and the high reading demand items (right side of graphs) with the difference being larger on the high reading demand items. That is, for most countries, better readers have a significantly greater advantage over poorer readers on mathematics items with high reading demands.

The significant difference in the achievement gap between low and high reading demand items seemed to arise from the expected pattern—the best readers having similar mathematics achievement across all items regardless of level of reading demands, but poor readers performing less well on items with more reading demands—most noticeably in Australia, Austria, Chinese Taipei, Croatia, Hungary, Lithuania, Portugal, the Russian Federation, Saudi Arabia, and the Slovak Republic.

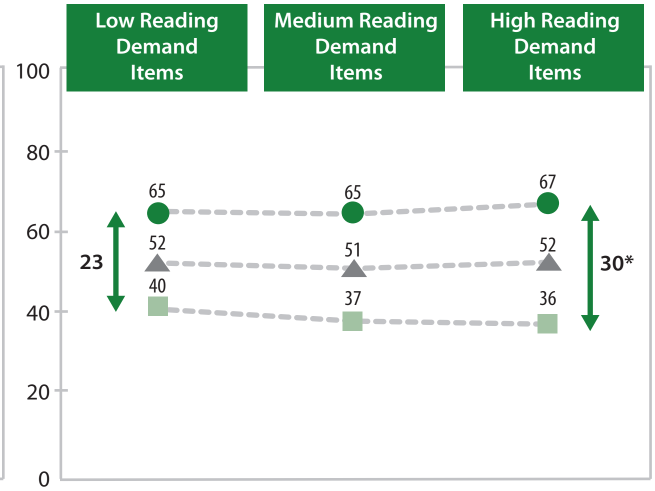
Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands

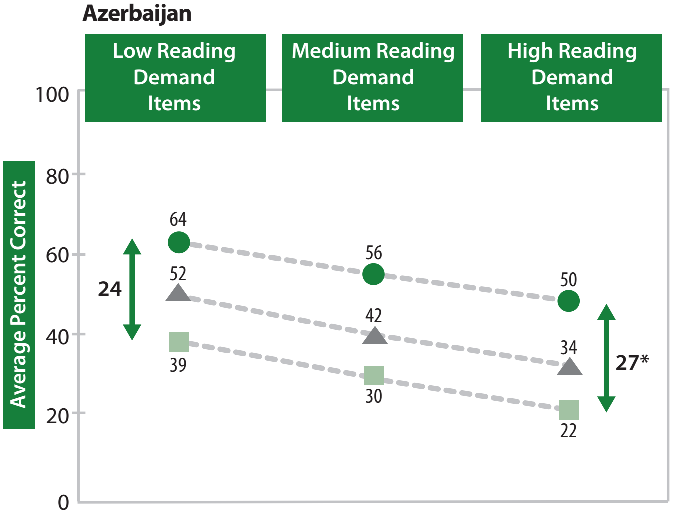
Australia



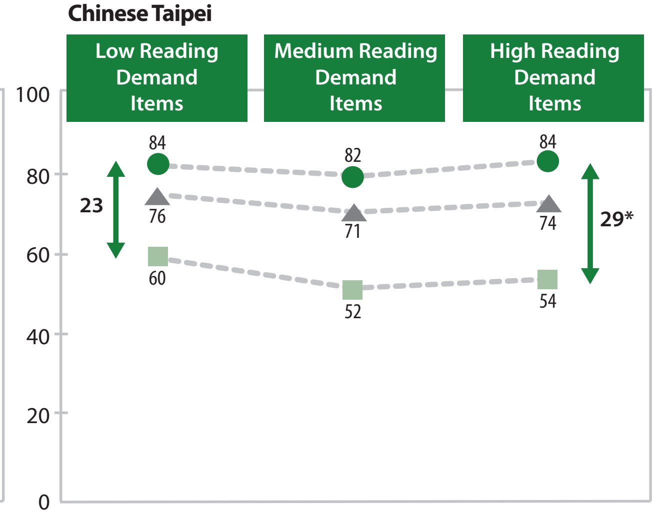
Austria



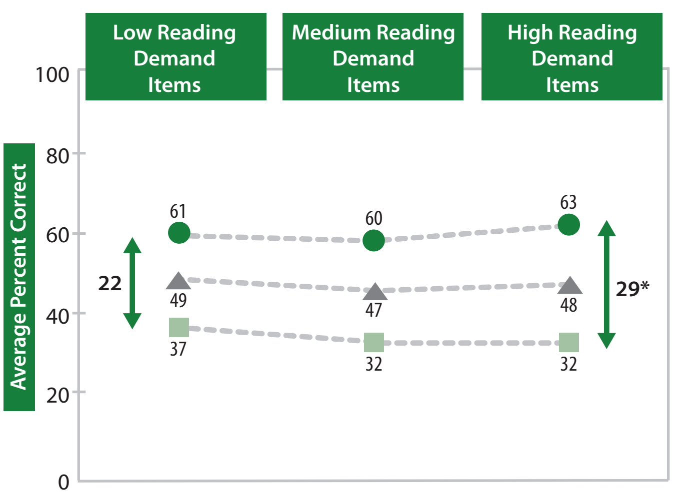
Azerbaijan



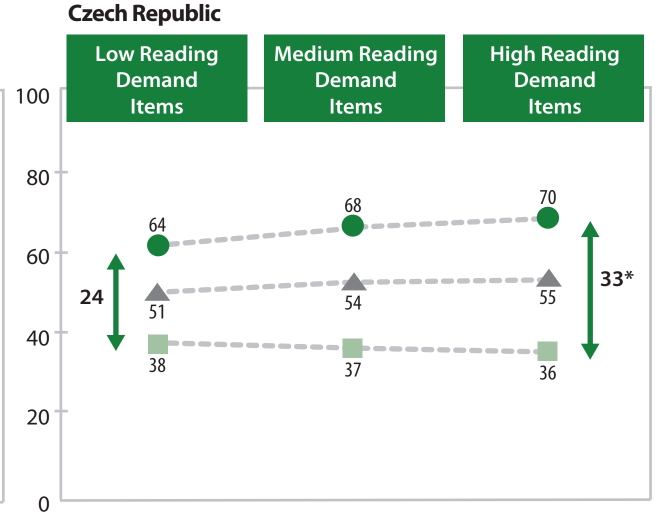
Chinese Taipei



Croatia



Czech Republic



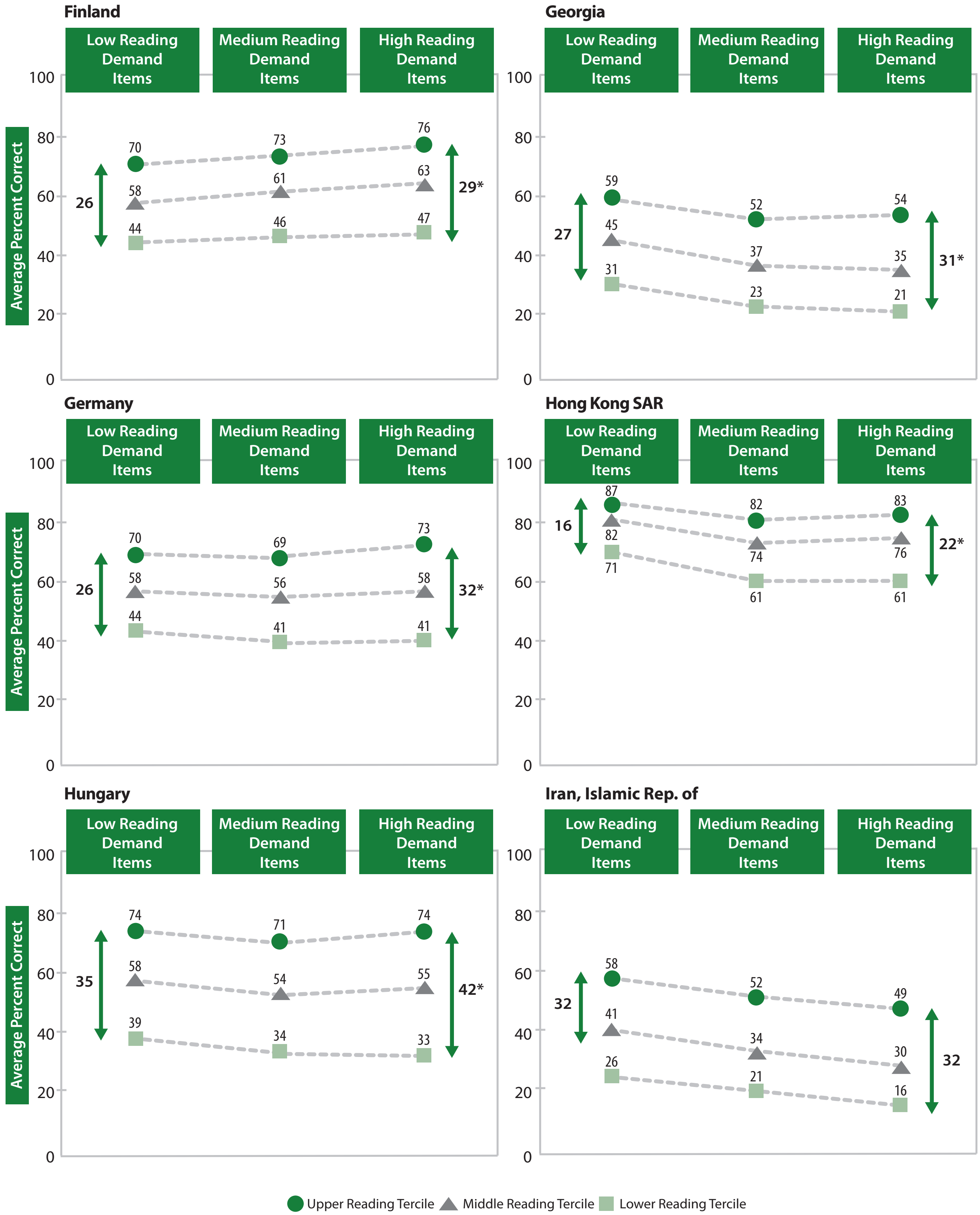
● Upper Reading Tercile ▲ Middle Reading Tercile ■ Lower Reading Tercile

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands

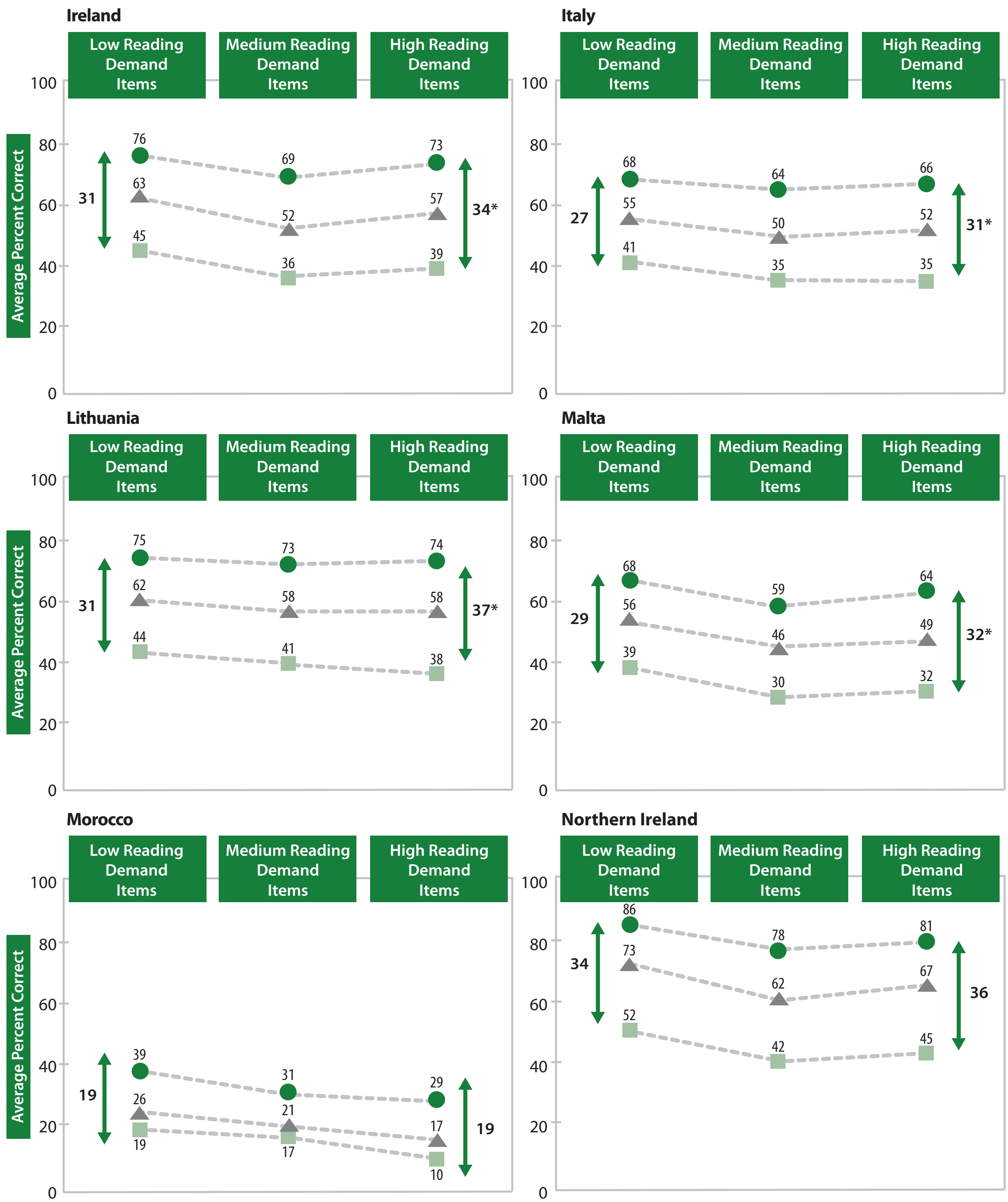


* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands



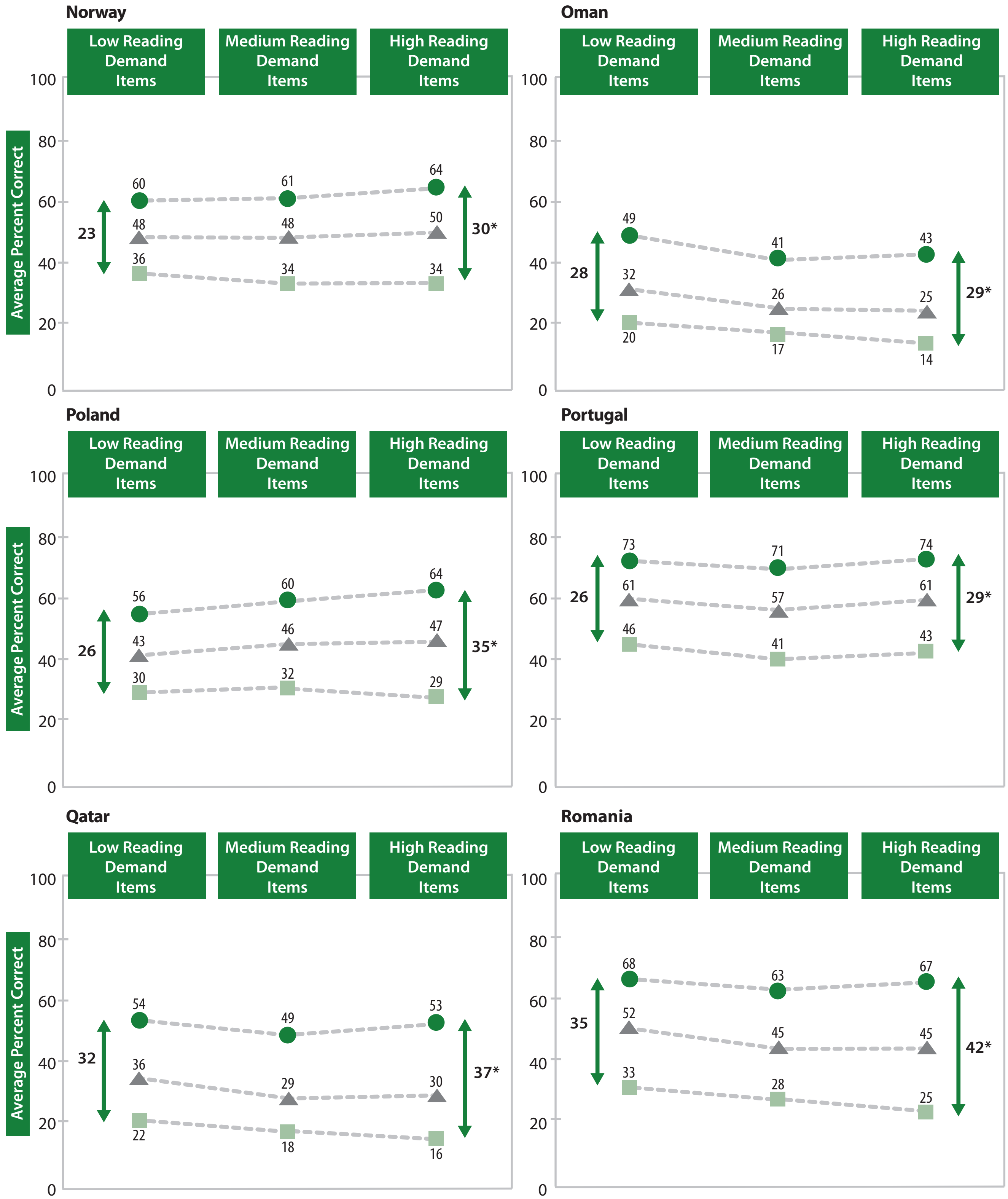
Upper Reading Tercile | Middle Reading Tercile | Lower Reading Tercile

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS and PIRLS 2011

Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands



● Upper Reading Tercile ▲ Middle Reading Tercile ■ Lower Reading Tercile

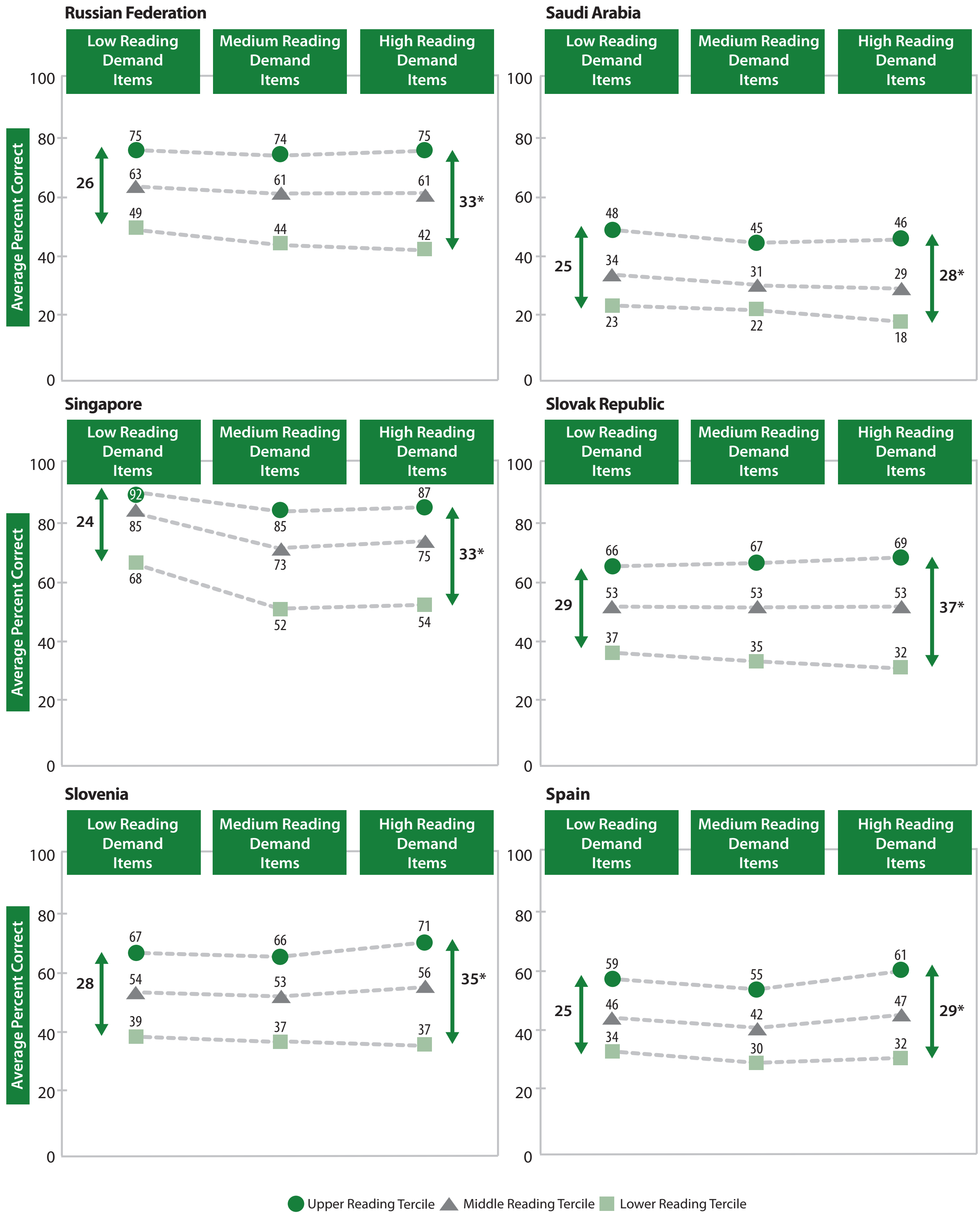
* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands. Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands

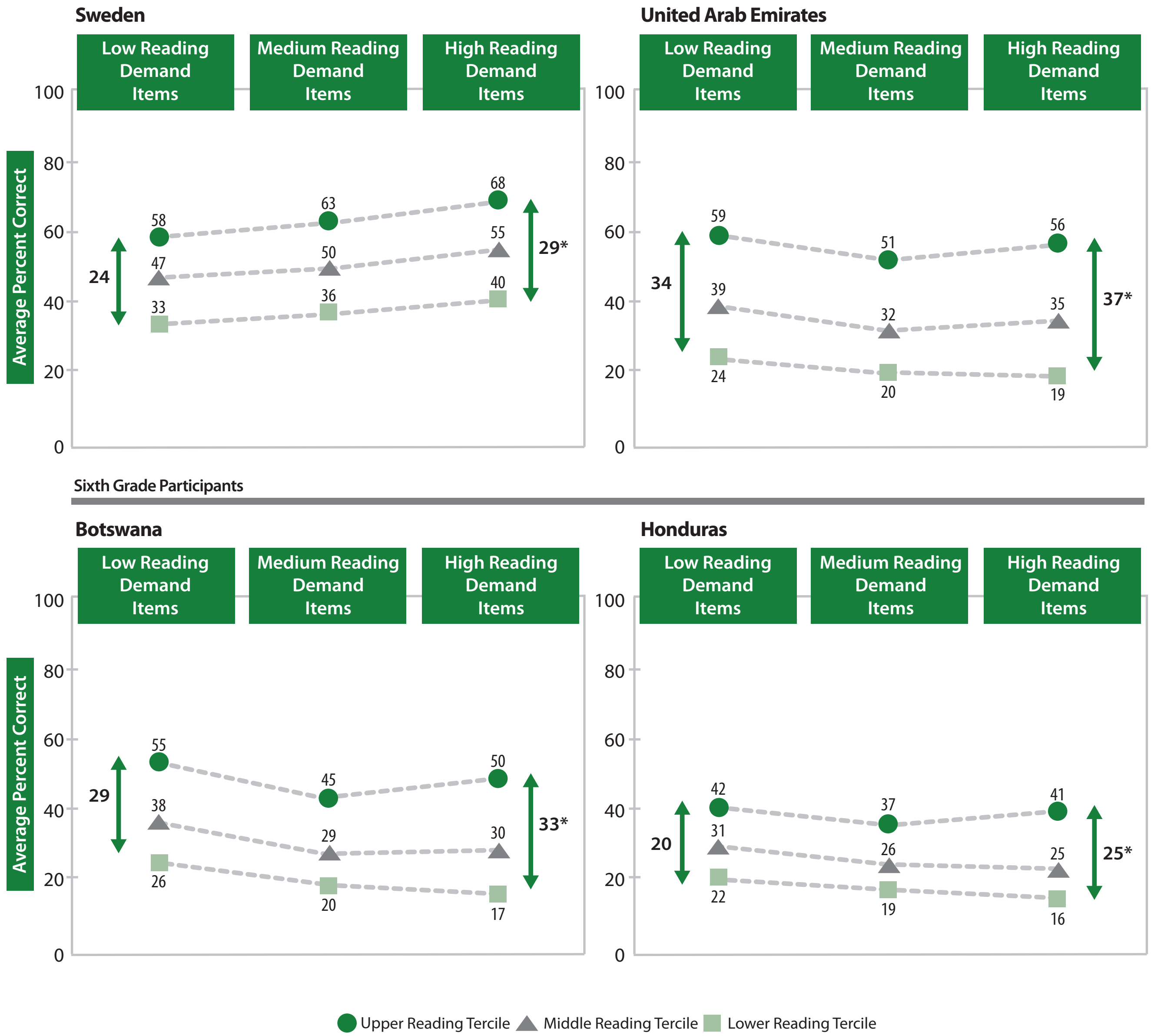


* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands



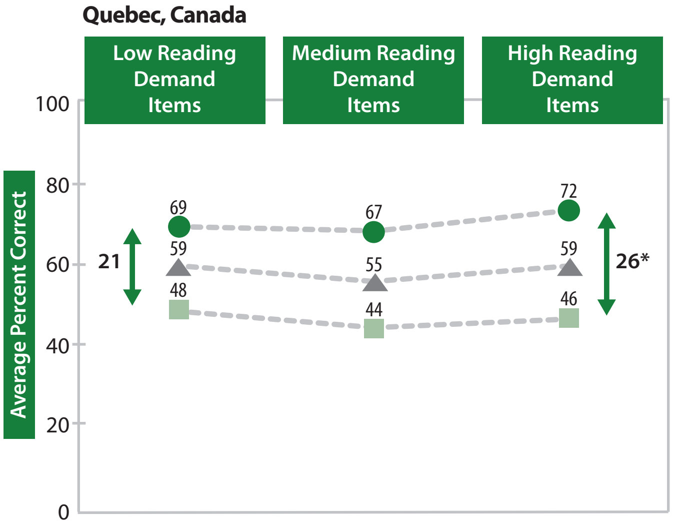
* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands. Because of rounding, some results may appear inconsistent.

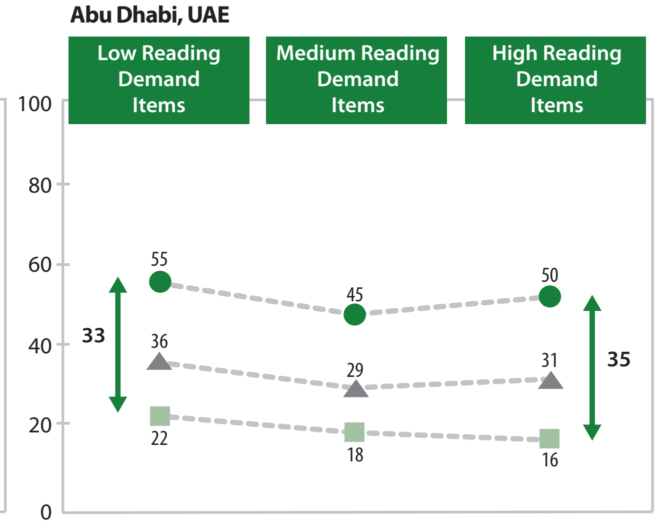
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

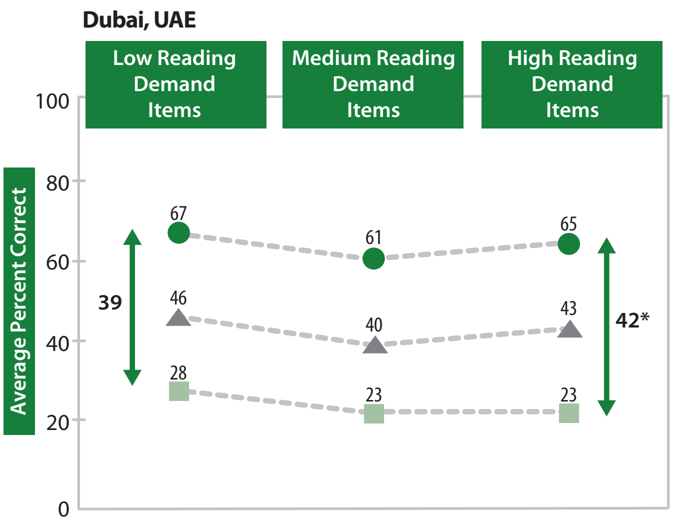
Exhibit 2.12: Mathematics Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demands

Benchmarking Participants







Upper Reading Tercile Middle Reading Tercile Lower Reading Tercile

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.

Because of rounding, some results may appear inconsistent.

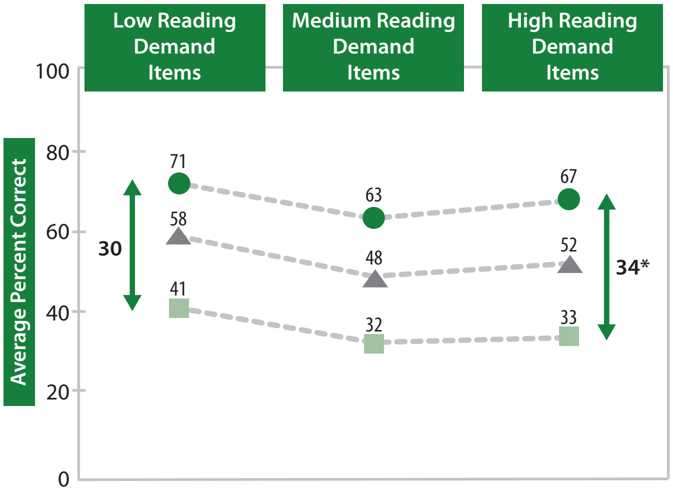
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.13 presents the TIMSS fourth grade science achievement results by level of reading demand and tercile of PIRLS reading achievement for each of the 34 countries and 3 benchmarking entities that assessed the same fourth grade students with TIMSS and PIRLS in 2011. Again, the results may reflect the restricted range in the level of reading demands in the fourth grade science items, or that at the fourth grade science content and reading are very closely linked. Consistent with results averaged across countries (Exhibit 2.11), there were fewer significant differences than in mathematics between the achievement gap for low reading demand items and high reading demand items that show an advantage for better readers over poorer readers on the high reading demand items. However, such significant differences were found in more than half of the countries, including Croatia, the Czech Republic, Hungary, Lithuania, Poland, Romania, the Russian Federation, the Slovak Republic, and Slovenia where the difference was 5 or more percentage points. Interestingly, compared to mathematics, there were more countries, such as Azerbaijan, Georgia, Iran, Morocco, Norway, Romania, and Saudi Arabia, where increased reading demands in the science items was systematically associated with lower achievement for the three levels of readers. In addition, there were a number of countries where performance dropped by about the same amount on the medium and high reading demand items for all three levels of readers.

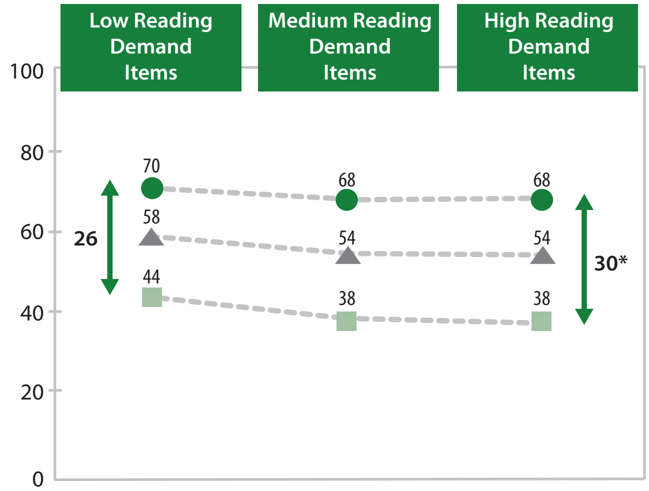
Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands

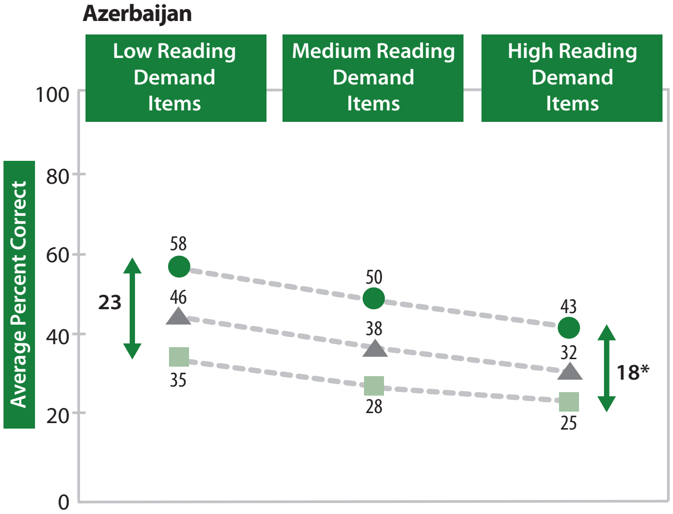
Australia



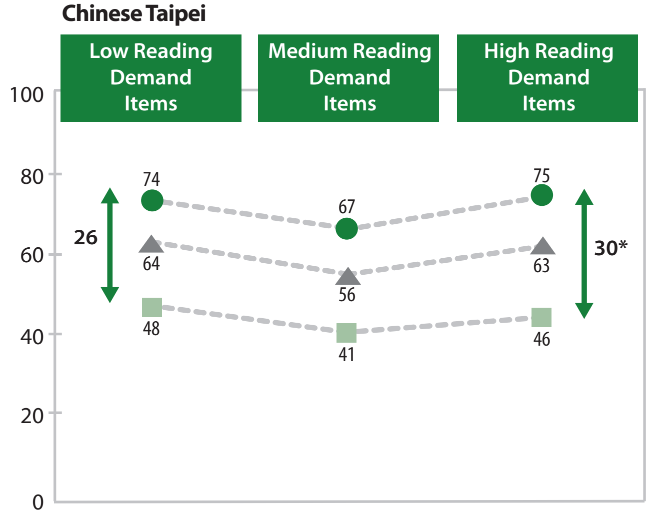
Austria



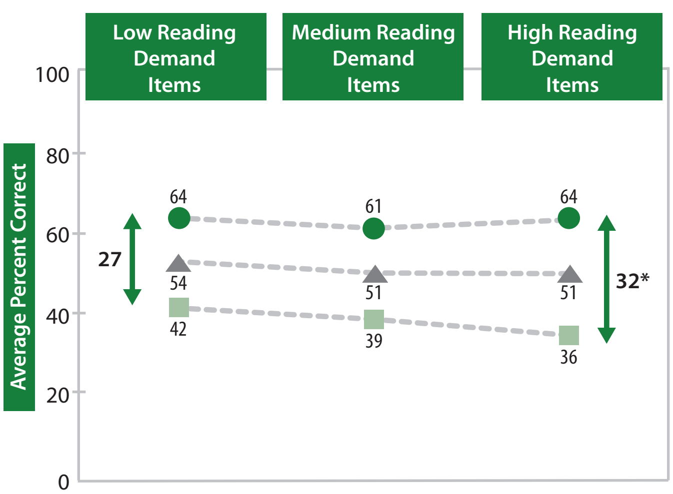
Azerbaijan



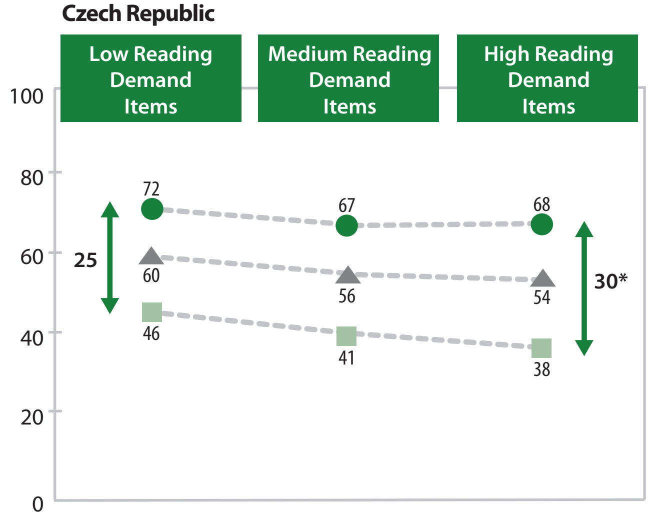
Chinese Taipei



Croatia



Czech Republic



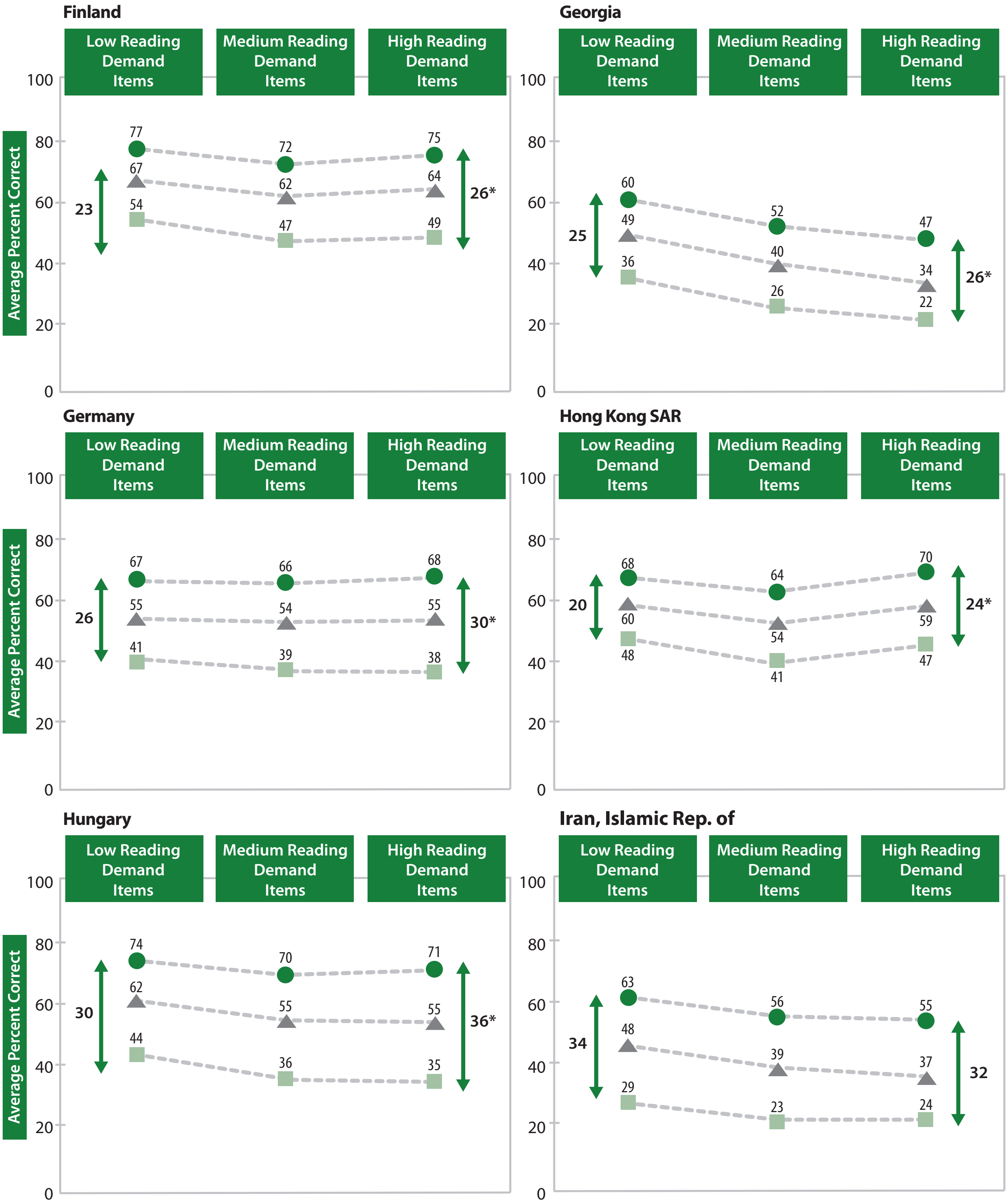
● Upper Reading Tercile ▲ Middle Reading Tercile ■ Lower Reading Tercile

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands



Upper Reading Tercile | Middle Reading Tercile | Lower Reading Tercile

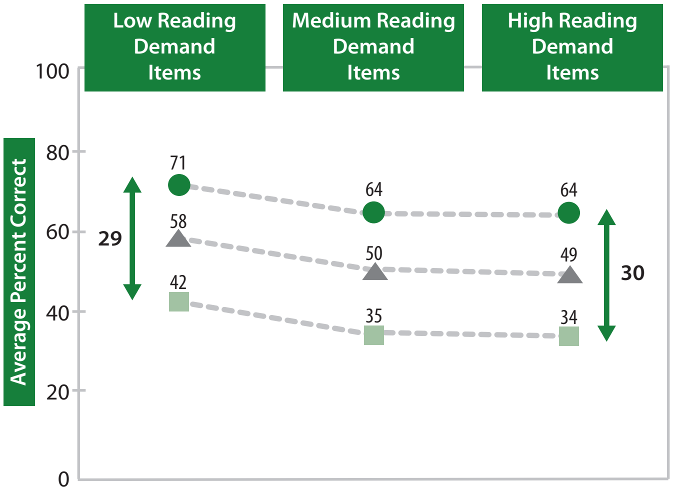
* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

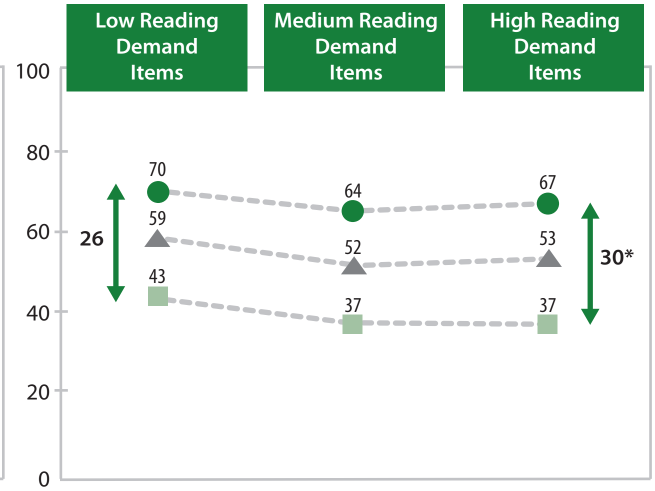
Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands

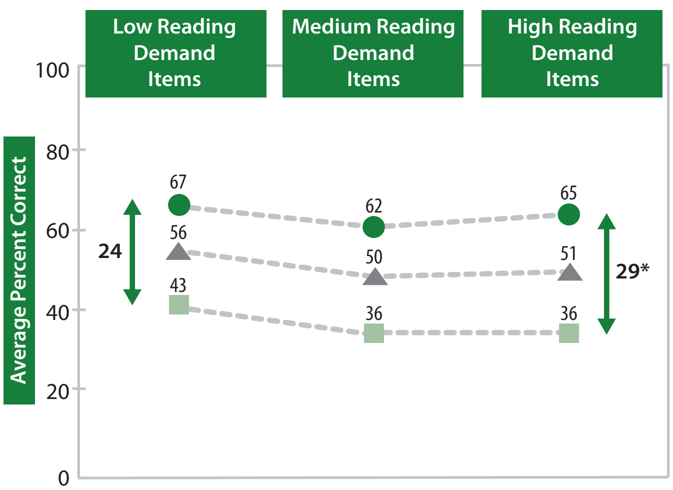
Ireland



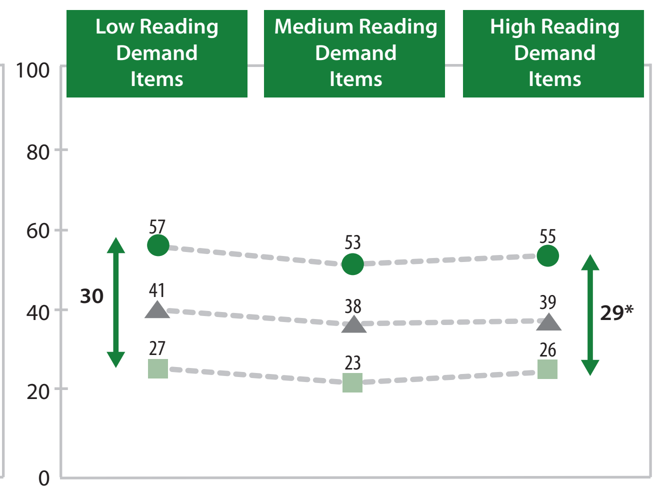
Italy



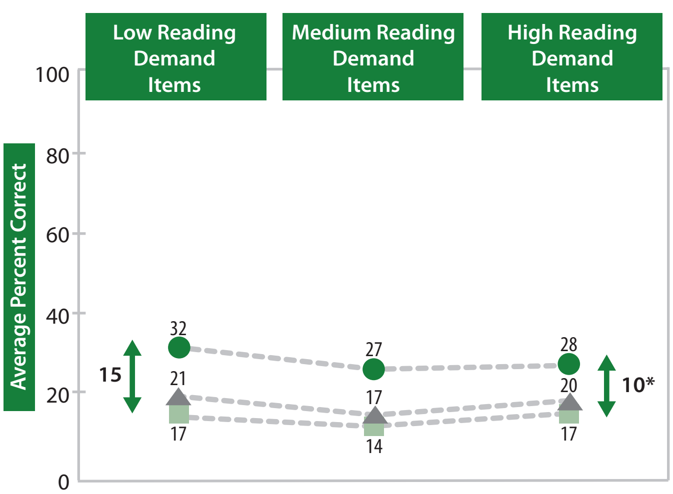
Lithuania



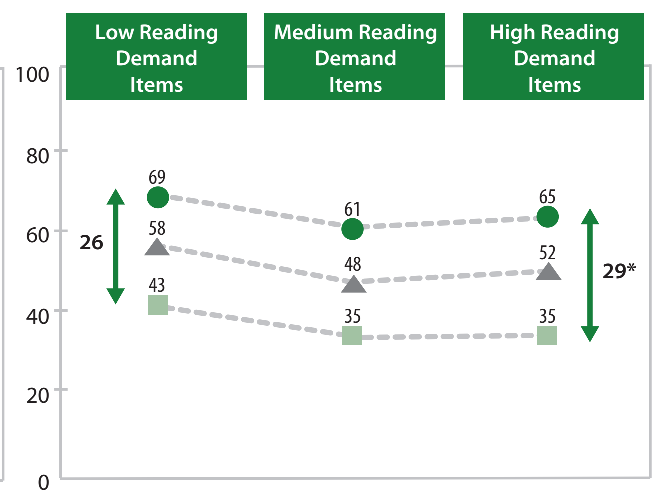
Malta



Morocco



Northern Ireland



● Upper Reading Tercile ▲ Middle Reading Tercile ■ Lower Reading Tercile

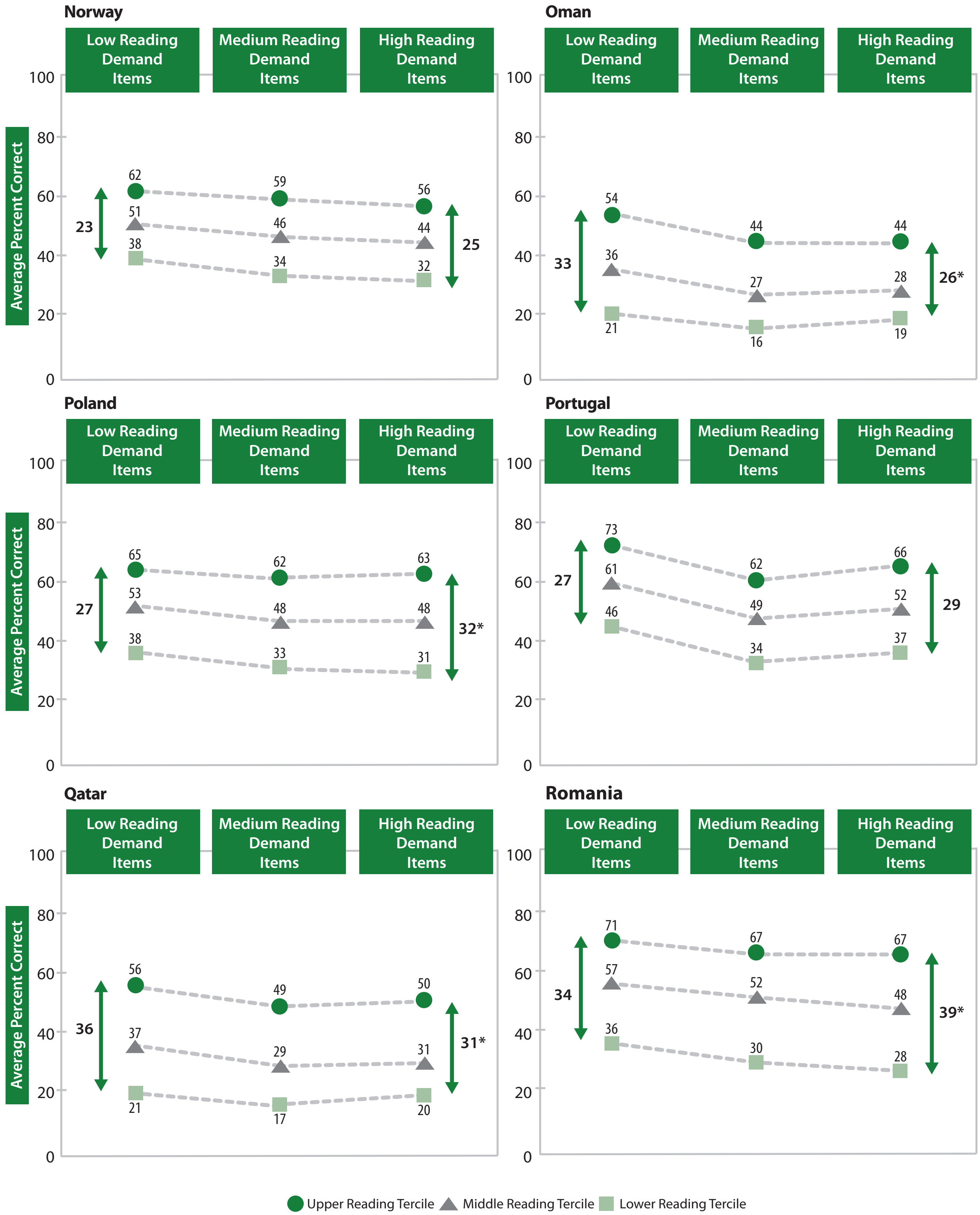
SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS and PIRLS 2011

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.

Because of rounding, some results may appear inconsistent.

Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands

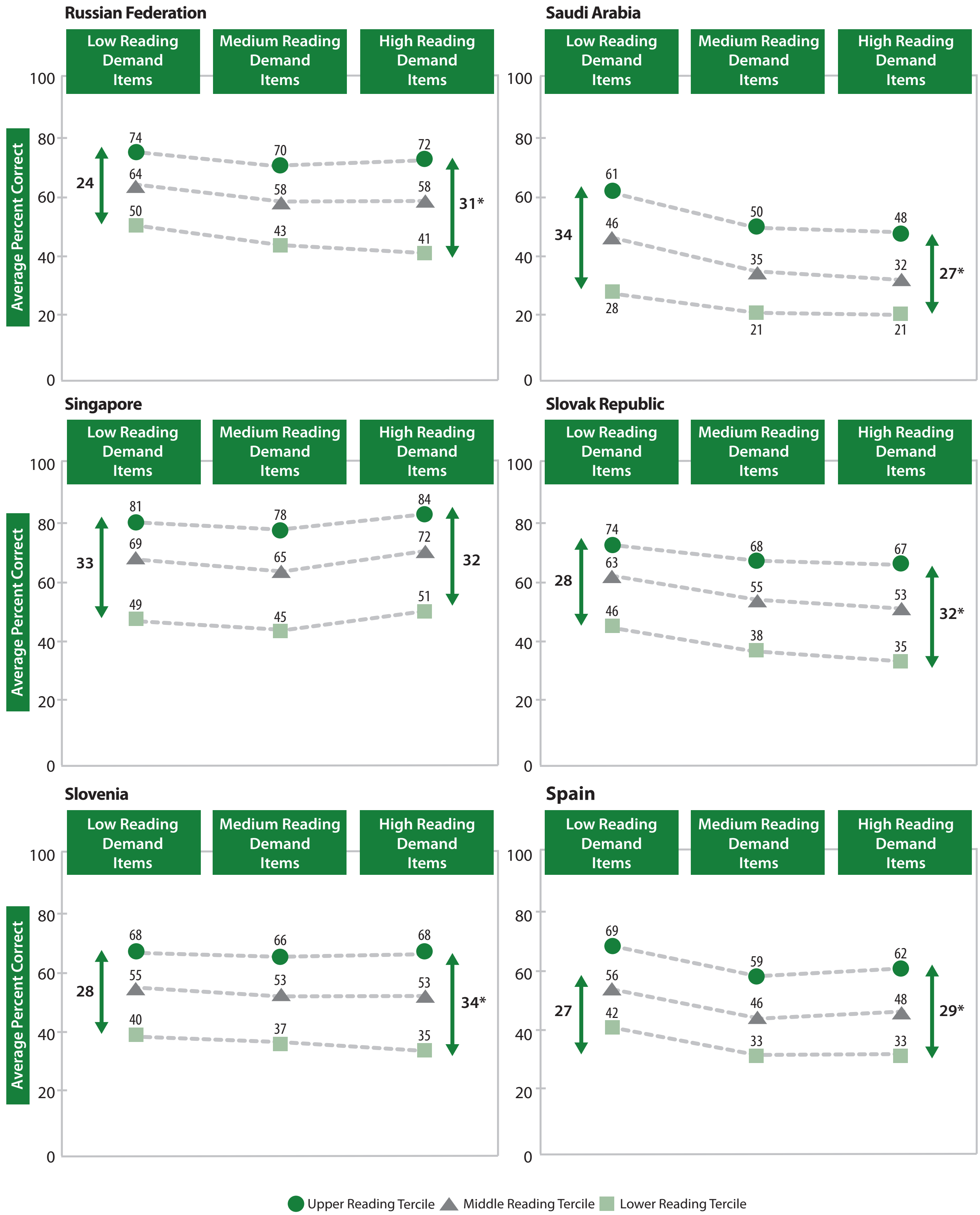


SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands

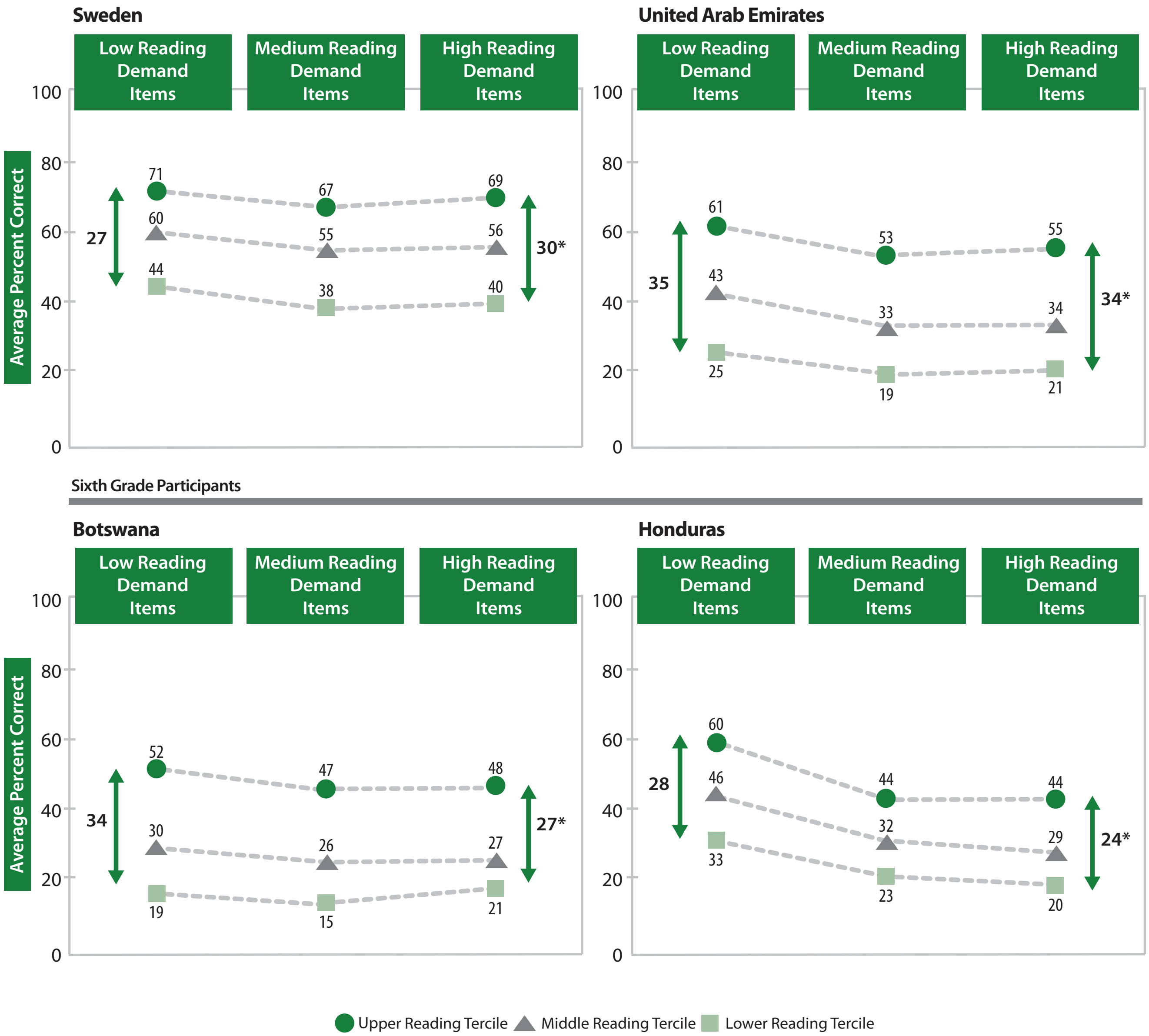


* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands



* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.

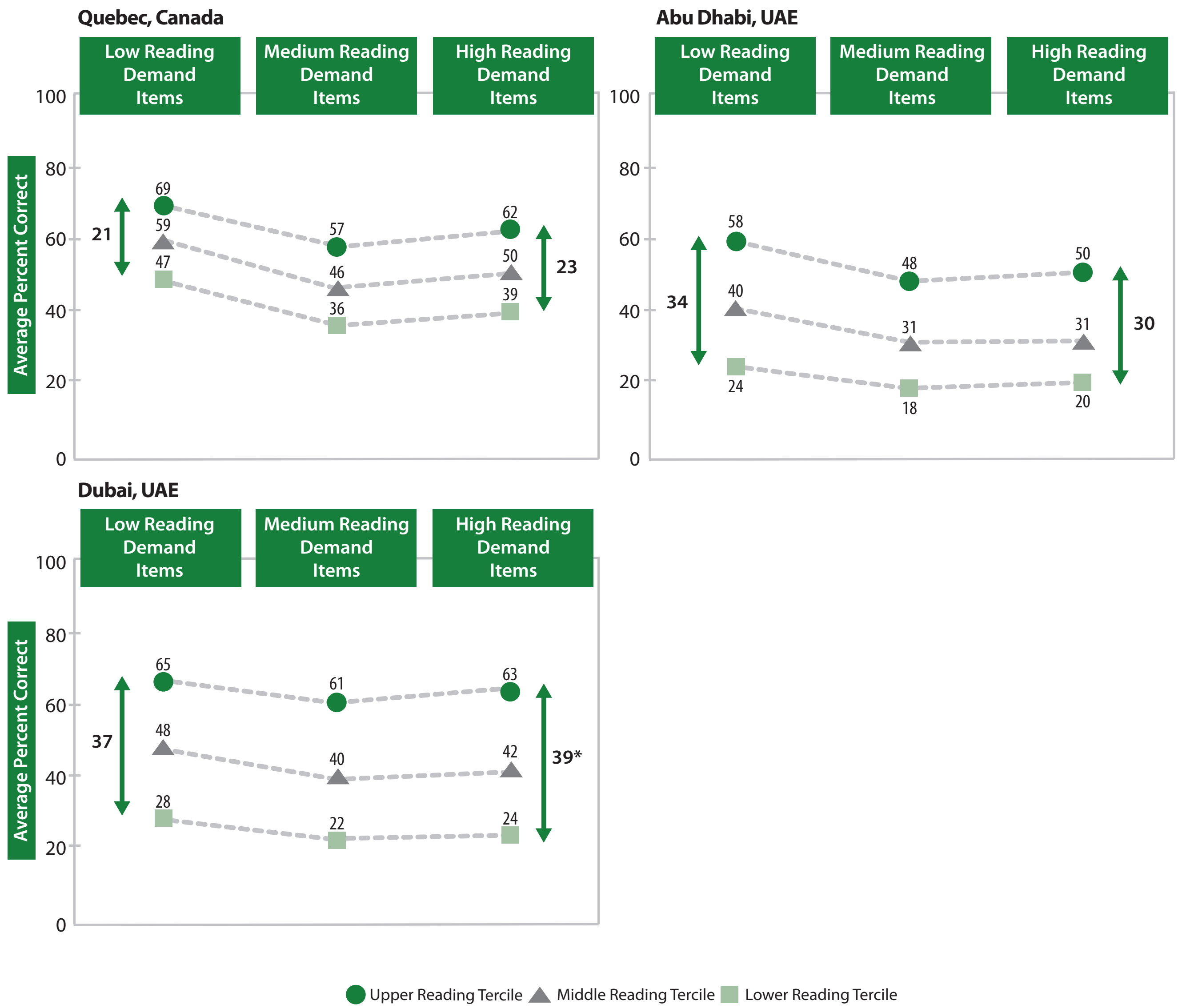
Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 2.13: Science Achievement, Country by Country—Fourth Grade (Continued)

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demands

Benchmarking Participants



* The inter-tercile difference for High Reading Demands is significantly different from the inter-tercile difference for Low Reading Demands.

Because of rounding, some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Considering the Results

This study hypothesized that the best readers would be unaffected by the reading demands of the items and therefore would perform similarly on the low, medium, and high demand items, whereas the poorest readers would perform relatively better on low demand items, and less well on high demand items. Some support for these hypotheses was found in the overall and country-by-country results, particularly in mathematics.

On average across countries, the mathematics achievement difference between poor and good readers was larger on the high reading demand items than on the low reading demand items. The average mathematics achievement of the best readers did not vary much by level of reading demands, whereas the average mathematics achievement of the least proficient readers was higher on the items with low reading demands than on the items with medium and high reading demands. While the poorest readers consistently achieved at a lower level in mathematics than the best readers, they were additionally disadvantaged on the mathematics items that required more reading.

Also, looking at the results for mathematics country by country, in nearly all instances the difference in average achievement between poor and good readers was larger on the high reading demand items than on the low reading demand items. That is, for most countries, better readers have a significantly greater advantage over poorer readers on mathematics items with high reading demands.

On average across countries in science, all three terciles of readers were similarly disadvantaged by more reading demands, so the gaps in achievement between the upper tercile of readers compared to the lower tercile of readers was similar at all three levels of reading demands. In addition, although achievement was higher on the items with low reading demands, there was little difference in the results between the medium and high reading demand items.

The country-by-country results in science showed that the difference in average achievement between poor and good readers was larger on the high reading demand items than on the low reading demand items in more than half of the countries. However, the difference also was approximately similar in a number of countries.

In summary, much was learned from this research regarding the challenges of educational measurement. Perhaps as a by-product, though still important, was developing procedures to look at the characteristics of the TIMSS fourth grade items through the lens of reading difficulty. In addition to the already lengthy checklists used to review items for various aspects of content validity and clarity, it is important to scrutinize the TIMSS items from the perspective of "mathematics reading" or "science reading" (e.g., the number of words, the number of different symbols, the load of the technical vocabulary, and the roles that are being played by visual displays).

More important, however, was gaining a deeper understanding of the extreme complexity of the educational endeavor and all of its interconnected parts. Students all over the world are learning mathematics and science, but they are learning these subjects in different ways. In particular, as this research has highlighted, curricular and instructional differences experienced by students can impact item difficulty. As we know, countries' mathematics and science curricula vary considerably, and the different amounts of emphasis placed on the topics covered has a powerful influence on student learning as well as on student achievement on TIMSS. Beyond that, instructional differences among countries not only affect achievement in the content domains, but also in the cognitive domains. There is an interrelationship between cognitive domain and reading demands, insofar as assessing in-depth content understanding and increased cognitive complexity generally involves greater reading demands; thus, TIMSS mathematics and science items become more difficult for a variety of reasons.

Especially relevant to educational research and policy broadly, though, is that reading is fundamental to further learning. It makes good sense that students who are better readers are therefore better positioned to learn more in mathematics and science as well as in their other subjects. Although the results of this study varied considerably from country to country, and even between mathematics and science within countries, the study showed reading ability to be associated with mathematics and science achievement to an extent that provides support for the idea that greater reading demands can make the fourth grade TIMSS items more challenging for weaker readers. Extrapolating this idea into the broader educational arena raises the question of how much reading intervention might influence learning across the curriculum.

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Chapter 3

Effective Schools in Reading, Mathematics, and Science at the Fourth Grade

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Boston College

Introduction

Results from several cycles of TIMSS and PIRLS as well as from considerable research conducted around the world have demonstrated the consistency of a number of fundamental school factors being associated with higher achievement across the school subjects of reading, mathematics, and science. Data gathered from the 34 countries and 3 benchmarking entities that conducted the TIMSS and PIRLS 2011 assessments with the same fourth grade students present a unique opportunity to study relative school effectiveness across countries in reading, mathematics, and science. This chapter examines how these

1 The authors are indebted to Henry Braun for his many insightful suggestions during the preparation of this chapter.

important school factors operate across countries at the fourth grade and vary in an international context.

The TIMSS 2011 fourth grade assessments in mathematics and science and the PIRLS 2011 assessment in reading comprehension provide comprehensive, robust achievement measures in these three core learning areas. The assessments were based on comprehensive frameworks developed collaboratively with the participating countries, and included large numbers of items to assess these frameworks (175 items in mathematics, 168 items in science, and 130 items in reading). For each country, the data are based on nationally representative samples of students. Altogether, nearly 200,000 students took part in TIMSS and PIRLS 2011, with each student assessed in all three of the core school subjects.

In addition to comprehensive assessments of achievement, TIMSS and PIRLS 2011 each included an array of background questionnaires to collect information about the contexts for teaching and learning in each of the participating countries. The context questionnaires administered to school principals, teachers, and students were designed to collect a range of information about school environments, school resources, teacher preparation, and classroom instruction. In addition, a questionnaire for parents collected information about students' home environment. The TIMSS and PIRLS 2011 participants jointly developed the questionnaires, and the response data were used to create new TIMSS and PIRLS context questionnaire scales using IRT methods. These scales measure important school factors, such as academic climate, resource adequacy, school safety, curricular emphasis, and instructional engagement, as well as aspects of the home environment. The context questionnaire scales were developed in parallel across reading, mathematics, and science, and provide a solid foundation for studying the relative effectiveness of school and classroom contexts for teaching and learning.

This chapter is intended to illustrate the power of the TIMSS and PIRLS 2011 data for studying school effectiveness by exploring relationships among school environment and instruction, student home background, and student achievement in reading, mathematics, and science in the participating countries. As such, the study is not intended to be a definitive analysis of the factors associated with effective schools in each country. Rather, this chapter presents an analytic framework that could provide an overview of how these relationships vary across countries and be used as a starting point for more detailed analyses within countries.

School Effectiveness Analyses

School effectiveness analyses seek to improve educational practice by studying what makes for a successful school beyond having a student body where most of the students are from advantaged socioeconomic backgrounds. Using this approach, an effective school is one that has an effect on student achievement over and above home influences. From an analytic perspective, school effectiveness studies make use of multilevel modeling in order to analyze the relationship between school factors and achievement after controlling for the influences of students' home backgrounds. Because TIMSS and PIRLS 2011 included a home questionnaire completed by students' parents and primary caregivers, the data provide considerable information about students' home environments. This study uses these data to examine the effects of home environment on students' achievement and then to control for those effects in looking at the school factors. Examining students' schooling in the light of home factors can help to better understand the interaction between home and school effects.

According to Sammons (2007), researchers have been examining different aspects of school effectiveness in order to improve educational outcomes for students for more than 40 years; further, while definitions of school effectiveness vary, most researchers agree that, when comparing schools with similar student populations, an effective school is one that "adds extra value" to student achievement. That is, the characteristics students have when entering school are strongly associated with achievement and should be explicitly controlled in the analysis model in order to better isolate the effects of a school. An effective school has the capacity to improve students' achievement despite the characteristics of the student body.

Teddlie and Reynolds (2000) have traced the origins of school effective research back to the mid-1960s in the United States when most educational research involved investigating the relationship between inputs (human and physical resources) and outputs (student achievement). A school was defined by its material resources, and differences in student achievement were attributed to unequal opportunities in terms of school environments (Scheerens & Bosker, 1997). However, because school differences primarily were attributed to student background characteristics rather than educational practices, educational researchers were criticized for not measuring the educational processes within schools (Teddlie & Reynolds, 2000). In addition, the lack of sophisticated methodology prevented researchers from making fair comparisons between schools (Creemers, Kyriakides, & Sammons, 2010).

In the 1980s, more contextual factors (e.g., psychological scales) and more sensitive outcome measures were used in school effectiveness research (Townsend, 2007). Also, advances in computing technology had made computer programs for multilevel modeling more widely available (Teddlie & Reynolds, 2000). The most notable improvement in school effectiveness research, according to Rumberger & Palardy (2004), was using multilevel modeling to estimate the effects of factors on student outcomes more accurately, by looking at the effects at different levels in the education system (i.e., the student level, classroom level, and school level).

School effectiveness research distinguishes itself from other strands of educational effectiveness research, such as economically oriented studies and instructional effectiveness studies, by focusing on the importance of differences between schools (Scheerens & Bosker, 1997). Research investigating school differences focuses on the aspects of schools that have an influence on achievement so that the results can be used to suggest improvements and shape reform policies. As such, school effectiveness research uses the school as the major unit of change in educational reform (Teddlie, 2010).

A Strong Conceptual Model

Like all studies of cross-sectional survey data, the statistical modeling conducted for this study is crucially dependent on the naturally-occurring variation and covariation in the data. The assumption is that expected relationships between variables will be reflected in observable patterns in the data. However, education systems are the result of management and development over many years, and often the variables of interest have been manipulated to achieve policy goals, so that expected relationships may not be apparent in the data. For example, the school system may be organized so that there is little difference between schools in the achievement of their students, making it difficult to relate school factors to student achievement. Similarly, there may be particular factors, such as instructional time, that are the same for all the schools in a country and consequently cannot play a role in a statistical model for that country. In this situation, it is important to have a strong conceptual model based on a clear vision of the essential characteristics of effective schools in order to guide the analysis.

This study of school effectiveness is deeply rooted in considerable work studying the factors that influence school quality, as documented in the *TIMSS 2011* and *PIRLS 2011 Contextual Frameworks* (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009; Mullis, Martin, Kennedy, Trong, & Sainsbury, 2009). Building on that body of research, the *TIMSS 2011 Results in Mathematics* (Mullis, Martin, Foy, & Arora, 2012), the *TIMSS 2011 Results in Science* (Martin, Mullis, Foy, & Stanco, 2012), and the *PIRLS 2011 Results in Reading* (Mullis, Martin, Foy, & Drucker, 2012) showed that students with the highest achievement typically attended schools that emphasize academic success, as indicated by rigorous curricular goals, effective teachers, students that desire to do well, and parental support. Students that attended schools with disorderly environments and reported more frequent bullying had much lower achievement than their counterparts in safe and orderly schools. Exhibit 3.1 presents this study's conceptual framework of school effectiveness, informed by the latest results from TIMSS and PIRLS 2011 as well as the existing body of school effectiveness research.

Exhibit 3.1: Model of Effective Schools

Strongly supported by the research, this study maintains a firm conviction that effective schools:
Are Safe and Orderly
Support Academic Success
Have adequate facilities and equipment
Are staffed with well-prepared teachers
Have well-resourced classrooms
Provide effective instruction

First, TIMSS and PIRLS 2011 results showed that students who attended schools with disorderly environments and who reported more frequent bullying had much lower achievement than their counterparts in safe and orderly schools. It makes sense that for a school to be effective, it needs a safe and orderly environment, and that schools with considerable disciplinary problems are not conducive to higher student achievement. When students and teachers are fearful and worried about their safety, it is difficult to maintain a strong focus on academics.

Second, students with the highest achievement in TIMSS and PIRLS 2011 typically attended schools that emphasized academic success. In order to achieve excellence, it is not enough to simply "keep order"; the school administration and teachers as well as the students and their parents must press for academic success. A school with a positive atmosphere supportive of high achievement and a rigorous academic program can even overcome socioeconomic disadvantages (McGuigan & Hoy, 2006). From this perspective, schools need to communicate their academic emphasis through clear and rigorous academic goals, and school administrators and teachers need to support these goals and believe that students can attain them. The effect of aiming for students' high achievement is greatest when there is a collective influence, including parents and the students themselves.

Third, TIMSS and PIRLS and many other studies have shown that resources are crucial for effective schooling, perhaps even more so in developing countries than in economically developed countries. The 2011 data showed that students in schools not affected by resource shortages had higher average achievement than their counterparts in less well-resourced schools. Successful schools are likely to have better working conditions and facilities, such that the physical environment is structurally sturdy, big enough, well-maintained, and comfortable (e.g., temperature and lighting). Additionally, effective schools have more instructional materials, such as books, computers, technologically innovative instructional aids, and equipment and supplies (everything from basic paper and pencils to science laboratory equipment).

Fourth, although the school environment and facilities can provide important support for teaching and learning, teacher quality is essential because most instruction is provided directly to students by classroom teachers. There is growing evidence that teacher preparation is a powerful predictor of students' achievement, perhaps even overcoming socioeconomic and language background factors (Darling-Hammond, 2000). To engage students in learning, teachers need to be well-prepared such that they have a solid mastery of the content in the subject to be taught and a repertoire of effective pedagogical approaches. In TIMSS 2011, higher achievement was related to teachers' having more teaching experience, being confident in their teaching, and being satisfied with their careers. The majority of fourth grade students had teachers with bachelor's degrees, and most had teachers that reported having at least ten years of teaching experience, being very well prepared to teach their subject matter, and feeling very confident in their teaching.

Fifth, teachers need well-resourced classrooms. There are many resources that can facilitate classroom teaching, such as textbooks, computers, instructional software, and equipment for various projects. There also are some materials associated with instruction in specific subjects. For example, because having students read books and a variety of different types of materials is fundamental to developing their reading comprehension skills and strategies, a number of educational systems have invested in classroom libraries so that children can have ready access to books and magazines as part of their reading lessons and activities. Similarly, access to calculators and a variety of manipulative materials can be important to mathematics instruction, and science equipment, models, and materials can be central to science instruction.

Sixth, teachers need to provide effective, engaging instruction. Teachers who are well-prepared and well-resourced most likely would be in the best position to provide effective, engaging instruction. According to work supported by the US Center for Education Statistics (McLaughlin et al., 2005), student engagement focuses on the importance of the activity that brings the student and the subject matter content together. Engagement refers to the cognitive interaction between the students and instructional content, and this interaction can be stimulated by any instructional approach. What matters is students' in-the-moment cognitive interaction with the instructional content such that learning takes place. Of course, if students are being involved in the instruction in some way, even by attentive listening, then there is a much higher likelihood of engagement and learning. In TIMSS and PIRLS 2011, internationally, the fourth grade students who were "engaged" in their mathematics, science, and reading lessons had the highest achievement, followed by those "somewhat engaged," and then those few students "not engaged" with much lower achievement.

Measures of School Effectiveness

The large amount of background data collected in TIMSS and PIRLS 2011 was reviewed in order to select the school effectiveness measures to include in the present study. As a fundamental selection criterion, the measures needed to address school characteristics included in the conceptual model. In addition, because the idea was to study relative effects across reading, mathematics, and science, the measures needed to be available in parallel across all three subjects. Also, as much as possible, measures needed to be consistently related to higher achievement at the fourth grade across the three subject areas and across the participating countries. Finally, as matter of reliability and efficiency, it was decided primarily to use or modify scales that were included in the TIMSS and PIRLS 2011 international reports.

In the end, 11 context questionnaire scales were selected for inclusion in the analysis and combined into five robust school effectiveness measures: three measures of effective school environment, and two measures of effective school instruction. In general, each of the five measures of school effectiveness was based on a school average of several context questionnaire scales, with each context questionnaire scale typically including about six questions/statements. The components of the five school effectiveness measures are described in the following sections, with further detail available in *Technical Appendix B: School Effectiveness Models and Analyses*.

School Environment

Following this study's conceptual model, the school effectiveness analyses include three measures of school environment:

- Schools are safe and orderly;
- Schools support academic success; and
- Schools have a physical environment and resources that are adequate for learning.

Schools Are Safe and Orderly

The measure of a school being safe and orderly was the school average of three different context questionnaire scales measuring school safety: one based on principals' reports of discipline problems in the school, one based on teachers' reports of school safety, and one based on students' reports of being bullied.

School Discipline and Safety Scale—Principals' reports of "hardly any problems," "minor problems," or "moderate problems" concerning 10 potential school problems:

- Students arriving late at school;
- Student absenteeism (i.e., unjustified absences);
- Classroom disturbances;
- Cheating;
- Profanity;
- Vandalism;
- Theft;
- Intimidation or verbal abuse among students (including texting, emailing, etc.);
- Physical fights among students; and
- Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.).

Safe and Orderly School Scale—Teachers' degree of agreement with the following five statements:

- This school is located in a safe neighborhood;
- I feel safe at this school;
- This school's security policies and practices are sufficient;
- The students behave in an orderly manner; and
- The students are respectful of the teacher.

Students Bullied at School Scale—Students' reports about how often they experienced the following six bullying behaviors:

- I was made fun of or called names;
- I was left out of games or activities by other students;
- Someone spread lies about me;
- Something was stolen from me;
- I was hit or hurt by other students (e.g., shoving, hitting, kicking); and
- I was made to do things I didn't want to do by other students.

Schools Support Academic Success

The measure of a school's degree of support for academic success was the school average of two context questionnaire scales. In this case, teachers and principals provided responses to the same emphasis on academic success scale.

Teachers' Reports, School Emphasis on Academic Success—Teachers' responses characterizing five aspects of their school as Very High, High, or Medium:

Principals' Reports, School Emphasis on Academic Success—Principals' responses characterizing five aspects of their school as Very High, High, or Medium:

- Teachers' understanding of the curricular goals;
- Teachers' degree of success in implementing the school's curriculum;
- Teachers' expectation for student achievement;
- Parental support for student achievement; and
- Students' desire to do well in school.

Adequate Environment and Resources

This effective schools measure was the school average of two context questionnaire scales: one based on teachers' views of their working conditions, and the other based on principals' perceptions of the degree to which the school facilities and resource availability were affecting the quality of instruction.

Teacher Working Conditions Scale—Teachers' reports that they had "Hardly Any Problems," "Minor Problems," or "Moderate Problems" concerning five potential problem areas:

- The school building needs significant repair;
- Classrooms are overcrowded;
- Teachers have too many teaching hours;
- Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students); and
- Teachers do not have adequate instruction materials and supplies.

School Resource Shortage Scale—Principals' responses about whether instruction was "Not Affected," "Somewhat Affected," or "Affected A Lot" by resource shortages in four areas: A. general school resources (six questions); B. mathematics resources (six questions); C. science resources (six questions); and D. reading resources (five questions). Although this entire set of questions was presented together to principals and analyzed as a single scale for this analysis, three separate scales were created for the three international reports containing the mathematics, science, and reading results (i.e., the general and mathematics questions, the general and science questions, and the general and reading questions).

Section A—General School Resources

- Instructional materials (e.g., textbooks);
- Supplies (e.g., paper, pencils);
- School buildings and grounds;
- Heating/cooling and lighting systems;
- Instructional space (e.g., classrooms); and
- Technologically competent staff.

Sections B, C, and D—Subject specific resources (Mathematics, Science, and Reading, respectively). Sections B, asking about mathematics, and C, asking about science, contained the same six questions. Section D, asking about reading, contained five of the six questions, the exception being "calculators for instruction":

- Teachers with a specialization in the subject;
- Computers for instruction;
- Computer software for instruction;
- Library materials for instruction;
- Audio-visual resources for instruction; and
- Calculators.

School Instruction

Selecting school effectiveness measures of classroom instruction was more challenging, because the TIMSS and PIRLS 2011 background data and context questionnaire scales about teacher quality and instructional engagement are less well developed than the data about school climate and resources. However, two indicators of instructional effectiveness are included in the school effectiveness models. The school effectiveness measures of school instructional quality are as follows:

- Early curricular emphasis on higher order reading processes; and
- Students engaged in reading, mathematics, and science lessons.

Early Curricular Emphasis on Reading Skills

This measure is one of the context questionnaire scales developed for PIRLS 2011.

Emphasis in Early Grades on Reading Skills and Strategies—Principals' responses about the earliest grade at which each of 11 reading skills and strategies were emphasized.

- Reading isolated sentences;
- Reading connected text;
- Locating information within the text;
- Identifying the main idea of a text;
- Explaining or supporting understanding of a text;
- Comparing a text with personal experience;
- Comparing different texts;
- Making predictions about what will happen next in a text;
- Making generalizations and drawing inferences based on a text;
- Describing the style or structure of a text; and
- Determining the author's perspective or intention.

Student Engaged in Reading, Mathematics, and Science Lessons

The measure of student engagement in instruction was the school average across three context questionnaire scales measuring students' engagement in their lessons: one for reading, one for mathematics, and one for science. Students reported separately about their mathematics and science lessons in terms of their degree of agreement with the five statements listed below:

Students Engaged in Lessons—Students' degree of agreement with five statements about their instruction:

- ♦ I know what my teachers expect me to do;
- ♦ I think of things not related to the lesson (reverse coded);
- ♦ My teacher is easy to understand;
- ♦ I am interested in what my teacher says; and
- ♦ My teachers gives my interesting things to do.

Students also reported about their reading lessons using the same scale but beginning with two questions specific to their reading materials.

Students Engaged in Reading Lessons—Students' degree of agreement with seven statements about their instruction:

- ♦ I like what I read about in school;
- ♦ My teacher gives me interesting things to read;
- ♦ I know what my teachers expect me to do;
- ♦ I think of things not related to the lesson (reverse coded);
- ♦ My teacher is easy to understand;
- ♦ I am interested in what my teacher says; and
- ♦ My teachers gives my interesting things to do.

Examining the Effects of Student Home Environment

Considerable research has shown that higher levels of school resources are associated with higher achievement. However, the relationship between school resources and student achievement is complicated. On one hand, as described earlier under the discussion of the adequacy of school facilities and instructional resources, a school can invest more money for such things as facilities, teachers' salaries, equipment, and materials. On the other hand, a school can have a more socioeconomically advantaged student population that has access to more resources, for example, because of its location or because it competes for students. The home backgrounds of students attending a school can be closely related to the learning environment of the school, with the two reinforcing each other and being strongly linked to academic achievement. Students from higher socioeconomic backgrounds are likely to be healthy and come to school better fed and clothed than their more disadvantaged counterparts. Students from home backgrounds supportive of learning are likely to have more positive attitudes toward learning, and perhaps, even better discipline. They are likely to come to school already having the prerequisite literacy and numeracy skills necessary for advancing in the curriculum. Beyond that, parents that have high educational expectations for their children are more likely to take an active interest in the quality of teachers, the adequacy of school facilities, and the availability of school resources.

In actuality, it is impossible to disentangle the effect of students' home environment on their educational achievement from the effect of their schooling on their educational achievement. However, it is possible to apply statistical models to the data that make predictions about the likely effect of the school variables on student achievement if all students came from equivalent home backgrounds.

Description of the Home Background Variables

Two home background context questionnaire scales from TIMSS and PIRLS 2011 were used to describe students' home environment:

- Home Resources for Learning Scale; and
- Could Accomplish Early Literacy/Numeracy Tasks When Entered School.

The **Home Resources for Learning Scale** is based on five different questions: two questions included in the student questionnaire, and three questions included in the home questionnaire completed by students' parents and primary caregivers. Students were scored according to their own and their parents' responses concerning the availability of the five resources listed below.

Number of books in the home (students' responses)

1. 0–10
2. 11–25
3. 26–100
4. 101–200
5. More than 200

Number of home study supports (students' responses)

1. None
2. Internet connection or own room
3. Both Internet and own room

Number of children's books in the home (parents' responses)

1. 0–10
2. 11–25
3. 26–50
4. 51–100
5. More than 100

Highest level of education of either parent (parents' responses)

1. Finished some primary or lower secondary or did not go to school
2. Finished lower secondary
3. Finished upper secondary
4. Finished post-secondary education
5. Finished university or higher

Highest level of occupation of either parent (parents' responses)

1. Has never worked outside the home for pay, general laborer, or semi-professional (skilled agricultural or fishery worker, craft or trade worker, plant or machine operator)
2. Clerical (clerk or service or sales worker)
3. Small business owner
4. Professional (corporate manger or senior official, professional, or technician or associate professional)

Early Literacy/Numeracy Tasks was the student's average of their scores on two early learning scales: Could Do Early Literacy Tasks When Began Primary School, and Could Do Early Numeracy Tasks When Began Primary School.

Could Do Early Literacy Tasks When Began Primary School—Students were scored according to the parents' responses to how well (i.e., "Very Well," "Moderately Well," "Not Very Well," or "Not at All") their child could do five early literacy activities when he/she began primary/elementary school:

- ♦ Recognize most of the letters of the alphabet;
- ♦ Read some words;
- ♦ Read sentences;
- ♦ Write letters of the alphabet; and
- ♦ Write some words.

Could Do Early Numeracy Tasks When Began Primary School—Students were scored according to their parents' responses to how well their child could do six early numeracy tasks, as shown below.

Could your child do the following when he/she began primary/elementary school?

1. Count by himself/herself (Up to 100 or higher, Up to 20, Up to 10, Not at all)
2. Recognize different shapes (e.g., square, rectangle, circle)
3. (More than 4 shapes, 3–4 shapes, 1–2 shapes, None)
4. Recognize the written numbers from 1–10 (All 10 numbers, 5–9 numbers, 1–4 numbers, None)
5. Write the numbers from 1–10 (All 10 numbers, 5–9 numbers, 1–4 numbers, None)
6. Do simple addition (yes or no)
7. Do simple subtraction (yes or no)

The School Effectiveness Analysis

In building an analytical model that shows the relationship between school variables and student achievement while controlling for the effects of home environment, it is important to recognize that these effects can operate at two levels: at the individual level through the direct effect of home environment on achievement, and at the school level through the effect of attending school with other students from similar advantaged or disadvantaged home backgrounds. Recognizing that, in any given school, students vary in their home backgrounds and also that schools can vary in the composition of their student body, this study adopted a two-level approach to statistically adjusting for home background differences, whereby both the differences between students within each school and the average differences between schools were explicitly modeled. This analysis shows the predicted effect on student achievement in reading, mathematics, and science of simultaneously adjusting the data so that all students in each school have equivalent home backgrounds and all schools have equivalent average home background. Although the analysis for each subject was based on a single model that controlled for both student-within-school and between-school differences, the results are presented separately so that the relative magnitude of their effects can be examined.

To investigate how the characteristics of effective schools were associated with achievement in reading, mathematics, and science, this study made use of multilevel regression modeling (also known as hierarchical linear modeling). This type of prediction modeling allows characteristics of persons (such as students) and groups (such as schools) to be included together to predict individual-level outcomes, while accounting for the clustering of individuals in groups and maintaining correct standard errors for testing the significance of the relationships (Raudenbush & Bryk, 2002). The goal of the analyses was to examine how the characteristics of effective schools were associated with achievement in reading, mathematics, and science across countries, and whether schools in some countries were relatively more effective in one or two of these subjects than the others.

Separately for each country, and for reading, mathematics, and science within each country, a series of multilevel regression models was formulated, each comprising a combination of the school explanatory measures and the student and school control variables. These models were used to describe how the school explanatory measures were associated with achievement, both before and after controlling for home background at student and school level. Specifically, for reading, mathematics and science, the models were grouped into three blocks, as described below.

School Explanatory Models

These models included the School Environment and School Instruction measures, separately and together, and were formulated in order to investigate the relationship between the school explanatory variables and student achievement in reading, mathematics, and science without reference to student home environment.

Home Background Control Model

This model included the Home Resources and Early Literacy/Numeracy measures together, and was formulated to investigate the relationship between home environment at the student and school level and student achievement in reading, mathematics, and science.

School Explanatory with Control Models

Combining the School Explanatory models and the Home Background Control model, these models were formulated to investigate the relationship between the school explanatory variables, separately and together, and student achievement in reading, mathematics, and science, after controlling for the home background characteristics of individual students within the school and of the student body of the school.

These multilevel regression models provided the detailed information needed to conduct a school effectiveness analysis of student achievement in reading, mathematics, and science.

Interpreting the Multilevel Regression Models

The regression coefficients in the multilevel models show the estimated effect of each predictor (school or student) variable, and are interpreted in the same way as an ordinary least squares regression coefficient; that is, for every one unit increase in the predictor variable, the outcome variable (student achievement) is predicted to increase or decrease by an amount indicated by the size and direction of the associated regression coefficient, holding all else constant. The regression coefficients are in the metric of the TIMSS and PIRLS achievement scales, in which 100 scale score points corresponds approximately to one standard deviation within a country.[2] The magnitude and direction of the regression coefficients in the models and the significance of the difference from zero indicate the relationship between each predictor and achievement, holding all else in the model constant.

The percentage of variance explained by the predictors in the models is a useful summary of the strength of the relationship between the predictors and achievement in reading, mathematics, and science. The percentage of variance explained can be interpreted as the extent to which the variance in student achievement would be reduced if the data were adjusted so that all students had the same value on the predictor variable. For each country and separately for reading, mathematics, and science, the total student variance is decomposed into the percentages due to differences between schools (i.e., the extent to which schools differ in the average achievement of their students) and the differences between students within the schools. In the multilevel regression models, school-level predictors were added to explain school-to-

2 The TIMSS achievement scales were established by TIMSS 1995, the first TIMSS assessment, so that 100 scale score points was equal to one standard deviation across all participating countries, and the scale centerpoint of 500 was equal to the mean score across countries. Scales were established separately by grade and for mathematics and science. Subsequently, data from TIMSS 1999, TIMSS 2003, TIMSS 2007, and TIMSS 2011 were placed on the TIMSS scale. Similarly, the PIRLS achievement scale was constructed so that 100 points was equal to the standard deviation across all countries that participated in PIRLS 2001, the first PIRLS assessment, and the centerpoint of 500 was set to the mean across countries.

school differences in achievement. The percentage of variance explained by the school-level predictors and by the school-level measures was combined as the percentage of total variance in achievement explained, information that is analogous to an R^2 statistic. A detailed description of the analysis procedures, the types of information provided by the models, and guidance on the interpretation of the findings are presented in *Technical Appendix B: School Effectiveness Models and Analyses*.

Results

The multilevel regression modeling was conducted separately for reading, mathematics, and science for each country. As a prelude to these analyses, Exhibits 3.2 through 3.4 present, for reading, mathematics, and science, respectively, the decomposition of total student achievement variance into the percentages due to differences between schools and the differences within schools, together with the school-level correlations of each of the five school explanatory variables with achievement. The school-level correlations represent the correlation between the school score on the school explanatory variables and average student achievement in the school.

According to the conceptual model for this study, student achievement should be higher in schools that are safe and orderly, have strong support for academic success, have adequate environment and resources, have a rigorous curriculum as evidenced by an early emphasis on reading skills, and where students are engaged in their reading, mathematics, and science lessons. On the basis of this model, the school-level correlations between each of these variables and student achievement should be positive and substantial in each country, because they represent the basic relationship between each school variable and average school achievement, without any statistical controls or adjustments. In fact, as shown in the exhibits, the correlations varied quite a lot both across countries and across the five explanatory variables. The correlations for reading, mathematics, and science were similar, on average, across countries and variables, although there were differences among individual countries.

Among the School Environment variables, school-level correlations were strongest for **Schools Support Academic Success**, with average correlations across countries of 0.34 to 0.35 for the three subjects. There was considerable variation within countries, however, with highest correlations in Botswana (0.61 to 0.62 across reading, mathematics, and science) and the lowest correlations in Italy (0.04 to 0.10). Correlations for **Schools are Safe and Orderly** were next highest, on average, ranging from 0.28 to 0.29 across the subjects, with the highest correlations in Australia (0.54 to 0.55) and the lowest in Poland (–0.07 to 0.14). Correlations were lower for the third School Environment variable, **Adequate Environment and Resources**, averaging 0.09 to 0.10 across countries. Correlations were highest in Qatar (0.33 to 0.39) and lowest in Croatia and the Czech Republic (–0.12).

With respect to the two School Instruction variables, school-level correlations were highest for **Students Engaged in Reading, Mathematics, and Science Lessons**, with an average correlation across countries of 0.15 to 0.16 for the three subjects. Correlations were highest in Botswana (0.59 to 0.64) and lowest in Poland (–0.19 to –0.23). In general, the lowest school-level correlations were for the School Instruction variable **Early Emphasis on Reading Skills**, with average correlations across countries of 0.07 to 0.08 for the three subjects. Correlations were highest in Dubai, UAE (0.48 for each subject) and lowest in Portugal (–0.10 to –0.12).

Country-by-Country Analyses

The results for individual countries are presented in Exhibits 3.5 through 3.41, with one exhibit for each country. The school explanatory and home background control variables are listed as rows in the upper part of each exhibit, and the regression coefficients for the School Explanatory models, the Home Background Control model, and the School Explanatory with Control models as columns intersecting the rows. Results are included for reading, mathematics, and science for each model. Each regression coefficient is presented together with its standard error and an indicator of whether it differs significantly from zero. The lower part of each exhibit shows the variance decomposition (between and within schools) for each of the multilevel regression models, separately for reading, mathematics, and science.

As an example of how the results of the school effectiveness analysis may be interpreted, the results for Australia, the first in the individual country presentations (Exhibit 3.5), are described in some detail. The Australian data show evidence of considerable differences among schools in student achievement (about one fourth of the total student variance—similar to the average across all countries), as well as strong relationships between the school environment and instruction variables and student achievement, and so are ideal for discussing the interpretation of results. The results for Botswana (Exhibit 3.37) also are described in detail. Botswana is a good example of a country where student achievement differs considerably from school to school, and where school factors are related to student achievement even after controlling for student home background—i.e., some schools may be considered to be more "effective" than others.

School Explanatory Models—Australia

As discussed earlier, according to the conceptual model underpinning the effective schools analysis, student achievement in reading, mathematics, and science should be higher in schools that are safe and orderly, support academic success, and have adequate environment and resources than in schools that are deficient in one or more of these areas. The data show support for this proposition for Australia, with school-level correlations of 0.54 to 0.55 across the subjects for **Schools are Safe and Orderly**, 0.43 to 0.44 for **Schools Support Academic Success**, and 0.28 for **Adequate Environment and Resources** (see Exhibits 3.2, 3.3, and 3.4).

As shown in the lower part of Exhibit 3.5, there were considerable differences among schools in Australia in the achievement of their students, with 23 percent of the total variance in reading achievement and 28 percent of the total variance in mathematics and science achievement due to differences between schools and available to be explained by school-to-school differences in the explanatory variables.

The School Environment model (the first column of data in Exhibit 3.5) shows for each subject the predicted relationship with achievement of each of the three school environment variables when combined in a single model. This model reflects not only the relationship between the school environment variables and achievement but also any correlations among the school environment variables. In the Australian data, as might be expected given the school-level correlations, being in a safe and orderly school was the strongest predictor of achievement in each of the three subjects, with regression coefficients of 20 to 21 points after controlling for the other two variables. Being in a school that supported academic success also was a significant predictor, with regression coefficients of 6 points in each subject. However, the model shows no effect for being in a school with adequate environment and resources. Presumably, when the model statistically adjusts the data so that the schools have the same degree of orderliness and same level of support for academic success, any variation in environment and resources is eliminated. The school environment variables explained between 41 and 43 percent of the school-to-school differences in reading, mathematics, and science scores in Australia, or between 10 and 12 percent of the total variance, suggesting that removing all differences in school environment would reduce total achievement differences by this amount.

In accordance with the conceptual model, the School Instruction model for Australia predicts that students in schools where the student body was engaged in their lessons would have higher reading, mathematics, and science scores than students in other schools. These school instruction variables explained 6 percent of the school-to-school differences in reading, mathematics, and science scores, or between 1 and 2 percent of the total variance. However, the model shows no effect for school-to-school variations in early emphasis in reading skills, either because controlling for level of engagement also eliminates any differences, or because there is no variation between Australian schools when emphasis is placed on various reading skills and strategies.

Although, in Australia, both the School Environment and the School Instruction models contained significant predictors of student achievement when considered separately, when these were combined in a single School Environment and Instruction model, the Students Engaged predictor no longer made an independent contribution, suggesting that the statistical adjustment made by the model to give schools the same degree of orderliness and level of support for academic success removes any differences in student engagement in lessons. Accordingly, the combined School Environment and School Instruction variables explained 44 percent of the school-to-school differences in reading achievement, and 43 percent of the school-to-school differences in mathematics and science achievement, only marginally more than the School Environment variables alone. Overall, the School Explanatory models accounted for between 10 and 12 percent of the total variance in reading, mathematics, and science scores.

Home Background Control Model—Australia

The Home Background Control model for Australia provides evidence of a strong relationship between students' home environment and their achievement in reading, mathematics, and science, and that this relationship operates both at the school level (in terms of the average level of the home background variables in the school, i.e., the student body composition), and within school (in terms of the difference between an individual student's home background and the average for the school). In Australia, the predicted effect of attending a school where many of the students came from well-resourced homes is particularly strong (regression coefficients of 49 to 56 points across subjects), suggesting that schools differ considerably in the composition of the student body and that achievement in all three subjects is higher in schools with many students from advantaged home backgrounds and lower in schools with many students from disadvantaged home backgrounds.

In addition to the school composition effect in Australia, the Home Background Control model predicts an extra benefit from having a level of home background above the average for the school (and, conversely, an extra disadvantage to having a home background level below the average for the school). This effect is represented by the students within school regression coefficients, which are positive for both Home Resources for Learning and Early Literacy/Numeracy Tasks for all three subjects.

The home background control variables explained between 58 and 61 percent of the school-to-school differences in Australia, and between 7 and 10 percent of the student-to-student differences within schools in reading, mathematics, and science scores. Overall, the student and school home background control variables explained 19 percent of the total variability in reading scores, and 24 percent of the total variability in mathematics and science scores.

School Explanatory with Control Models—Australia

The School Explanatory with Control models show the predicted effect on the school explanatory variables of statistically eliminating all differences between schools in the average level of student home background and also eliminating all home background differences among the students within the schools. For Australia, eliminating the differences in home background between schools and students had the effect of reducing the regression coefficients for **Schools Are Safe and Orderly** by half, and reducing the **Schools Support Academic Success** coefficients to just above zero. Although the **Schools Are Safe and Orderly** coefficients were reduced, they remained substantial (8 to 11 score points), and because all differences due to home background have been eliminated, these coefficients may be interpreted as the effects of the school environment variables over and above all other factors.

Combined, the school explanatory and control variables accounted for about two-thirds of the school-to-school differences in achievement in Australia (67% for reading and mathematics; and 69% for science), representing an increase of 8 to 9 percent over the amount accounted for by the home background control variables alone. Overall, 21 percent of the total variability in reading scores, and 26 percent of the total variability in mathematics and science scores was explained by the school explanatory variables and the home background control variables.

Effective Schools Analysis—Botswana

As one of the countries with relatively large differences between schools in achievement, Botswana provides a further example of how the effective schools analysis can reveal differential effects of school environment and instructional variables on student achievement, even after adjusting for home background effects. As shown in Exhibit 3.37, about one-third of the total variance in student achievement (38% in reading, 31% in mathematics, and 35% in science) was due to differences between schools and was available to be explained by school-to-school differences in the explanatory variables.

In Botswana, school-level correlations with achievement for the school environment variables were highest for **Schools Support Academic Success** (0.61 to 0.62), next highest for **Schools Are Safe and Orderly** (0.46 to 0.49), and lowest for **Adequate Environment and Resources** (0.22 to 0.23) (see Exhibits 3.2, 3.3, and 3.4). When these were combined in the School Environment model (the first column of data in Exhibit 3.37), being in a school that supported academic success and being in a safe and orderly school were the strongest predictors of achievement in each of the three subjects, with regression coefficients of 14 to 22 points after controlling for each of the other variables. As for Australia, the model for Botswana showed no effect for being in a school with adequate environment and resources. The school environment variables explained between 44 and 46 percent of the school-to-school differences in reading, mathematics, and science scores in Botswana, or between 14 and 17 percent of the total variance, suggesting that eliminating all differences in school environment would reduce total achievement differences by this amount. This was slightly more than in Australia.

Although Botswana was similar to Australia in that there was essentially no correlation between **Early Emphasis on Reading Skills** and achievement, the countries differed in that there was a much stronger correlation with **Students Engaged in their Lessons** in Botswana—about 0.6, compared to about 0.2. The School Instruction model for Botswana accounted for 36 to 43 percent of the school-to-school differences in reading, mathematics, and science scores, or between 13 and 15 percent of the total variance. Further, in the combined School

Environment and School Instruction model, the **Students Engaged in their Lessons** variable had the strongest relationship with achievement (regression coefficients of 32 to 54 points), followed by **Schools Support Academic Success** (regression coefficients of 11 to 17 points). Altogether, in Botswana the School Environment and School Instruction variables accounted for 58 percent of the school-to-school differences in reading achievement, 62 percent in mathematics, and 63 percent in science, or between 19 and 22 percent of the total variance in reading, mathematics, and science scores.

Similar to the situation in Australia, the Home Background Control model for Botswana showed a strong relationship between students' home environment and their achievement in reading, mathematics, and science. The predicted effect of attending a school where many of the students came from well-resourced homes is particularly strong (regression coefficients 26 to 39 points), and the within-school effect, the predicted advantage or disadvantage of having a level of home background above or below the average for the school, also was significant for all three subjects. The home background control variables explained between 56 and 68 percent of the school-to-school differences, and between 4 and 7 percent of the student-to-student differences within schools in reading, mathematics, and science scores. Overall, the student and school home background control variables explained 30 percent of the total variability in reading scores, 20 percent in mathematics, and 25 percent in science.

In Botswana, in contrast to Australia, eliminating the differences in home background between schools and students (the School Explanatory with Control model) does not remove the School Instruction effects, and reduces but does not eliminate the School Environment effects. The predicted effect of the **Students Engaged in their Lessons** variable was reduced somewhat but still substantial (regression coefficients of 27 to 44 points), while the regression coefficients for **Schools Are Safe and Orderly** (7 to 9 points) and **Schools Support Academic Success** (5 to 7 points) retain small but significant effects.

Combined, the school explanatory and control variables accounted for four-fifths or more of the school-to-school differences in achievement in Botswana (84% for reading and science; and 80% for mathematics), representing an increase of 16 to 24 percentage points over the amount accounted for by the home background control variables alone. Overall, 36 percent of the total variability in reading scores, 28 percent in mathematics, and 33 percent in science was accounted for by the school explanatory variables and the home background control variables.

Results across TIMSS and PIRLS 2011 Participants

Looking across the individual country results in Exhibits 3.5 through 3.41, the average percentage of variance due to differences between schools was fairly similar for reading (22%), mathematics (26%), and science (25%), although there were considerable differences from country to country. Slovenia had the smallest percentage of variance in achievement between schools, with 5 percent for reading and 8 percent for mathematics and science. In several other countries, including Austria, Chinese Taipei, Croatia, Finland, Norway, and Poland, the percentage of variance between schools was 10 percent or less in at least one subject. Because schools in these countries do not differ very much in the average achievement of their students, there is little scope for finding school variables that account for this difference.

The largest percentage of variance in achievement between schools was observed for Dubai, UAE, where approximately 50 percent was between schools. Honduras, United Arab Emirates, Qatar, Azerbaijan, and Abu Dhabi, UAE also had relatively large percentages of variance between schools.

The Home Background Control model was successful in capturing the relationship between home background and student achievement in reading, mathematics, and science in every participant, although the exact nature of the relationship varied among the countries. The Home Resources for Learning variable was the strongest predictor, with significant effects at both the school level (in terms of the average level of home resources for students in the school) and within the school (in terms of the difference between an individual's home resources and the average for the school) in almost every country. The Early Literacy/Numeracy Tasks was a less powerful predictor, with significant between-school effects in about half of the countries.

As shown in Exhibits 3.2 through 3.5, the school variables posited by the conceptual model are positively correlated with student achievement in most countries, providing *prima facie* evidence from the data for the validity of the model. The School Explanatory models show that many of these relationships persist when the school environment and school instruction variables are combined in a single model (without any other controls). Only two countries, the Czech Republic and the Russian Federation, had no significant predictors of student achievement in these School Explanatory models.

The School Explanatory with Home Background Control model shows how the effect of the School Environment and Instruction variables on achievement is predicted to change when the data are adjusted statistically so that all students have the same home background. As would be expected, given that schools with many students from supportive home environments often have positive school environment and instruction, introducing the home background variables as controls reduces the strength of the relationship between school environment and instruction and student achievement. Whereas only in the Czech Republic and the Russian Federation was there no relationship between the school variables and achievement before controlling for home background, there were seven more countries with no significant relationship after including the home background controls: Austria, Honduras, Iran, Poland, Romania, Slovenia, and Sweden.

All of the 28 remaining countries and benchmarking participants had a significant relationship between at least one of the School Environment or Instruction variables and achievement in reading, mathematics, or science after controlling for home background. Of the School Environment variables, **Schools Are Safe and Orderly** was related to achievement in at least one subject over and above the effects of home background in 15 countries, and in all three subjects in 7 countries. **Schools Support Academic Success** was a positive predictor of achievement in at least one subject in 10 countries and in all three in 2 countries. **Adequate Environment and Resources** had a predicted effect on achievement independent of home background in at least one subject in just 3 countries, and in all three subjects in just one country.

Of the two School Instruction variables, **Students Engaged in Reading, Mathematics, and Science Lessons** was the more powerful predictor, and was positively related to achievement in at least one subject in 17 countries after controlling for home background and in all three subjects in 9 countries. In contrast, **Early Emphasis in Reading Skills** was a significant predictor in just two countries.

Looking across the countries, 15 of the participants had just one significant predictor after controlling for home background. These included Australia, Chinese Taipei, Croatia, Finland, Lithuania, Northern Ireland, Norway, the Slovak Republic (**Schools Are Safe and Orderly**); Quebec (**Schools Support Academic Success**); Italy (**Adequate Environment and Resources**); and Georgia, Hong Kong SAR, Hungary, Portugal, and Singapore (**Students Engaged in Reading, Mathematics, and Science Lessons**). **Students Engaged in Reading, Mathematics, and Science Lessons** was a significant predictor after controlling for home background in all 8 of the countries with two significant predictors, with **Schools Support Academic Success** the second predictor in

Azerbaijan, Ireland, Saudi Arabia, Abu Dhabi, and Dubai; **Schools Are Safe and Orderly** the second predictor in Malta and Spain; and **Adequate Environment and Resources** the second predictor in Morocco.

Germany, Oman, Qatar, and Botswana each had three significant predictors of achievement after controlling for home background, with **Schools Are Safe and Orderly** a significant predictor in each case. The other two predictors were **Schools Support Academic Success** and **Students Engaged in Reading, Mathematics, and Science Lessons** in Oman and Botswana; **Schools Support Academic Success** and **Early Emphasis on Reading Skills** in Germany; and **Schools Support Academic Success** and **Students Engaged in Reading, Mathematics, and Science Lessons** in Qatar. The largest number of significant predictors after controlling for home background was in the United Arab Emirates, where **Schools Are Safe and Orderly**, **Schools Support Academic Success**, **Early Emphasis on Reading Skills**, and **Students Engaged in Reading, Mathematics, and Science Lessons** each had a positive effect.

Summary

Conscious that education systems typically have evolved as the result of management and development over many years, and that the variables of interest have been manipulated to achieve policy goals so that expected relationships may not be apparent in the data, this study relied on a strong conceptual model based on a clear vision of the essential characteristics of effective schools to guide the analyses. Building on the school effectiveness research literature and capitalizing on the unique array of school and student variables available in the *TIMSS and PIRLS 2011 Fourth Grade Combined International Database (Foy,* 2013), the conceptual model specified a small number of school characteristics considered essential for effective schooling in all countries: a school environment that was safe and orderly, supportive of academic success, and with adequate facilities and equipment, and school instruction that emphasized higher order reading processes and student engagement in reading, mathematics, and science lessons.

Because the conceptual model is based on the idea that all effective schools possess these characteristics to some degree, it raises the expectation that the TIMSS and PIRLS data would show positive relationships between these characteristics and student achievement in each country. In fact, however, the countries varied considerably in the extent to which the relationships predicted by the conceptual model were observed in the data. In a number of countries, most notably Slovenia, Austria, Chinese Taipei, Croatia, Finland, Norway, and Poland, primary schools are organized so that there is little school-to-school difference in student achievement and, consequently, there is little scope for relationships between school characteristics and achievement at the fourth grade in the data from these countries. School effectiveness analyses in countries such as these are limited in the information they can provide about characteristics of effective schooling.

However, there also were countries where schools differed considerably in the achievement of their students, to the extent that, on average across all participating countries, about one fourth of the total student variance was attributable to differences among schools. In such countries, a strong positive relationship often was in evidence between one or more school characteristic and achievement in reading, mathematics, and science. For example, Botswana, as described earlier, had considerable differences among schools in student achievement and positive relationships between school environment and instruction, home background, and student achievement, and these relationships persisted after controlling for the effects of home background.

In summary, this study found considerable differences across countries in the way student achievement is distributed across schools and in the way school variables are related to student achievement, although the results were fairly similar for reading, mathematics, and science. For example, the average percentage of variance due to differences between schools was 22 percent for reading, 26 percent for mathematics, and 25 percent for science. Despite the differences, the Home Background Control model was successful in capturing the relationship between home background and student achievement in reading, mathematics, and science in every country, although the exact nature of the relationship varied among the countries. The Home Resources for Learning variable was the strongest predictor, with significant effects at both the school level and within the school in almost every country. The Early Literacy/Numeracy Tasks was a less powerful predictor, with significant between-school effects in about half of the countries.

The school variables posited by the conceptual model were positively correlated with student achievement in most countries, providing *prima facie* evidence from the data for the validity of the model. The School Explanatory models showed that many of these relationships persisted when the school environment and school instruction variables were combined in a single model (without any other controls). Only two countries, the Czech Republic and the Russian Federation, had no significant predictors of student achievement in these School Explanatory models. Almost all of the remaining countries and benchmarking participants had a significant relationship between at least one of the School Environment or Instruction variables and achievement in reading, mathematics, or science after controlling for home background.

Of the School Environment variables, **Schools Are Safe and Orderly** was related to achievement in at least one subject over and above the effects of home background in 15 countries, and in all three subjects in 7 countries. **Schools Support Academic Success** was a positive predictor of achievement in at least one subject in 10 countries and in all three in 2 countries. **Adequate Environment and Resources** had a predicted effect on achievement independent of home background in at least one subject in just 3 countries, and in all three subjects in just one country. Of the two School Instruction variables, **Students Engaged in Reading, Mathematics, and Science Lessons** was the more powerful predictor, and was positively related to achievement in at least one subject in 17 countries after controlling for home background and in all three subjects in 9 countries. In contrast, **Early Emphasis in Reading Skills** was a significant predictor in just two countries.

Exhibit 3.2: Variance Decomposition and Correlations of School Explanatory Variables with Reading Achievement

Country	Percentage of Total Variance		School-level Correlations				
	Between Schools	Within Schools	Schools Are Safe and Orderly	Schools Support Academic Success	Adequate Environment and Resources	Early Emphasis on Reading Skills	Students Engaged in Reading, Mathematics, and Science Lessons
Australia	23	77	0.55	0.44	0.28	0.03	0.21
Austria	9	91	0.36	0.36	0.04	-0.05	-0.13
Azerbaijan	44	56	0.23	0.16	0.05	-0.03	0.43
Chinese Taipei	10	90	0.18	0.27	0.03	-0.03	0.27
Croatia	10	90	0.09	0.22	-0.12	0.11	-0.14
Czech Republic	15	85	0.04	0.15	-0.12	-0.03	-0.01
Finland	7	93	0.39	0.40	0.08	0.13	-0.06
Georgia	25	75	0.12	0.22	-0.03	0.01	0.37
Germany	24	76	0.43	0.53	0.16	0.24	-0.04
Hong Kong SAR	21	79	0.17	0.04	-0.03	0.19	0.40
Hungary	32	68	0.45	0.52	-0.03	0.07	0.02
Iran, Islamic Rep. of	39	61	0.19	0.35	0.13	0.25	0.00
Ireland	12	88	0.55	0.43	0.13	0.12	0.07
Italy	17	83	0.20	0.04	0.15	-0.02	0.08
Lithuania	19	81	0.24	0.40	0.00	0.15	0.20
Malta	28	72	0.45	0.55	0.26	0.03	0.47
Morocco	38	62	0.25	0.45	0.21	0.28	0.45
Northern Ireland	11	89	0.41	0.34	0.11	0.08	0.18
Norway	8	92	0.31	0.36	-0.01	-0.02	0.24
Oman	18	82	0.20	0.41	0.24	0.26	0.34
Poland	10	90	-0.07	0.35	-0.01	-0.04	-0.19
Portugal	18	82	0.26	0.40	-0.01	-0.12	0.37
Qatar	38	62	0.52	0.43	0.36	0.23	0.45
Romania	35	65	0.35	0.44	0.08	0.13	0.37
Russian Federation	25	75	0.15	0.20	0.14	-0.03	0.03
Saudi Arabia	36	64	0.31	0.54	0.26	0.18	0.48
Singapore	25	75	0.29	0.43	-0.01	-0.02	0.08
Slovak Republic	18	82	0.27	0.39	0.04	0.04	-0.03
Slovenia	5	95	0.09	0.17	0.03	-0.04	-0.07
Spain	18	82	0.36	0.42	0.03	-0.11	0.18
Sweden	13	87	0.47	0.36	0.25	0.08	-0.07
United Arab Emirates	43	57	0.39	0.39	0.33	0.42	0.32
International Avg.	22	78	0.29	0.35	0.09	0.08	0.16
Sixth Grade Countries							
Botswana	38	62	0.46	0.62	0.22	0.02	0.59
Honduras	43	57	0.15	0.10	0.35	0.25	-0.06
Benchmarking Participants							
Quebec, Canada	11	89	0.30	0.45	0.26	0.02	0.21
Abu Dhabi, UAE	40	60	0.36	0.41	0.33	0.21	0.30
Dubai, UAE	51	49	0.43	0.38	0.34	0.48	0.39

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.3: Variance Decomposition and Correlations of School Explanatory Variables with Mathematics Achievement

Country	Percentage of Total Variance		School-level Correlations				
	Between Schools	Within Schools	Schools Are Safe and Orderly	Schools Support Academic Success	Adequate Environment and Resources	Early Emphasis on Reading Skills	Students Engaged in Reading, Mathematics, and Science Lessons
Australia	28	72	0.54	0.43	0.28	0.04	0.21
Austria	16	84	0.38	0.37	0.15	-0.05	-0.08
Azerbaijan	48	52	0.19	0.16	0.11	-0.08	0.54
Chinese Taipei	11	89	0.18	0.27	0.06	-0.01	0.26
Croatia	13	87	0.06	0.21	-0.02	0.16	-0.13
Czech Republic	21	79	0.04	0.14	-0.12	-0.01	0.00
Finland	9	91	0.39	0.41	0.14	0.18	-0.06
Georgia	38	62	0.07	0.25	-0.03	-0.04	0.34
Germany	27	73	0.39	0.52	0.13	0.21	-0.08
Hong Kong SAR	22	78	0.18	0.13	-0.03	0.18	0.41
Hungary	36	64	0.48	0.53	-0.02	0.07	0.01
Iran, Islamic Rep. of	38	62	0.15	0.31	0.11	0.20	-0.02
Ireland	17	83	0.52	0.42	0.12	0.07	0.12
Italy	26	74	0.18	0.10	0.20	0.01	0.08
Lithuania	20	80	0.21	0.42	0.00	0.13	0.14
Malta	20	80	0.47	0.54	0.23	0.00	0.41
Morocco	44	56	0.21	0.36	0.20	0.20	0.41
Northern Ireland	17	83	0.42	0.28	0.07	0.03	0.20
Norway	14	86	0.35	0.35	0.04	0.02	0.21
Oman	20	80	0.18	0.36	0.16	0.23	0.35
Poland	13	87	-0.11	0.35	-0.03	-0.04	-0.23
Portugal	38	62	0.28	0.40	0.04	-0.11	0.35
Qatar	45	55	0.44	0.38	0.39	0.22	0.36
Romania	38	62	0.37	0.43	0.09	0.09	0.29
Russian Federation	34	66	0.16	0.12	0.09	-0.05	0.05
Saudi Arabia	37	63	0.21	0.37	0.12	0.09	0.22
Singapore	25	75	0.27	0.42	-0.03	-0.01	0.10
Slovak Republic	27	73	0.29	0.38	0.02	0.06	0.04
Slovenia	8	92	0.08	0.17	0.00	-0.06	-0.11
Spain	21	79	0.42	0.49	0.03	-0.05	0.20
Sweden	12	88	0.51	0.46	0.28	0.14	-0.09
United Arab Emirates	45	55	0.34	0.36	0.30	0.42	0.27
International Avg.	26	74	0.28	0.34	0.10	0.07	0.15
Sixth Grade Countries							
Botswana	31	69	0.49	0.61	0.23	0.03	0.62
Honduras	47	53	0.13	0.13	0.39	0.21	-0.04
Benchmarking Participants							
Quebec, Canada	15	85	0.29	0.45	0.27	-0.05	0.08
Abu Dhabi, UAE	42	58	0.33	0.37	0.31	0.25	0.22
Dubai, UAE	52	48	0.41	0.37	0.33	0.48	0.36

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.4: Variance Decomposition and Correlations of School Explanatory Variables with Science Achievement

Country	Percentage of Total Variance		School-level Correlations				
	Between Schools	Within Schools	Schools Are Safe and Orderly	Schools Support Academic Success	Adequate Environment and Resources	Early Emphasis on Reading Skills	Students Engaged in Reading, Mathematics, and Science Lessons
Australia	28	72	0.54	0.44	0.28	0.02	0.21
Austria	13	87	0.42	0.38	0.14	-0.04	-0.15
Azerbaijan	49	51	0.22	0.18	0.06	-0.04	0.55
Chinese Taipei	10	90	0.18	0.26	0.06	0.01	0.24
Croatia	11	89	0.10	0.20	-0.12	0.10	-0.13
Czech Republic	14	86	0.07	0.15	-0.10	-0.03	0.02
Finland	10	90	0.42	0.43	0.08	0.14	-0.13
Georgia	32	68	0.05	0.21	-0.07	-0.03	0.34
Germany	26	74	0.44	0.55	0.16	0.20	-0.07
Hong Kong SAR	20	80	0.13	0.08	-0.04	0.18	0.36
Hungary	38	62	0.46	0.51	-0.04	0.06	0.01
Iran, Islamic Rep. of	42	58	0.13	0.32	0.09	0.20	-0.06
Ireland	19	81	0.53	0.42	0.12	0.12	0.12
Italy	26	74	0.20	0.07	0.15	-0.01	0.06
Lithuania	23	77	0.23	0.38	-0.01	0.12	0.18
Malta	24	76	0.41	0.55	0.31	0.01	0.41
Morocco	36	64	0.22	0.40	0.21	0.22	0.45
Northern Ireland	22	78	0.40	0.31	0.05	0.05	0.21
Norway	9	91	0.34	0.41	0.03	-0.03	0.20
Oman	21	79	0.19	0.36	0.15	0.23	0.40
Poland	11	89	-0.13	0.34	-0.05	-0.06	-0.23
Portugal	34	66	0.26	0.42	0.02	-0.10	0.37
Qatar	42	58	0.48	0.39	0.33	0.18	0.41
Romania	37	63	0.38	0.42	0.08	0.13	0.35
Russian Federation	33	67	0.16	0.15	0.12	-0.01	0.05
Saudi Arabia	37	63	0.29	0.50	0.21	0.15	0.39
Singapore	25	75	0.27	0.44	-0.02	-0.02	0.06
Slovak Republic	26	74	0.28	0.37	0.02	0.05	0.03
Slovenia	8	92	0.09	0.14	0.01	-0.05	-0.10
Spain	19	81	0.37	0.43	0.04	-0.06	0.16
Sweden	15	85	0.54	0.41	0.27	0.08	-0.10
United Arab Emirates	41	59	0.36	0.39	0.30	0.39	0.35
International Avg.	25	75	0.28	0.34	0.09	0.07	0.16
Sixth Grade Countries							
Botswana	35	65	0.47	0.61	0.22	0.03	0.64
Honduras	52	48	0.13	0.10	0.32	0.22	-0.09
Benchmarking Participants							
Quebec, Canada	14	86	0.28	0.45	0.22	-0.03	0.17
Abu Dhabi, UAE	38	62	0.35	0.41	0.31	0.20	0.32
Dubai, UAE	49	51	0.42	0.39	0.33	0.48	0.41

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.5: School Effectiveness Models for Reading, Mathematics, and Science – Australia

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	21 (3.5) ▲	—	20 (3.5) ▲	—	10 (3.5) ▲	—	10 (3.5) ▲
	MAT	21 (4.1) ▲	—	21 (4.1) ▲	—	11 (4.0) ▲	—	11 (4.0) ▲
	SCI	20 (3.5) ▲	—	19 (3.5) ▲	—	8 (3.3) ▲	—	8 (3.3) ▲
Schools Support Academic Success	REA	6 (2.1) ▲	—	6 (2.1) ▲	—	2 (1.8)	—	3 (1.8)
	MAT	6 (2.4) ▲	—	7 (2.4) ▲	—	3 (2.1)	—	3 (2.1)
	SCI	6 (2.0) ▲	—	6 (2.0) ▲	—	3 (1.6)	—	3 (1.6)
Adequate Environment and Resources	REA	2 (2.5)	—	2 (2.5)	—	1 (1.9)	—	1 (1.9)
	MAT	3 (2.5)	—	3 (2.5)	—	2 (2.0)	—	1 (2.0)
	SCI	2 (2.5)	—	2 (2.5)	—	1 (1.8)	—	1 (1.8)
School Instruction								
Early Emphasis on Reading Skills	REA	—	0 (1.8)	2 (1.5)	—	—	1 (1.4)	1 (1.3)
	MAT	—	1 (1.9)	2 (1.7)	—	—	2 (1.5)	2 (1.4)
	SCI	—	0 (1.7)	2 (1.5)	—	—	1 (1.3)	1 (1.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	15 (5.2) ▲	6 (4.2)	—	—	7 (3.7)	4 (3.6)
	MAT	—	16 (5.6) ▲	6 (4.3)	—	—	6 (3.7)	3 (3.6)
	SCI	—	14 (5.2) ▲	5 (4.2)	—	—	6 (3.2)	3 (3.2)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (1.3) ▲	12 (1.3) ▲	12 (1.3) ▲	12 (1.3) ▲
	MAT	—	—	—	12 (1.4) ▲	12 (1.4) ▲	12 (1.4) ▲	12 (1.4) ▲
	SCI	—	—	—	13 (1.1) ▲	13 (1.1) ▲	13 (1.1) ▲	13 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	11 (1.3) ▲	11 (1.3) ▲	11 (1.3) ▲	11 (1.3) ▲
	MAT	—	—	—	15 (1.4) ▲	15 (1.4) ▲	15 (1.4) ▲	15 (1.4) ▲
	SCI	—	—	—	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	49 (3.7) ▲	38 (3.8) ▲	48 (3.9) ▲	38 (3.8) ▲
	MAT	—	—	—	56 (4.0) ▲	43 (3.9) ▲	55 (3.9) ▲	42 (3.9) ▲
	SCI	—	—	—	49 (3.4) ▲	40 (3.6) ▲	48 (3.5) ▲	39 (3.6) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	19 (6.8) ▲	15 (7.0) ▲	17 (6.9) ▲	15 (7.0) ▲
	MAT	—	—	—	23 (8.4) ▲	19 (8.8) ▲	22 (8.2) ▲	19 (8.5) ▲
	SCI	—	—	—	21 (6.0) ▲	18 (6.2) ▲	19 (6.2) ▲	17 (6.2) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (23%)	43	6	44	58	66	59	67
Within Schools (77%)	—	—	—	7	6	7	6
Total	10	1	10	19	20	19	21
Mathematics							
Between Schools (28%)	41	6	43	58	66	60	67
Within Schools (72%)	—	—	—	10	10	10	10
Total	12	2	12	24	26	24	26
Science							
Between Schools (28%)	42	6	43	61	68	62	69
Within Schools (72%)	—	—	—	10	10	10	10
Total	12	2	12	24	26	25	26

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.6: School Effectiveness Models for Reading, Mathematics, and Science – Austria

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	8 (3.3) ▲	—	8 (3.3) ▲	—	4 (2.4)	—	4 (2.4)
	MAT	9 (4.1) ▲	—	9 (4.1) ▲	—	6 (3.7)	—	5 (3.6)
	SCI	10 (3.7) ▲	—	10 (3.7) ▲	—	6 (3.1)	—	5 (3.0)
Schools Support Academic Success	REA	5 (2.4) ▲	—	5 (2.4) ▲	—	2 (2.0)	—	2 (1.9)
	MAT	5 (2.6) ▲	—	6 (2.6) ▲	—	2 (2.4)	—	3 (2.4)
	SCI	6 (2.4) ▲	—	6 (2.5) ▲	—	2 (2.2)	—	2 (2.2)
Adequate Environment and Resources	REA	-2 (1.3)	—	-2 (1.4)	—	-2 (1.2)	—	-2 (1.2)
	MAT	0 (1.7)	—	0 (1.7)	—	0 (1.6)	—	1 (1.6)
	SCI	-1 (1.5)	—	-1 (1.6)	—	0 (1.3)	—	0 (1.3)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (1.7)	-2 (1.6)	—	—	-2 (1.5)	-2 (1.4)
	MAT	—	-2 (2.0)	-3 (1.7)	—	—	-3 (1.8)	-3 (1.6)
	SCI	—	-1 (2.0)	-2 (1.7)	—	—	-3 (1.8)	-3 (1.6)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-4 (3.9)	-4 (3.8)	—	—	-2 (3.2)	-2 (3.2)
	MAT	—	-3 (5.1)	-2 (4.9)	—	—	0 (4.5)	1 (4.6)
	SCI	—	-5 (4.9)	-5 (4.7)	—	—	-2 (3.9)	-2 (4.0)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	19 (0.8) ▲	19 (0.8) ▲	19 (0.8) ▲	19 (0.8) ▲
	MAT	—	—	—	16 (0.7) ▲	16 (0.7) ▲	16 (0.7) ▲	16 (0.7) ▲
	SCI	—	—	—	20 (0.9) ▲	20 (1.0) ▲	20 (1.0) ▲	20 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	5 (0.8) ▲	5 (0.8) ▲	5 (0.8) ▲	5 (0.8) ▲
	MAT	—	—	—	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲
	SCI	—	—	—	5 (0.7) ▲	5 (0.7) ▲	5 (0.7) ▲	5 (0.7) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	27 (2.6) ▲	24 (2.9) ▲	27 (2.6) ▲	24 (2.9) ▲
	MAT	—	—	—	25 (3.5) ▲	21 (3.6) ▲	26 (3.5) ▲	21 (3.5) ▲
	SCI	—	—	—	26 (3.4) ▲	23 (3.5) ▲	26 (3.4) ▲	23 (3.5) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	-1 (6.4)	0 (6.3)	-2 (6.0)	-1 (5.9)
	MAT	—	—	—	7 (7.0)	9 (7.0)	6 (6.4)	8 (6.3)
	SCI	—	—	—	-4 (6.7)	-3 (6.7)	-5 (6.3)	-4 (6.3)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (9%)	25	2	28	55	58	57	60
Within Schools (91%)	—	—	—	18	18	18	18
Total	2	0	2	21	22	21	22
Mathematics							
Between Schools (16%)	22	1	24	37	42	38	44
Within Schools (84%)	—	—	—	20	20	20	20
Total	3	0	4	23	23	23	24
Science							
Between Schools (13%)	26	2	28	46	52	48	54
Within Schools (87%)	—	—	—	20	20	20	20
Total	3	0	4	24	24	24	25

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.7: School Effectiveness Models for Reading, Mathematics, and Science – Azerbaijan

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	11 (4.5) ▲	—	8 (4.3)	—	10 (4.7) ▲	—	7 (4.6)
	MAT	16 (5.6) ▲	—	9 (5.5)	—	15 (5.3) ▲	—	9 (5.1)
	SCI	17 (5.8) ▲	—	11 (5.1) ▲	—	16 (5.8) ▲	—	10 (5.2)
Schools Support Academic Success	REA	6 (3.6)	—	6 (2.8) ▲	—	6 (3.7)	—	6 (2.8) ▲
	MAT	5 (4.8)	—	6 (3.5)	—	6 (4.9)	—	5 (3.8)
	SCI	7 (4.6)	—	7 (3.2) ▲	—	6 (4.9)	—	6 (3.5)
Adequate Environment and Resources	REA	-1 (4.4)	—	-1 (3.2)	—	-2 (4.5)	—	-1 (3.5)
	MAT	5 (5.7)	—	5 (3.9)	—	5 (5.6)	—	3 (4.0)
	SCI	0 (6.5)	—	0 (4.0)	—	0 (6.5)	—	0 (4.1)
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (2.8)	1 (2.7)	—	—	1 (2.8)	1 (2.7)
	MAT	—	-4 (3.6)	-3 (3.4)	—	—	-4 (3.8)	-4 (3.6)
	SCI	—	0 (3.3)	0 (3.2)	—	—	0 (3.2)	0 (3.1)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	34 (9.3) ▲	31 (8.9) ▲	—	—	36 (8.3) ▲	33 (7.8) ▲
	MAT	—	57 (10.3) ▲	53 (10.0) ▲	—	—	63 (8.4) ▲	59 (8.2) ▲
	SCI	—	59 (9.4) ▲	56 (9.0) ▲	—	—	62 (8.3) ▲	58 (8.0) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	6 (1.0) ▲	6 (1.0) ▲	6 (1.0) ▲	6 (1.0) ▲
	MAT	—	—	—	9 (1.2) ▲	9 (1.2) ▲	9 (1.2) ▲	9 (1.2) ▲
	SCI	—	—	—	9 (1.1) ▲	9 (1.1) ▲	9 (1.1) ▲	9 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	4 (0.8) ▲	4 (0.8) ▲	4 (0.8) ▲	4 (0.8) ▲
	MAT	—	—	—	4 (0.9) ▲	4 (0.9) ▲	4 (0.9) ▲	4 (0.9) ▲
	SCI	—	—	—	5 (1.0) ▲	5 (1.0) ▲	5 (1.0) ▲	5 (1.0) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	13 (7.6)	8 (7.6)	18 (6.5) ▲	13 (6.4) ▲
	MAT	—	—	—	12 (10.4)	7 (9.9)	20 (8.5) ▲	16 (8.2)
	SCI	—	—	—	16 (10.5)	10 (10.2)	24 (8.6) ▲	19 (8.1) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	-11 (7.4)	-11 (7.5)	-13 (7.2)	-13 (7.3)
	MAT	—	—	—	-11 (8.8)	-10 (8.3)	-15 (7.8)	-14 (7.5)
	SCI	—	—	—	-10 (8.6)	-9 (8.1)	-13 (7.9)	-12 (7.6)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (44%)	10	20	26	4	13	25	30
Within Schools (56%)	—	—	—	3	3	3	3
Total	4	9	11	3	7	13	15
Mathematics							
Between Schools (48%)	10	29	34	0	10	31	35
Within Schools (52%)	—	—	—	5	5	5	5
Total	5	14	17	3	7	17	19
Science							
Between Schools (49%)	11	33	39	1	12	36	41
Within Schools (51%)	—	—	—	5	5	5	5
Total	5	16	19	3	8	20	22

( ) Percentage of available variance shown in parentheses.

Exhibit 3.8: School Effectiveness Models for Reading, Mathematics, and Science – Chinese Taipaei

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	5 (3.8)	—	4 (3.5)	—	5 (2.2) ▲	—	5 (2.2) ▲
	MAT	4 (3.5)	—	3 (3.3)	—	5 (2.1) ▲	—	4 (2.1)
	SCI	4 (3.5)	—	4 (3.3)	—	5 (1.9) ▲	—	5 (1.9) ▲
Schools Support Academic Success	REA	6 (2.4) ▲	—	6 (2.4) ▲	—	0 (1.3)	—	0 (1.3)
	MAT	6 (2.3) ▲	—	6 (2.2) ▲	—	0 (1.5)	—	0 (1.5)
	SCI	6 (2.2) ▲	—	5 (2.2) ▲	—	-1 (1.3)	—	-1 (1.3)
Adequate Environment and Resources	REA	0 (2.0)	—	0 (2.0)	—	-1 (1.4)	—	-1 (1.3)
	MAT	0 (2.2)	—	1 (2.1)	—	0 (1.6)	—	0 (1.5)
	SCI	0 (2.1)	—	1 (2.0)	—	0 (1.4)	—	1 (1.3)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (1.5)	-1 (1.4)	—	—	-1 (0.8)	-1 (0.7)
	MAT	—	0 (1.5)	-1 (1.3)	—	—	-1 (0.8)	-1 (0.8)
	SCI	—	0 (1.5)	-1 (1.3)	—	—	-1 (0.8)	-1 (0.8)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	12 (3.5) ▲	10 (3.3) ▲	—	—	4 (2.5)	4 (2.5)
	MAT	—	12 (3.7) ▲	10 (3.7) ▲	—	—	4 (2.6)	4 (2.6)
	SCI	—	11 (3.5) ▲	8 (3.5) ▲	—	—	2 (2.6)	2 (2.5)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	10 (0.7) ▲	10 (0.7) ▲	10 (0.7) ▲	10 (0.7) ▲
	MAT	—	—	—	12 (0.8) ▲	12 (0.8) ▲	12 (0.8) ▲	12 (0.8) ▲
	SCI	—	—	—	12 (0.7) ▲	12 (0.7) ▲	12 (0.7) ▲	12 (0.7) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	14 (1.0) ▲	14 (1.0) ▲	14 (1.0) ▲	14 (1.0) ▲
	MAT	—	—	—	17 (1.1) ▲	17 (1.1) ▲	17 (1.1) ▲	17 (1.1) ▲
	SCI	—	—	—	15 (1.2) ▲	15 (1.2) ▲	15 (1.2) ▲	15 (1.2) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	20 (2.0) ▲	20 (2.1) ▲	20 (2.1) ▲	20 (2.1) ▲
	MAT	—	—	—	22 (2.5) ▲	22 (2.5) ▲	22 (2.6) ▲	22 (2.6) ▲
	SCI	—	—	—	22 (2.1) ▲	22 (2.2) ▲	22 (2.1) ▲	22 (2.2) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	27 (8.7) ▲	27 (7.5) ▲	26 (8.4) ▲	25 (7.3) ▲
	MAT	—	—	—	23 (6.3) ▲	22 (6.6) ▲	21 (6.0) ▲	20 (6.4) ▲
	SCI	—	—	—	21 (6.6) ▲	21 (6.0) ▲	20 (6.3) ▲	20 (5.8) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (10%)	14	11	21	75	77	77	78
Within Schools (90%)	—	—	—	15	15	15	15
Total	2	1	2	21	21	21	21
Mathematics							
Between Schools (11%)	13	10	20	74	76	76	78
Within Schools (89%)	—	—	—	20	20	20	20
Total	1	1	2	25	26	26	26
Science							
Between Schools (10%)	13	8	18	79	81	80	82
Within Schools (90%)	—	—	—	20	20	20	20
Total	1	1	2	26	26	26	26

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.9: School Effectiveness Models for Reading, Mathematics, and Science – Croatia

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	2 (2.8)	—	3 (2.7)	—	4 (1.9)	—	4 (1.9) ▲
	MAT	1 (3.2)	—	2 (3.0)	—	3 (2.0)	—	3 (2.0)
	SCI	2 (2.9)	—	3 (2.7)	—	4 (2.1)	—	4 (2.0)
Schools Support Academic Success	REA	5 (1.9) ▲	—	5 (1.9) ▲	—	0 (1.2)	—	0 (1.2)
	MAT	5 (2.1) ▲	—	4 (2.0) ▲	—	-1 (1.3)	—	-1 (1.2)
	SCI	4 (1.7) ▲	—	4 (1.7) ▲	—	-1 (1.1)	—	-1 (1.1)
Adequate Environment and Resources	REA	-3 (1.5)	—	-2 (1.6)	—	-1 (1.2)	—	-1 (1.2)
	MAT	-1 (1.7)	—	0 (1.8)	—	1 (1.2)	—	1 (1.3)
	SCI	-3 (1.5)	—	-2 (1.6)	—	-1 (1.2)	—	-1 (1.2)
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (1.5)	0 (1.6)	—	—	0 (1.0)	0 (1.1)
	MAT	—	2 (1.8)	1 (1.8)	—	—	0 (1.2)	0 (1.2)
	SCI	—	1 (1.4)	0 (1.4)	—	—	-1 (1.0)	-1 (1.0)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-7 (3.5) ▼	-8 (3.6) ▼	—	—	-2 (2.7)	-2 (2.6)
	MAT	—	-8 (4.3)	-9 (4.6) ▼	—	—	-1 (2.6)	-2 (2.7)
	SCI	—	-7 (3.4) ▼	-8 (3.6) ▼	—	—	-2 (2.7)	-2 (2.7)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (0.8) ▲	12 (0.8) ▲	12 (0.8) ▲	12 (0.8) ▲
	MAT	—	—	—	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲
	SCI	—	—	—	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (0.7) ▲	12 (0.7) ▲	12 (0.7) ▲	12 (0.7) ▲
	MAT	—	—	—	16 (0.9) ▲	16 (0.9) ▲	16 (0.9) ▲	16 (0.9) ▲
	SCI	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	23 (2.1) ▲	22 (2.0) ▲	23 (2.0) ▲	22 (1.9) ▲
	MAT	—	—	—	24 (2.4) ▲	25 (2.6) ▲	24 (2.4) ▲	25 (2.6) ▲
	SCI	—	—	—	21 (2.7) ▲	21 (2.6) ▲	21 (2.7) ▲	21 (2.7) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	9 (4.3) ▲	10 (4.2) ▲	9 (4.3) ▲	10 (4.2) ▲
	MAT	—	—	—	15 (5.5) ▲	15 (5.3) ▲	15 (5.5) ▲	15 (5.2) ▲
	SCI	—	—	—	4 (5.5)	6 (5.2)	4 (5.4)	5 (5.1)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (10%)	11	6	16	73	74	73	74
Within Schools (90%)	—	—	—	16	16	16	16
Total	1	1	2	22	22	22	22
Mathematics							
Between Schools (13%)	6	6	12	69	70	70	70
Within Schools (87%)	—	—	—	21	21	21	21
Total	1	1	2	27	27	27	27
Science							
Between Schools (11%)	9	5	13	62	64	62	64
Within Schools (89%)	—	—	—	16	16	16	16
Total	1	1	1	21	21	21	21

( ) Percentage of available variance shown in parentheses.

Exhibit 3.10: School Effectiveness Models for Reading, Mathematics, and Science – Czech Republic

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	2 (5.4)	—	2 (5.5)	—	4 (3.0)	—	4 (2.9)
	MAT	1 (7.7)	—	2 (7.8)	—	5 (3.9)	—	5 (3.8)
	SCI	3 (5.9)	—	3 (5.9)	—	5 (3.2)	—	5 (3.2)
Schools Support Academic Success	REA	2 (2.4)	—	3 (2.4)	—	-1 (1.5)	—	-2 (1.5)
	MAT	3 (3.0)	—	3 (2.9)	—	-2 (1.5)	—	-2 (1.6)
	SCI	3 (2.5)	—	3 (2.5)	—	-1 (1.5)	—	-2 (1.6)
Adequate Environment and Resources	REA	-4 (2.9)	—	-5 (3.0)	—	-2 (1.6)	—	-1 (1.5)
	MAT	-5 (3.8)	—	-5 (3.8)	—	-2 (2.0)	—	-2 (1.9)
	SCI	-4 (3.2)	—	-4 (3.2)	—	-1 (1.7)	—	-1 (1.7)
School Instruction								
Early Emphasis on Reading Skills	REA	—	0 (1.4)	-1 (1.3)	—	—	1 (0.9)	1 (0.9)
	MAT	—	0 (1.5)	-1 (1.5)	—	—	1 (0.9)	1 (0.9)
	SCI	—	0 (1.4)	-1 (1.3)	—	—	1 (0.9)	1 (0.8)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-1 (4.7)	-2 (4.5)	—	—	1 (3.3)	1 (3.2)
	MAT	—	-1 (5.5)	-2 (5.2)	—	—	1 (3.4)	1 (3.4)
	SCI	—	1 (4.2)	0 (4.2)	—	—	3 (3.1)	3 (3.2)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲
	MAT	—	—	—	17 (1.2) ▲	17 (1.2) ▲	17 (1.2) ▲	17 (1.2) ▲
	SCI	—	—	—	17 (1.3) ▲	17 (1.3) ▲	17 (1.3) ▲	17 (1.3) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	7 (0.8) ▲	7 (0.8) ▲	7 (0.8) ▲	7 (0.8) ▲
	MAT	—	—	—	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲
	SCI	—	—	—	7 (1.0) ▲	7 (1.0) ▲	7 (1.0) ▲	7 (1.0) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	31 (4.5) ▲	31 (4.3) ▲	31 (4.5) ▲	31 (4.4) ▲
	MAT	—	—	—	37 (5.9) ▲	38 (5.6) ▲	38 (6.0) ▲	38 (5.8) ▲
	SCI	—	—	—	31 (4.9) ▲	32 (4.8) ▲	32 (4.9) ▲	32 (4.9) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	16 (5.5) ▲	17 (5.2) ▲	16 (5.7) ▲	16 (5.4) ▲
	MAT	—	—	—	26 (7.7) ▲	26 (7.2) ▲	25 (7.9) ▲	26 (7.5) ▲
	SCI	—	—	—	19 (5.7) ▲	19 (5.4) ▲	18 (6.0) ▲	19 (5.6) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (15%)	6	0	7	76	77	76	77
Within Schools (85%)	—	—	—	16	16	16	16
Total	1	0	1	25	25	25	25
Mathematics							
Between Schools (21%)	5	0	6	77	78	77	79
Within Schools (79%)	—	—	—	19	19	19	19
Total	1	0	1	31	31	31	31
Science							
Between Schools (14%)	6	0	6	73	75	74	76
Within Schools (86%)	—	—	—	17	17	17	17
Total	1	0	1	25	25	25	25

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.11: School Effectiveness Models for Reading, Mathematics, and Science – Finland

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	9 (3.2) ▲	—	9 (3.2) ▲	—	10 (2.6) ▲	—	10 (2.6) ▲
	MAT	9 (3.1) ▲	—	9 (3.1) ▲	—	10 (2.6) ▲	—	10 (2.5) ▲
	SCI	11 (2.6) ▲	—	11 (2.6) ▲	—	10 (2.3) ▲	—	11 (2.3) ▲
Schools Support Academic Success	REA	5 (2.4) ▲	—	5 (2.5)	—	0 (2.2)	—	-1 (2.3)
	MAT	5 (2.2) ▲	—	5 (2.3) ▲	—	0 (2.2)	—	-1 (2.1)
	SCI	6 (2.2) ▲	—	6 (2.3) ▲	—	2 (2.1)	—	2 (2.2)
Adequate Environment and Resources	REA	-2 (1.8)	—	-2 (1.8)	—	1 (1.6)	—	1 (1.5)
	MAT	-1 (1.6)	—	0 (1.6)	—	2 (1.5)	—	3 (1.5)
	SCI	-3 (1.6)	—	-3 (1.5)	—	0 (1.5)	—	0 (1.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (1.9)	0 (1.7)	—	—	1 (1.7)	1 (1.5)
	MAT	—	2 (2.5)	1 (2.3)	—	—	2 (2.4)	2 (2.1)
	SCI	—	1 (2.0)	0 (1.9)	—	—	1 (1.7)	1 (1.6)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-4 (5.4)	-3 (5.2)	—	—	1 (4.6)	0 (4.2)
	MAT	—	-3 (6.2)	-3 (6.2)	—	—	-1 (5.7)	-1 (5.4)
	SCI	—	-6 (5.3)	-5 (5.0)	—	—	0 (4.4)	-1 (4.0)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	11 (1.1) ▲	11 (1.1) ▲	11 (1.0) ▲	11 (1.0) ▲
	MAT	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
	SCI	—	—	—	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	15 (1.0) ▲	15 (1.0) ▲	15 (1.0) ▲	15 (1.0) ▲
	MAT	—	—	—	18 (0.8) ▲	18 (0.8) ▲	18 (0.8) ▲	18 (0.8) ▲
	SCI	—	—	—	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	19 (4.1) ▲	19 (4.3) ▲	19 (3.9) ▲	19 (4.0) ▲
	MAT	—	—	—	15 (5.3) ▲	15 (5.8) ▲	15 (4.9) ▲	16 (5.1) ▲
	SCI	—	—	—	20 (4.7) ▲	18 (4.4) ▲	20 (4.9) ▲	18 (4.3) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	10 (6.2)	10 (5.4)	10 (6.3)	10 (5.5)
	MAT	—	—	—	15 (6.1) ▲	15 (5.6) ▲	15 (6.2) ▲	15 (5.5) ▲
	SCI	—	—	—	7 (5.9)	6 (5.3)	7 (6.1)	6 (5.3)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (7%)	39	3	40	30	58	31	58
Within Schools (93%)	—	—	—	22	22	22	22
Total	3	0	3	23	25	23	25
Mathematics							
Between Schools (9%)	32	4	34	18	42	20	44
Within Schools (91%)	—	—	—	28	28	28	28
Total	3	0	3	27	29	27	29
Science							
Between Schools (10%)	40	4	42	25	53	26	54
Within Schools (90%)	—	—	—	20	20	20	20
Total	4	0	4	20	23	20	23

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.12: School Effectiveness Models for Reading, Mathematics, and Science – Georgia

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	5 (4.2)	—	3 (3.7)	—	3 (3.5)	—	2 (3.2)
	MAT	0 (5.8)	—	-2 (4.8)	—	-1 (5.4)	—	-2 (4.5)
	SCI	0 (5.1)	—	-2 (4.3)	—	-2 (4.6)	—	-4 (4.0)
Schools Support Academic Success	REA	9 (3.8) ▲	—	7 (3.6)	—	2 (3.3)	—	1 (3.0)
	MAT	16 (5.9) ▲	—	13 (5.5) ▲	—	12 (6.8)	—	10 (6.2)
	SCI	12 (4.8) ▲	—	10 (4.4) ▲	—	7 (5.7)	—	6 (5.2)
Adequate Environment and Resources	REA	-4 (3.8)	—	-6 (3.7)	—	-7 (3.2) ▼	—	-7 (3.1) ▼
	MAT	-8 (4.9)	—	-9 (4.9)	—	-11 (4.6) ▼	—	-11 (4.5) ▼
	SCI	-7 (4.6)	—	-8 (4.6)	—	-9 (4.1) ▼	—	-10 (4.0) ▼
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (3.1)	0 (3.3)	—	—	-1 (2.6)	0 (2.7)
	MAT	—	-2 (4.1)	-2 (4.1)	—	—	-3 (3.4)	-2 (3.4)
	SCI	—	0 (3.5)	0 (3.6)	—	—	-2 (3.1)	-1 (3.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	31 (9.2) ▲	29 (9.5) ▲	—	—	23 (8.8) ▲	24 (8.7) ▲
	MAT	—	40 (12.5) ▲	37 (12.9) ▲	—	—	35 (11.8) ▲	35 (11.4) ▲
	SCI	—	35 (11.6) ▲	34 (12.0) ▲	—	—	29 (11.2) ▲	31 (10.8) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲
	MAT	—	—	—	10 (1.5) ▲	10 (1.5) ▲	10 (1.5) ▲	10 (1.5) ▲
	SCI	—	—	—	11 (1.3) ▲	11 (1.3) ▲	11 (1.3) ▲	11 (1.3) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	9 (0.8) ▲	9 (0.8) ▲	9 (0.8) ▲	9 (0.8) ▲
	MAT	—	—	—	8 (1.1) ▲	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲
	SCI	—	—	—	9 (1.0) ▲	9 (1.1) ▲	9 (1.0) ▲	9 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	20 (3.2) ▲	21 (3.4) ▲	18 (3.2) ▲	20 (3.4) ▲
	MAT	—	—	—	21 (4.7) ▲	19 (5.1) ▲	18 (4.6) ▲	18 (5.1) ▲
	SCI	—	—	—	17 (4.4) ▲	17 (4.9) ▲	15 (4.4) ▲	15 (4.9) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	5 (5.4)	4 (5.3)	4 (5.0)	4 (4.9)
	MAT	—	—	—	-1 (9.2)	-2 (9.1)	-2 (8.2)	-3 (8.3)
	SCI	—	—	—	4 (7.5)	3 (7.5)	3 (6.7)	3 (6.8)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (25%)	9	16	22	34	37	41	45
Within Schools (75%)	—	—	—	11	11	11	11
Total	2	4	5	17	18	19	20
Mathematics							
Between Schools (38%)	10	14	21	11	16	20	25
Within Schools (62%)	—	—	—	11	11	11	11
Total	4	5	8	11	13	14	16
Science							
Between Schools (32%)	8	15	21	16	21	25	30
Within Schools (68%)	—	—	—	12	12	12	12
Total	3	5	7	13	15	16	18

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.13: School Effectiveness Models for Reading, Mathematics, and Science – Germany

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	9 (3.3) ▲	—	9 (3.3) ▲	—	9 (3.1) ▲	—	9 (3.1) ▲
	MAT	6 (3.1)	—	7 (3.1) ▲	—	6 (3.0) ▲	—	7 (2.9) ▲
	SCI	8 (3.4) ▲	—	9 (3.5) ▲	—	8 (3.2) ▲	—	8 (3.2) ▲
Schools Support Academic Success	REA	16 (3.4) ▲	—	15 (3.0) ▲	—	6 (3.2)	—	6 (2.9)
	MAT	15 (3.2) ▲	—	14 (2.7) ▲	—	7 (3.0) ▲	—	6 (2.8) ▲
	SCI	17 (3.2) ▲	—	15 (2.9) ▲	—	7 (3.0) ▲	—	7 (2.8) ▲
Adequate Environment and Resources	REA	-1 (2.1)	—	-1 (2.0)	—	1 (1.9)	—	1 (1.9)
	MAT	-1 (1.9)	—	-2 (1.8)	—	0 (1.7)	—	0 (1.7)
	SCI	-1 (1.9)	—	-1 (1.8)	—	1 (1.7)	—	1 (1.7)
School Instruction								
Early Emphasis on Reading Skills	REA	—	8 (2.8) ▲	5 (2.3) ▲	—	—	5 (2.1) ▲	4 (1.9) ▲
	MAT	—	7 (2.7) ▲	4 (2.2) ▲	—	—	4 (2.1)	3 (1.9)
	SCI	—	7 (2.8) ▲	4 (2.3)	—	—	4 (2.1) ▲	3 (2.0)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-4 (4.8)	-3 (3.7)	—	—	1 (4.3)	-1 (3.8)
	MAT	—	-6 (4.5)	-5 (3.6)	—	—	-2 (4.2)	-4 (3.6)
	SCI	—	-6 (4.9)	-5 (3.8)	—	—	-1 (4.3)	-3 (3.8)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	16 (0.8) ▲	16 (0.8) ▲	16 (0.8) ▲	16 (0.8) ▲
	MAT	—	—	—	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲
	SCI	—	—	—	17 (0.8) ▲	16 (0.8) ▲	17 (0.8) ▲	16 (0.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	7 (0.9) ▲	7 (0.9) ▲	7 (0.9) ▲	7 (0.9) ▲
	MAT	—	—	—	9 (1.0) ▲	9 (1.0) ▲	9 (1.0) ▲	9 (1.0) ▲
	SCI	—	—	—	5 (1.1) ▲	5 (1.1) ▲	5 (1.1) ▲	5 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	35 (3.9) ▲	26 (3.7) ▲	33 (3.6) ▲	25 (3.8) ▲
	MAT	—	—	—	31 (3.9) ▲	22 (3.8) ▲	30 (3.8) ▲	21 (3.9) ▲
	SCI	—	—	—	36 (4.1) ▲	26 (3.9) ▲	34 (3.9) ▲	25 (4.0) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	8 (10.4)	11 (9.4)	6 (10.0)	10 (9.0)
	MAT	—	—	—	10 (9.5)	13 (8.5)	9 (9.3)	13 (8.2)
	SCI	—	—	—	5 (10.3)	9 (9.2)	4 (10.0)	8 (8.9)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (24%)	40	10	44	49	58	53	61
Within Schools (76%)	—	—	—	15	15	15	15
Total	10	2	11	23	25	24	26
Mathematics							
Between Schools (27%)	37	9	41	44	52	47	55
Within Schools (73%)	—	—	—	17	17	17	17
Total	10	3	11	24	26	25	27
Science							
Between Schools (26%)	41	9	44	48	58	51	59
Within Schools (74%)	—	—	—	17	17	17	17
Total	11	2	11	25	27	25	28

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.14: School Effectiveness Models for Reading, Mathematics, and Science – Hong Kong SAR

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	7 (4.0)	—	2 (3.9)	—	4 (2.2) ▲	—	3 (2.1)
	MAT	6 (3.9)	—	1 (3.9)	—	3 (2.1)	—	2 (2.2)
	SCI	5 (4.2)	—	0 (4.3)	—	2 (2.2)	—	1 (2.4)
Schools Support Academic Success	REA	0 (2.6)	—	-4 (2.5)	—	-4 (1.9)	—	-5 (2.0) ▼
	MAT	3 (2.6)	—	-1 (2.5)	—	-2 (1.7)	—	-2 (1.7)
	SCI	2 (2.7)	—	-2 (2.6)	—	-2 (1.8)	—	-3 (1.9)
Adequate Environment and Resources	REA	-2 (3.8)	—	-2 (3.5)	—	-1 (1.9)	—	-1 (1.8)
	MAT	-2 (3.6)	—	-2 (3.3)	—	-2 (2.5)	—	-2 (2.4)
	SCI	-2 (4.2)	—	-2 (3.9)	—	-2 (2.2)	—	-2 (2.2)
School Instruction								
Early Emphasis on Reading Skills	REA	—	3 (1.6) ▲	4 (1.6) ▲	—	—	1 (1.1)	1 (1.0)
	MAT	—	3 (1.5) ▲	3 (1.5)	—	—	0 (0.9)	0 (0.9)
	SCI	—	3 (1.6) ▲	3 (1.6) ▲	—	—	1 (1.0)	1 (1.0)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	22 (4.3) ▲	23 (5.2) ▲	—	—	8 (3.3) ▲	9 (3.5) ▲
	MAT	—	22 (4.4) ▲	22 (5.0) ▲	—	—	7 (3.3) ▲	7 (3.5)
	SCI	—	20 (4.4) ▲	21 (5.3) ▲	—	—	4 (3.4)	6 (3.7)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	2 (0.7) ▲	2 (0.7) ▲	3 (0.7) ▲	2 (0.7) ▲
	MAT	—	—	—	3 (0.7) ▲	3 (0.7) ▲	3 (0.7) ▲	3 (0.7) ▲
	SCI	—	—	—	5 (0.8) ▲	5 (0.8) ▲	5 (0.8) ▲	5 (0.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	13 (1.1) ▲	13 (1.1) ▲	13 (1.1) ▲	13 (1.1) ▲
	MAT	—	—	—	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲
	SCI	—	—	—	15 (1.4) ▲	15 (1.4) ▲	15 (1.4) ▲	15 (1.4) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	3 (2.0)	5 (2.2) ▲	2 (2.1)	4 (2.2) ▲
	MAT	—	—	—	6 (2.0) ▲	7 (2.2) ▲	5 (2.0) ▲	6 (2.2) ▲
	SCI	—	—	—	5 (1.9) ▲	6 (2.1) ▲	4 (2.0) ▲	6 (2.1) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	62 (4.7) ▲	60 (4.5) ▲	59 (4.5) ▲	56 (4.4) ▲
	MAT	—	—	—	55 (4.9) ▲	54 (4.8) ▲	53 (5.0) ▲	52 (5.0) ▲
	SCI	—	—	—	60 (5.2) ▲	58 (5.2) ▲	58 (5.2) ▲	56 (5.2) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (21%)	4	20	22	68	70	70	73
Within Schools (79%)	—	—	—	8	8	8	8
Total	1	4	4	20	21	21	21
Mathematics							
Between Schools (22%)	4	20	20	68	69	70	71
Within Schools (78%)	—	—	—	10	10	10	10
Total	1	4	5	23	23	23	24
Science							
Between Schools (20%)	2	17	18	69	69	69	71
Within Schools (80%)	—	—	—	11	11	11	11
Total	0	3	4	22	23	23	23

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.15: School Effectiveness Models for Reading, Mathematics, and Science – Hungary

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	11 (6.1)	—	10 (6.3)	—	1 (3.7)	—	0 (3.8)
	MAT	16 (5.5) ▲	—	16 (5.6) ▲	—	4 (3.6)	—	2 (3.7)
	SCI	13 (6.3) ▲	—	13 (6.4)	—	3 (3.9)	—	1 (4.0)
Schools Support Academic Success	REA	16 (3.9) ▲	—	16 (3.8) ▲	—	2 (2.6)	—	1 (2.3)
	MAT	18 (4.0) ▲	—	18 (3.9) ▲	—	3 (2.5)	—	3 (2.3)
	SCI	17 (4.2) ▲	—	18 (4.0) ▲	—	3 (2.9)	—	2 (2.7)
Adequate Environment and Resources	REA	-2 (2.2)	—	-3 (2.1)	—	1 (1.5)	—	1 (1.4)
	MAT	-3 (2.3)	—	-3 (2.2)	—	1 (1.3)	—	1 (1.3)
	SCI	-3 (2.3)	—	-4 (2.2)	—	0 (1.7)	—	0 (1.6)
School Instruction								
Early Emphasis on Reading Skills	REA	—	0 (3.5)	-2 (2.7)	—	—	0 (1.8)	0 (1.8)
	MAT	—	0 (3.6)	-3 (2.4)	—	—	0 (1.7)	-1 (1.7)
	SCI	—	0 (3.7)	-3 (2.7)	—	—	0 (1.9)	0 (2.0)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	5 (11.6)	2 (9.3)	—	—	15 (6.1) ▲	15 (5.9) ▲
	MAT	—	7 (11.7)	2 (9.3)	—	—	17 (6.6) ▲	16 (6.3) ▲
	SCI	—	6 (12.6)	3 (10.3)	—	—	17 (7.9) ▲	17 (7.8) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	16 (0.8) ▲	16 (0.8) ▲	16 (0.9) ▲	16 (0.8) ▲
	MAT	—	—	—	17 (0.8) ▲	17 (0.8) ▲	17 (0.8) ▲	17 (0.8) ▲
	SCI	—	—	—	17 (0.9) ▲	17 (0.9) ▲	17 (0.9) ▲	17 (0.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	8 (0.8) ▲	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲
	MAT	—	—	—	9 (0.8) ▲	9 (0.8) ▲	9 (0.8) ▲	9 (0.8) ▲
	SCI	—	—	—	6 (1.0) ▲	6 (1.0) ▲	6 (1.0) ▲	6 (1.0) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	29 (2.0) ▲	27 (2.7) ▲	29 (2.0) ▲	29 (2.4) ▲
	MAT	—	—	—	35 (2.1) ▲	31 (2.6) ▲	35 (2.1) ▲	32 (2.3) ▲
	SCI	—	—	—	31 (2.1) ▲	28 (2.9) ▲	31 (2.1) ▲	30 (2.7) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	2 (7.0)	3 (7.1)	6 (7.6)	6 (7.5)
	MAT	—	—	—	-3 (7.8)	-2 (8.0)	2 (8.6)	2 (8.6)
	SCI	—	—	—	-1 (8.2)	0 (8.6)	4 (9.0)	4 (9.1)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (32%)	37	0	38	74	74	76	76
Within Schools (68%)	—	—	—	20	20	20	20
Total	12	0	12	37	37	38	38
Mathematics							
Between Schools (36%)	43	0	43	77	77	78	79
Within Schools (64%)	—	—	—	22	22	22	22
Total	15	0	15	42	42	42	42
Science							
Between Schools (38%)	37	0	38	68	69	70	70
Within Schools (62%)	—	—	—	21	21	21	21
Total	14	0	15	39	39	40	40

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.16: School Effectiveness Models for Reading, Mathematics, and Science – Iran, Islamic Republic of

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	0 (4.4)	—	0 (4.3)	—	6 (3.5)	—	6 (3.6)
	MAT	-1 (4.8)	—	-1 (4.8)	—	5 (3.8)	—	4 (3.8)
	SCI	-2 (5.3)	—	-1 (5.2)	—	5 (4.1)	—	5 (4.2)
Schools Support Academic Success	REA	14 (3.7) ▲	—	12 (3.6) ▲	—	3 (3.1)	—	3 (3.1)
	MAT	13 (3.9) ▲	—	11 (3.9) ▲	—	2 (3.2)	—	2 (3.2)
	SCI	15 (4.1) ▲	—	13 (4.1) ▲	—	3 (3.3)	—	3 (3.3)
Adequate Environment and Resources	REA	2 (3.7)	—	3 (3.7)	—	-1 (2.8)	—	-1 (2.8)
	MAT	2 (3.7)	—	3 (3.7)	—	-2 (2.7)	—	-2 (2.8)
	SCI	1 (4.3)	—	2 (4.1)	—	-2 (3.1)	—	-2 (3.2)
School Instruction								
Early Emphasis on Reading Skills	REA	—	12 (2.6) ▲	10 (2.6) ▲	—	—	3 (1.9)	2 (1.9)
	MAT	—	9 (2.5) ▲	7 (2.5) ▲	—	—	1 (1.9)	0 (1.9)
	SCI	—	11 (2.9) ▲	9 (2.8) ▲	—	—	1 (2.1)	0 (2.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	3 (5.8)	0 (5.9)	—	—	5 (4.4)	3 (4.5)
	MAT	—	3 (5.8)	0 (6.0)	—	—	5 (4.5)	3 (4.6)
	SCI	—	0 (6.6)	-3 (6.6)	—	—	2 (4.7)	0 (4.7)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	8 (0.9) ▲	8 (0.9) ▲	8 (0.9) ▲	8 (0.9) ▲
	MAT	—	—	—	7 (1.1) ▲	7 (1.1) ▲	7 (1.1) ▲	7 (1.1) ▲
	SCI	—	—	—	8 (1.1) ▲	8 (1.1) ▲	8 (1.1) ▲	8 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲
	MAT	—	—	—	9 (0.7) ▲	9 (0.7) ▲	9 (0.7) ▲	9 (0.7) ▲
	SCI	—	—	—	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	24 (2.0) ▲	23 (2.4) ▲	23 (2.0) ▲	22 (2.4) ▲
	MAT	—	—	—	23 (2.2) ▲	22 (2.5) ▲	23 (2.4) ▲	23 (2.6) ▲
	SCI	—	—	—	26 (2.2) ▲	26 (2.5) ▲	26 (2.4) ▲	26 (2.6) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	4 (4.8)	4 (4.9)	3 (4.7)	3 (4.9)
	MAT	—	—	—	0 (4.9)	0 (5.0)	0 (4.9)	0 (5.1)
	SCI	—	—	—	4 (5.3)	4 (5.5)	4 (5.4)	4 (5.6)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (39%)	13	10	19	57	59	58	59
Within Schools (61%)	—	—	—	7	7	7	7
Total	5	4	7	26	27	27	27
Mathematics							
Between Schools (38%)	10	6	14	51	53	52	53
Within Schools (62%)	—	—	—	8	8	8	8
Total	4	2	5	25	25	25	25
Science							
Between Schools (42%)	10	7	15	55	56	55	56
Within Schools (58%)	—	—	—	7	7	7	7
Total	4	3	6	27	28	27	28

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.17: School Effectiveness Models for Reading, Mathematics, and Science – Ireland

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	11 (4.0) ▲	—	11 (3.9) ▲	—	7 (3.1) ▲	—	5 (3.2)
	MAT	12 (3.8) ▲	—	11 (3.8) ▲	—	6 (3.9)	—	4 (3.8)
	SCI	11 (4.2) ▲	—	11 (4.1) ▲	—	5 (4.3)	—	3 (4.2)
Schools Support Academic Success	REA	5 (2.2) ▲	—	5 (2.2) ▲	—	2 (1.9)	—	2 (1.9)
	MAT	5 (2.2) ▲	—	6 (2.4) ▲	—	3 (2.1)	—	4 (2.2)
	SCI	6 (2.4) ▲	—	7 (2.5) ▲	—	4 (2.3)	—	5 (2.4) ▲
Adequate Environment and Resources	REA	-1 (2.1)	—	-2 (2.1)	—	-1 (1.5)	—	-1 (1.6)
	MAT	0 (2.5)	—	-1 (2.3)	—	1 (2.1)	—	0 (2.0)
	SCI	0 (2.9)	—	-1 (2.9)	—	1 (2.5)	—	0 (2.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	3 (1.7)	2 (1.8)	—	—	2 (1.5)	2 (1.4)
	MAT	—	1 (1.7)	0 (1.7)	—	—	1 (1.6)	1 (1.5)
	SCI	—	3 (1.8)	2 (1.9)	—	—	2 (1.8)	2 (1.6)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	6 (4.4)	5 (4.4)	—	—	7 (3.3) ▲	6 (3.5)
	MAT	—	10 (6.6)	9 (6.5)	—	—	13 (5.2) ▲	12 (5.5) ▲
	SCI	—	9 (6.4)	9 (6.2)	—	—	11 (5.4) ▲	11 (5.4) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	19 (1.0) ▲	19 (1.0) ▲	19 (1.0) ▲	19 (1.0) ▲
	MAT	—	—	—	17 (0.9) ▲	17 (0.9) ▲	17 (0.9) ▲	17 (0.9) ▲
	SCI	—	—	—	17 (1.3) ▲	17 (1.3) ▲	17 (1.3) ▲	17 (1.3) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	8 (1.2) ▲	8 (1.1) ▲	8 (1.2) ▲	8 (1.1) ▲
	MAT	—	—	—	10 (1.3) ▲	10 (1.3) ▲	10 (1.3) ▲	10 (1.3) ▲
	SCI	—	—	—	7 (1.0) ▲	7 (1.0) ▲	7 (1.0) ▲	7 (1.0) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	27 (3.1) ▲	23 (3.1) ▲	27 (3.2) ▲	24 (3.1) ▲
	MAT	—	—	—	25 (3.8) ▲	20 (4.0) ▲	25 (3.7) ▲	21 (3.8) ▲
	SCI	—	—	—	27 (3.6) ▲	22 (3.8) ▲	27 (3.7) ▲	23 (3.6) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	2 (7.5)	5 (7.0)	0 (7.6)	3 (7.1)
	MAT	—	—	—	-2 (7.1)	1 (6.9)	-5 (7.6)	-3 (7.4)
	SCI	—	—	—	-1 (7.6)	1 (7.0)	-5 (8.0)	-4 (7.4)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (12%)	37	4	38	57	68	61	70
Within Schools (88%)	—	—	—	20	20	20	20
Total	4	0	4	25	26	25	26
Mathematics							
Between Schools (17%)	31	4	33	37	46	43	51
Within Schools (83%)	—	—	—	21	21	21	21
Total	5	1	6	24	25	25	26
Science							
Between Schools (19%)	29	4	32	40	49	46	54
Within Schools (81%)	—	—	—	19	19	19	19
Total	5	1	6	23	25	24	25

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.18: School Effectiveness Models for Reading, Mathematics, and Science – Italy

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	7 (2.6) ▲	—	7 (2.6) ▲	—	5 (2.6) ▲	—	5 (2.6)
	MAT	7 (4.4)	—	7 (4.4)	—	5 (4.3)	—	5 (4.3)
	SCI	9 (3.9) ▲	—	9 (3.9) ▲	—	7 (4.0)	—	7 (4.0)
Schools Support Academic Success	REA	-3 (2.5)	—	-2 (2.6)	—	-3 (2.2)	—	-3 (2.2)
	MAT	-1 (3.1)	—	-1 (3.3)	—	-2 (3.1)	—	-2 (3.2)
	SCI	-2 (3.1)	—	-2 (3.2)	—	-2 (2.9)	—	-2 (3.1)
Adequate Environment and Resources	REA	3 (2.4)	—	3 (2.5)	—	3 (2.0)	—	3 (2.0)
	MAT	6 (3.2) ▲	—	6 (3.2) ▲	—	7 (3.0) ▲	—	7 (3.1) ▲
	SCI	4 (3.2)	—	4 (3.2)	—	4 (2.8)	—	4 (2.8)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (1.6)	-1 (1.6)	—	—	0 (1.5)	0 (1.5)
	MAT	—	0 (2.0)	-1 (2.1)	—	—	1 (2.0)	0 (2.2)
	SCI	—	-1 (2.1)	-2 (2.2)	—	—	0 (2.0)	-1 (2.1)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	4 (3.8)	3 (4.1)	—	—	6 (4.0)	5 (4.1)
	MAT	—	6 (5.8)	3 (5.6)	—	—	6 (5.9)	4 (5.4)
	SCI	—	4 (5.7)	2 (5.6)	—	—	6 (5.8)	4 (5.5)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	16 (0.9) ▲	16 (0.9) ▲	16 (0.9) ▲	16 (0.9) ▲
	MAT	—	—	—	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲
	SCI	—	—	—	15 (1.0) ▲	15 (1.0) ▲	15 (1.0) ▲	15 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	7 (0.9) ▲	7 (0.9) ▲	7 (0.9) ▲	7 (0.9) ▲
	MAT	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
	SCI	—	—	—	6 (0.9) ▲	6 (0.9) ▲	6 (0.9) ▲	6 (0.9) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	22 (3.5) ▲	21 (3.4) ▲	22 (3.5) ▲	21 (3.4) ▲
	MAT	—	—	—	20 (4.6) ▲	19 (4.6) ▲	20 (4.5) ▲	19 (4.5) ▲
	SCI	—	—	—	23 (4.4) ▲	22 (4.3) ▲	23 (4.4) ▲	22 (4.3) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	2 (5.3)	3 (5.3)	0 (5.4)	2 (5.4)
	MAT	—	—	—	7 (6.5)	8 (6.7)	4 (6.6)	7 (6.8)
	SCI	—	—	—	1 (6.2)	2 (6.4)	-1 (6.3)	1 (6.4)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (17%)	6	1	7	22	26	23	26
Within Schools (83%)	—	—	—	15	15	15	15
Total	1	0	1	16	17	16	17
Mathematics							
Between Schools (26%)	7	1	7	8	13	9	14
Within Schools (74%)	—	—	—	15	15	15	15
Total	2	0	2	13	14	13	14
Science							
Between Schools (26%)	5	0	6	14	18	15	18
Within Schools (74%)	—	—	—	14	14	14	14
Total	1	0	2	14	15	14	15

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.19: School Effectiveness Models for Reading, Mathematics, and Science – Lithuania

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	8 (6.0)	—	7 (5.5)	—	7 (3.3) ▲	—	7 (3.4) ▲
	MAT	6 (6.5)	—	5 (6.3)	—	5 (3.7)	—	6 (3.8)
	SCI	8 (6.5)	—	7 (5.8)	—	7 (2.9) ▲	—	7 (2.9) ▲
Schools Support Academic Success	REA	11 (2.8) ▲	—	9 (2.6) ▲	—	0 (1.9)	—	0 (1.8)
	MAT	13 (3.4) ▲	—	12 (3.2) ▲	—	1 (2.0)	—	1 (2.0)
	SCI	10 (3.5) ▲	—	9 (3.3) ▲	—	-1 (2.1)	—	-1 (2.1)
Adequate Environment and Resources	REA	-4 (3.9)	—	-4 (4.0)	—	2 (1.8)	—	1 (1.8)
	MAT	-5 (4.6)	—	-5 (4.6)	—	2 (2.2)	—	2 (2.2)
	SCI	-5 (4.8)	—	-5 (4.8)	—	1 (2.2)	—	1 (2.2)
School Instruction								
Early Emphasis on Reading Skills	REA	—	5 (1.8) ▲	4 (1.9) ▲	—	—	2 (1.2)	2 (1.2)
	MAT	—	4 (2.1) ▲	3 (1.9)	—	—	2 (1.1)	2 (1.1)
	SCI	—	3 (2.0)	3 (2.0)	—	—	1 (1.2)	2 (1.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	18 (6.1) ▲	13 (5.0) ▲	—	—	8 (3.1) ▲	6 (3.1)
	MAT	—	14 (6.3) ▲	9 (5.3)	—	—	3 (3.6)	1 (3.5)
	SCI	—	18 (6.2) ▲	13 (4.8) ▲	—	—	7 (3.2) ▲	5 (3.1)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲
	MAT	—	—	—	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲
	SCI	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	15 (0.9) ▲	15 (0.9) ▲	15 (0.9) ▲	15 (0.9) ▲
	MAT	—	—	—	18 (0.9) ▲	18 (0.9) ▲	18 (0.9) ▲	18 (0.9) ▲
	SCI	—	—	—	14 (0.9) ▲	14 (0.9) ▲	14 (0.9) ▲	14 (0.9) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	19 (3.4) ▲	19 (3.1) ▲	18 (3.0) ▲	19 (2.8) ▲
	MAT	—	—	—	21 (3.7) ▲	21 (3.6) ▲	21 (3.6) ▲	21 (3.4) ▲
	SCI	—	—	—	18 (3.4) ▲	19 (3.3) ▲	18 (3.2) ▲	18 (3.1) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	26 (6.6) ▲	25 (5.8) ▲	24 (6.1) ▲	23 (5.2) ▲
	MAT	—	—	—	27 (5.4) ▲	26 (5.4) ▲	26 (5.5) ▲	26 (5.3) ▲
	SCI	—	—	—	29 (5.7) ▲	28 (5.5) ▲	27 (5.3) ▲	27 (5.1) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (19%)	24	15	31	78	82	80	83
Within Schools (81%)	—	—	—	21	21	21	21
Total	5	3	6	32	33	33	33
Mathematics							
Between Schools (20%)	23	9	27	78	81	78	81
Within Schools (80%)	—	—	—	22	22	22	22
Total	5	2	5	33	34	33	34
Science							
Between Schools (23%)	20	12	26	77	80	78	81
Within Schools (77%)	—	—	—	20	20	20	20
Total	5	3	6	33	34	33	34

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.20: School Effectiveness Models for Reading, Mathematics, and Science – Malta

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	21 (5.7) ▲	—	18 (5.6) ▲	—	11 (4.9) ▲	—	8 (4.1) ▲
	MAT	15 (3.6) ▲	—	14 (3.6) ▲	—	10 (3.2) ▲	—	9 (3.0) ▲
	SCI	16 (4.6) ▲	—	14 (4.6) ▲	—	7 (4.0)	—	6 (3.6)
Schools Support Academic Success	REA	21 (4.2) ▲	—	19 (4.1) ▲	—	8 (3.1) ▲	—	4 (2.9)
	MAT	12 (2.7) ▲	—	11 (2.7) ▲	—	6 (2.5) ▲	—	5 (2.6)
	SCI	18 (3.8) ▲	—	16 (3.8) ▲	—	6 (2.9) ▲	—	4 (2.9)
Adequate Environment and Resources	REA	0 (4.6)	—	-1 (4.5)	—	-3 (2.8)	—	-3 (2.7)
	MAT	-1 (2.9)	—	-1 (2.8)	—	-2 (2.2)	—	-2 (2.1)
	SCI	2 (3.9)	—	2 (3.9)	—	0 (2.6)	—	0 (2.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-2 (3.2)	-3 (2.7)	—	—	-2 (1.8)	-2 (1.7)
	MAT	—	-1 (2.2)	-3 (1.9)	—	—	-1 (1.6)	-2 (1.5)
	SCI	—	-1 (2.8)	-3 (2.4)	—	—	-2 (1.7)	-2 (1.7)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	47 (9.7) ▲	22 (8.1) ▲	—	—	30 (6.9) ▲	24 (6.3) ▲
	MAT	—	27 (6.8) ▲	10 (5.9)	—	—	17 (5.7) ▲	10 (5.5)
	SCI	—	36 (8.2) ▲	15 (7.1) ▲	—	—	21 (6.1) ▲	16 (6.1) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	24 (1.4) ▲	24 (1.4) ▲	24 (1.4) ▲	24 (1.4) ▲
	MAT	—	—	—	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲
	SCI	—	—	—	23 (1.6) ▲	23 (1.6) ▲	23 (1.6) ▲	23 (1.6) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲
	MAT	—	—	—	10 (1.0) ▲	10 (1.0) ▲	10 (1.0) ▲	10 (1.0) ▲
	SCI	—	—	—	8 (1.2) ▲	8 (1.2) ▲	8 (1.2) ▲	8 (1.2) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	65 (5.8) ▲	52 (6.9) ▲	64 (5.1) ▲	57 (6.3) ▲
	MAT	—	—	—	34 (4.5) ▲	24 (5.0) ▲	34 (4.1) ▲	25 (4.9) ▲
	SCI	—	—	—	55 (5.5) ▲	45 (6.2) ▲	55 (4.8) ▲	48 (5.8) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	41 (9.2) ▲	35 (9.4) ▲	22 (9.9) ▲	22 (9.9) ▲
	MAT	—	—	—	27 (8.0) ▲	21 (8.2) ▲	16 (8.6)	16 (8.8)
	SCI	—	—	—	32 (9.7) ▲	28 (9.6) ▲	19 (10.2)	20 (10.3)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (28%)	48	25	52	75	81	83	85
Within Schools (72%)	—	—	—	13	13	13	13
Total	13	7	14	30	32	33	33
Mathematics							
Between Schools (20%)	49	21	53	57	69	64	71
Within Schools (80%)	—	—	—	10	10	10	10
Total	10	4	10	19	22	21	22
Science							
Between Schools (24%)	44	20	48	74	78	80	81
Within Schools (76%)	—	—	—	13	13	13	13
Total	11	5	12	28	29	29	30

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.21: School Effectiveness Models for Reading, Mathematics, and Science – Morocco

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	5 (5.0)	—	1 (4.7)	—	4 (4.6)	—	0 (4.3)
	MAT	4 (5.0)	—	0 (4.8)	—	5 (4.8)	—	1 (4.7)
	SCI	5 (5.9)	—	0 (5.6)	—	5 (5.9)	—	1 (5.7)
Schools Support Academic Success	REA	18 (3.7) ▲	—	12 (3.7) ▲	—	13 (4.2) ▲	—	8 (3.9)
	MAT	12 (4.1) ▲	—	7 (4.2)	—	12 (4.9) ▲	—	8 (4.6)
	SCI	17 (4.6) ▲	—	11 (4.4) ▲	—	15 (5.8) ▲	—	10 (5.4)
Adequate Environment and Resources	REA	8 (3.7) ▲	—	10 (3.5) ▲	—	10 (3.5) ▲	—	11 (3.2) ▲
	MAT	10 (3.8) ▲	—	11 (3.5) ▲	—	9 (3.9) ▲	—	10 (3.6) ▲
	SCI	10 (4.3) ▲	—	11 (3.8) ▲	—	10 (4.4) ▲	—	11 (3.9) ▲
School Instruction								
Early Emphasis on Reading Skills	REA	—	11 (3.2) ▲	7 (3.6)	—	—	8 (3.5) ▲	6 (3.7)
	MAT	—	5 (3.3)	3 (3.9)	—	—	5 (3.6)	4 (3.9)
	SCI	—	7 (3.4) ▲	4 (4.0)	—	—	6 (3.7)	4 (4.0)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	30 (6.6) ▲	26 (6.6) ▲	—	—	27 (6.5) ▲	24 (6.5) ▲
	MAT	—	28 (7.0) ▲	25 (6.9) ▲	—	—	27 (6.9) ▲	24 (6.7) ▲
	SCI	—	34 (7.7) ▲	30 (7.6) ▲	—	—	33 (7.5) ▲	30 (7.3) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	1 (1.1)	1 (1.1)	1 (1.1)	1 (1.1)
	MAT	—	—	—	0 (1.2)	0 (1.2)	0 (1.2)	0 (1.2)
	SCI	—	—	—	1 (1.5)	1 (1.5)	1 (1.5)	1 (1.5)
Early Literacy/Numeracy Tasks	REA	—	—	—	14 (1.5) ▲	14 (1.5) ▲	14 (1.5) ▲	14 (1.5) ▲
	MAT	—	—	—	10 (1.4) ▲	10 (1.4) ▲	10 (1.4) ▲	10 (1.4) ▲
	SCI	—	—	—	15 (1.8) ▲	15 (1.8) ▲	15 (1.8) ▲	15 (1.8) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	17 (8.4) ▲	8 (8.5)	14 (7.2)	8 (7.3)
	MAT	—	—	—	8 (8.6)	0 (8.8)	6 (7.4)	1 (7.8)
	SCI	—	—	—	12 (9.6)	2 (10.1)	9 (8.0)	3 (8.8)
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	8 (6.4)	10 (6.1)	5 (5.4)	7 (5.3)
	MAT	—	—	—	-5 (7.2)	-3 (6.9)	-8 (6.1)	-6 (6.1)
	SCI	—	—	—	-3 (8.5)	-1 (8.1)	-7 (7.0)	-4 (7.0)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (38%)	22	27	37	17	29	35	41
Within Schools (62%)	—	—	—	7	7	7	7
Total	8	10	14	11	15	18	20
Mathematics							
Between Schools (44%)	13	20	26	1	12	20	25
Within Schools (56%)	—	—	—	6	6	6	6
Total	6	9	11	4	9	12	14
Science							
Between Schools (36%)	17	25	33	4	16	25	32
Within Schools (64%)	—	—	—	6	6	6	6
Total	6	9	12	6	10	13	15

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.22: School Effectiveness Models for Reading, Mathematics, and Science – Northern Ireland

TIMSS & PIRLS 2011 4th Grade

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	14 (4.0) ▲	—	14 (3.6) ▲	—	10 (3.4) ▲	—	10 (3.1) ▲
	MAT	20 (5.5) ▲	—	20 (5.0) ▲	—	14 (4.6) ▲	—	13 (4.3) ▲
	SCI	17 (5.4) ▲	—	16 (4.9) ▲	—	12 (5.1) ▲	—	11 (4.5) ▲
Schools Support Academic Success	REA	5 (2.2) ▲	—	5 (2.1) ▲	—	3 (1.6)	—	2 (1.6)
	MAT	4 (2.7)	—	3 (2.7)	—	0 (2.0)	—	0 (2.0)
	SCI	6 (2.3) ▲	—	5 (2.3)	—	3 (1.9)	—	2 (1.9)
Adequate Environment and Resources	REA	2 (1.9)	—	2 (1.9)	—	0 (1.5)	—	0 (1.5)
	MAT	1 (2.5)	—	1 (2.5)	—	-1 (1.8)	—	-1 (1.9)
	SCI	0 (2.5)	—	0 (2.6)	—	-1 (2.1)	—	-1 (2.1)
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (2.4)	2 (2.1)	—	—	-1 (1.7)	0 (1.5)
	MAT	—	-1 (3.0)	1 (2.7)	—	—	-3 (2.4)	-2 (2.2)
	SCI	—	-1 (2.9)	1 (2.5)	—	—	-2 (2.4)	-1 (2.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	10 (4.7) ▲	6 (4.3)	—	—	3 (4.4)	1 (3.8)
	MAT	—	14 (5.4) ▲	10 (4.8) ▲	—	—	5 (5.1)	3 (4.4)
	SCI	—	14 (5.5) ▲	9 (5.0)	—	—	6 (5.9)	4 (5.1)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	16 (1.1) ▲	16 (1.1) ▲	16 (1.1) ▲	16 (1.1) ▲
	MAT	—	—	—	16 (1.5) ▲	16 (1.5) ▲	16 (1.5) ▲	16 (1.5) ▲
	SCI	—	—	—	15 (0.9) ▲	15 (0.9) ▲	15 (0.9) ▲	15 (0.9) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	9 (1.4) ▲	9 (1.4) ▲	9 (1.4) ▲	9 (1.4) ▲
	MAT	—	—	—	9 (1.4) ▲	9 (1.4) ▲	9 (1.4) ▲	9 (1.4) ▲
	SCI	—	—	—	6 (1.3) ▲	5 (1.3) ▲	5 (1.3) ▲	5 (1.3) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	37 (5.2) ▲	32 (5.0) ▲	37 (5.3) ▲	31 (5.1) ▲
	MAT	—	—	—	48 (5.9) ▲	42 (5.7) ▲	48 (6.1) ▲	43 (5.9) ▲
	SCI	—	—	—	40 (6.0) ▲	34 (5.9) ▲	39 (6.3) ▲	34 (6.2) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	7 (8.7)	10 (7.6)	6 (10.0)	9 (8.6)
	MAT	—	—	—	6 (8.7)	11 (8.2)	4 (10.1)	10 (9.2)
	SCI	—	—	—	5 (9.2)	9 (8.5)	3 (11.1)	7 (9.7)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (11%)	36	7	40	67	79	68	79
Within Schools (89%)	—	—	—	8	8	8	8
Total	4	1	4	14	16	14	16
Mathematics							
Between Schools (17%)	28	7	31	60	68	62	69
Within Schools (83%)	—	—	—	8	8	8	8
Total	5	1	5	17	18	17	19
Science							
Between Schools (22%)	27	7	30	46	56	49	57
Within Schools (78%)	—	—	—	10	10	10	10
Total	6	2	6	18	20	18	20

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.23: School Effectiveness Models for Reading, Mathematics, and Science – Norway

Variables		HLM Regression Coefficients: School Explanatory Models – School Environment	School Explanatory Models – School Instruction	School Explanatory Models – School Environment and Instruction	Home Background Control Model	School Explanatory with Home Background Control Models – School Environment	School Explanatory with Home Background Control Models – School Instruction	School Explanatory with Home Background Control Models – School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	7 (3.7)	—	7 (3.9)	—	7 (3.7) ▲	—	7 (3.4) ▲
	MAT	10 (4.7) ▲	—	11 (5.2) ▲	—	11 (5.0) ▲	—	10 (4.8) ▲
	SCI	7 (3.8)	—	7 (4.0)	—	7 (3.3) ▲	—	6 (3.2)
Schools Support Academic Success	REA	6 (2.3) ▲	—	5 (2.4) ▲	—	3 (2.2)	—	2 (2.2)
	MAT	7 (3.4)	—	6 (3.5)	—	4 (3.6)	—	3 (3.4)
	SCI	7 (2.4) ▲	—	7 (2.5) ▲	—	3 (2.2)	—	2 (2.2)
Adequate Environment and Resources	REA	-5 (2.5)	—	-4 (2.5)	—	-2 (2.6)	—	-1 (2.4)
	MAT	-4 (3.2)	—	-4 (3.2)	—	-2 (3.4)	—	-1 (3.3)
	SCI	-4 (2.4)	—	-4 (2.4)	—	-1 (2.2)	—	0 (2.1)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (1.7)	-1 (1.6)	—	—	0 (1.6)	-1 (1.5)
	MAT	—	0 (2.2)	-1 (2.0)	—	—	0 (2.1)	-1 (1.9)
	SCI	—	-1 (1.5)	-1 (1.4)	—	—	0 (1.2)	-1 (1.1)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	8 (4.3)	4 (4.1)	—	—	9 (4.2) ▲	7 (3.9)
	MAT	—	8 (5.7)	4 (5.7)	—	—	11 (5.6)	7 (5.4)
	SCI	—	6 (4.4)	2 (4.3)	—	—	8 (4.3)	5 (4.0)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲
	MAT	—	—	—	9 (1.5) ▲	9 (1.5) ▲	9 (1.5) ▲	9 (1.5) ▲
	SCI	—	—	—	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲
	MAT	—	—	—	13 (0.9) ▲	13 (0.9) ▲	13 (0.9) ▲	13 (0.9) ▲
	SCI	—	—	—	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	20 (4.3) ▲	16 (4.9) ▲	21 (4.1) ▲	17 (4.5) ▲
	MAT	—	—	—	21 (5.6) ▲	15 (6.7) ▲	22 (5.3) ▲	17 (5.9) ▲
	SCI	—	—	—	21 (3.5) ▲	17 (4.3) ▲	21 (3.3) ▲	18 (3.8) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	5 (7.8)	11 (8.0)	6 (7.4)	10 (7.4)
	MAT	—	—	—	7 (10.1)	15 (10.4)	8 (9.9)	15 (10.1)
	SCI	—	—	—	4 (6.7)	9 (6.6)	5 (6.3)	9 (6.3)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained: School Explanatory Models – School Environment	School Explanatory Models – School Instruction	School Explanatory Models – School Environment and Instruction	Home Background Control Model	School Explanatory with Home Background Control Models – School Environment	School Explanatory with Home Background Control Models – School Instruction	School Explanatory with Home Background Control Models – School Environment and Instruction
Reading							
Between Schools (8%)	29	10	32	26	38	38	45
Within Schools (92%)	—	—	—	19	19	19	19
Total	2	1	3	19	20	20	21
Mathematics							
Between Schools (14%)	24	6	26	15	29	22	33
Within Schools (86%)	—	—	—	18	18	18	18
Total	3	1	3	18	20	19	20
Science							
Between Schools (9%)	32	6	33	29	43	37	47
Within Schools (91%)	—	—	—	21	21	21	21
Total	3	1	3	22	23	22	23

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.24: School Effectiveness Models for Reading, Mathematics, and Science – Oman

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	7 (3.7)	—	5 (3.5)	—	11 (3.3) ▲	—	9 (3.3) ▲
	MAT	8 (3.6) ▲	—	6 (3.5)	—	11 (3.4) ▲	—	8 (3.4) ▲
	SCI	10 (4.3) ▲	—	7 (4.0)	—	14 (4.0) ▲	—	9 (4.0) ▲
Schools Support Academic Success	REA	12 (2.7) ▲	—	9 (2.6) ▲	—	8 (2.5) ▲	—	7 (2.5) ▲
	MAT	12 (2.7) ▲	—	9 (2.7) ▲	—	8 (2.6) ▲	—	6 (2.6) ▲
	SCI	15 (3.1) ▲	—	11 (3.1) ▲	—	11 (2.9) ▲	—	8 (3.0) ▲
Adequate Environment and Resources	REA	3 (2.9)	—	4 (2.8)	—	0 (2.7)	—	1 (2.7)
	MAT	-1 (2.9)	—	1 (2.8)	—	-3 (2.8)	—	-1 (2.7)
	SCI	-2 (3.6)	—	0 (3.4)	—	-4 (3.4)	—	-2 (3.2)
School Instruction								
Early Emphasis on Reading Skills	REA	—	5 (2.0) ▲	4 (1.9)	—	—	2 (1.7)	2 (1.7)
	MAT	—	4 (2.0) ▲	3 (1.9)	—	—	2 (1.8)	2 (1.8)
	SCI	—	5 (2.3) ▲	3 (2.3)	—	—	2 (2.1)	2 (2.1)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	22 (4.2) ▲	19 (4.3) ▲	—	—	21 (4.4) ▲	17 (4.5) ▲
	MAT	—	24 (4.2) ▲	20 (4.5) ▲	—	—	23 (4.4) ▲	19 (4.7) ▲
	SCI	—	34 (5.3) ▲	30 (5.6) ▲	—	—	33 (5.5) ▲	29 (5.9) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲
	MAT	—	—	—	13 (0.9) ▲	13 (0.9) ▲	13 (0.9) ▲	13 (0.9) ▲
	SCI	—	—	—	15 (1.3) ▲	15 (1.3) ▲	15 (1.3) ▲	15 (1.3) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	19 (1.0) ▲	19 (1.0) ▲	19 (1.0) ▲	19 (1.0) ▲
	MAT	—	—	—	18 (0.9) ▲	18 (0.9) ▲	18 (0.9) ▲	18 (0.9) ▲
	SCI	—	—	—	22 (1.2) ▲	22 (1.2) ▲	22 (1.2) ▲	22 (1.2) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	22 (3.5) ▲	19 (3.5) ▲	19 (3.5) ▲	18 (3.5) ▲
	MAT	—	—	—	18 (3.9) ▲	16 (3.8) ▲	15 (3.7) ▲	14 (3.8) ▲
	SCI	—	—	—	18 (4.6) ▲	17 (4.4) ▲	16 (4.4) ▲	14 (4.4) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	-9 (13.9)	-6 (13.1)	-10 (11.6)	-7 (11.4)
	MAT	—	—	—	-5 (11.7)	-4 (11.0)	-7 (9.3)	-5 (9.1)
	SCI	—	—	—	-6 (15.2)	-4 (14.2)	-7 (11.4)	-6 (11.2)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (18%)	18	16	28	17	29	28	36
Within Schools (82%)	—	—	—	15	15	15	15
Total	3	3	5	15	18	17	19
Mathematics							
Between Schools (20%)	13	16	24	10	20	22	28
Within Schools (80%)	—	—	—	16	16	16	16
Total	3	3	5	15	17	17	18
Science							
Between Schools (21%)	14	21	28	7	19	24	30
Within Schools (79%)	—	—	—	17	17	17	17
Total	3	4	6	15	17	18	20

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.25: School Effectiveness Models for Reading, Mathematics, and Science – Poland

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	-7 (4.5)	—	-5 (4.4)	—	3 (3.6)	—	2 (3.4)
	MAT	-8 (5.0)	—	-6 (4.8)	—	1 (4.0)	—	0 (3.9)
	SCI	-8 (4.8)	—	-6 (4.6)	—	1 (3.7)	—	1 (3.5)
Schools Support Academic Success	REA	9 (2.1) ▲	—	8 (2.1) ▲	—	3 (1.9)	—	3 (1.8)
	MAT	8 (2.1) ▲	—	8 (2.0) ▲	—	3 (1.8)	—	3 (1.8)
	SCI	8 (2.2) ▲	—	8 (2.2) ▲	—	3 (1.9)	—	3 (1.9)
Adequate Environment and Resources	REA	-3 (2.0)	—	-3 (2.0)	—	-2 (1.9)	—	-1 (1.8)
	MAT	-3 (2.2)	—	-3 (2.2)	—	-1 (2.1)	—	-1 (2.1)
	SCI	-4 (2.2)	—	-4 (2.1)	—	-2 (1.9)	—	-2 (1.8)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (2.4)	-2 (2.3)	—	—	0 (1.7)	-1 (1.7)
	MAT	—	-1 (2.5)	-2 (2.4)	—	—	-1 (1.8)	-1 (1.8)
	SCI	—	-1 (2.5)	-2 (2.3)	—	—	-1 (1.8)	-1 (1.8)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-13 (6.1) ▼	-8 (5.5)	—	—	8 (5.5)	7 (5.3)
	MAT	—	-16 (6.5) ▼	-11 (5.7)	—	—	3 (6.1)	3 (5.8)
	SCI	—	-15 (6.0) ▼	-9 (5.5)	—	—	5 (5.5)	5 (5.4)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	18 (0.8) ▲	18 (0.8) ▲	18 (0.8) ▲	18 (0.8) ▲
	MAT	—	—	—	16 (0.8) ▲	16 (0.8) ▲	16 (0.8) ▲	16 (0.8) ▲
	SCI	—	—	—	18 (0.8) ▲	18 (0.8) ▲	18 (0.8) ▲	18 (0.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	13 (0.9) ▲	13 (0.9) ▲	13 (0.9) ▲	13 (0.9) ▲
	MAT	—	—	—	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲
	SCI	—	—	—	11 (0.9) ▲	11 (0.9) ▲	11 (0.9) ▲	11 (0.9) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	21 (2.6) ▲	20 (2.5) ▲	22 (2.6) ▲	22 (2.5) ▲
	MAT	—	—	—	19 (2.8) ▲	19 (2.6) ▲	20 (2.8) ▲	19 (2.7) ▲
	SCI	—	—	—	20 (2.5) ▲	20 (2.3) ▲	22 (2.7) ▲	21 (2.5) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	7 (5.2)	6 (5.4)	8 (5.3)	7 (5.4)
	MAT	—	—	—	10 (5.1)	9 (5.3)	10 (5.3)	9 (5.4)
	SCI	—	—	—	9 (5.2)	8 (5.5)	9 (5.2)	7 (5.5)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (10%)	22	6	24	64	67	67	70
Within Schools (90%)	—	—	—	25	25	25	25
Total	2	1	2	29	29	29	30
Mathematics							
Between Schools (13%)	22	10	26	59	61	60	62
Within Schools (87%)	—	—	—	26	26	26	26
Total	3	1	3	30	30	30	30
Science							
Between Schools (11%)	23	9	27	68	70	70	72
Within Schools (89%)	—	—	—	24	24	24	24
Total	2	1	3	29	29	29	30

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.26: School Effectiveness Models for Reading, Mathematics, and Science – Portugal

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	2 (3.5)	—	-2 (3.4)	—	4 (3.2)	—	1 (2.9)
	MAT	0 (5.6)	—	-4 (5.4)	—	6 (5.3)	—	1 (4.9)
	SCI	0 (5.1)	—	-4 (4.8)	—	3 (5.1)	—	-1 (4.7)
Schools Support Academic Success	REA	9 (2.8) ▲	—	8 (2.6) ▲	—	5 (2.3) ▲	—	4 (2.1)
	MAT	12 (4.3) ▲	—	9 (4.1) ▲	—	6 (3.3)	—	4 (3.1)
	SCI	12 (4.2) ▲	—	10 (3.9) ▲	—	8 (3.5) ▲	—	6 (3.2)
Adequate Environment and Resources	REA	-5 (2.6)	—	-5 (2.4) ▼	—	-7 (2.4) ▼	—	-7 (2.2) ▼
	MAT	-4 (3.8)	—	-4 (3.6)	—	-8 (3.3) ▼	—	-8 (3.2) ▼
	SCI	-5 (3.2)	—	-5 (3.0)	—	-7 (3.0) ▼	—	-7 (2.9) ▼
School Instruction								
Early Emphasis on Reading Skills	REA	—	-4 (2.4)	-4 (2.3)	—	—	-2 (2.0)	-2 (1.8)
	MAT	—	-6 (3.9)	-6 (3.8)	—	—	-5 (3.5)	-5 (3.3)
	SCI	—	-6 (3.5)	-6 (3.3)	—	—	-5 (3.4)	-5 (3.3)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	21 (4.7) ▲	17 (5.1) ▲	—	—	19 (4.8) ▲	17 (5.0) ▲
	MAT	—	25 (6.6) ▲	22 (7.5) ▲	—	—	23 (6.8) ▲	21 (7.4) ▲
	SCI	—	26 (6.7) ▲	23 (7.2) ▲	—	—	24 (7.2) ▲	22 (7.7) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲
	MAT	—	—	—	10 (1.0) ▲	10 (1.0) ▲	10 (1.0) ▲	10 (1.0) ▲
	SCI	—	—	—	11 (1.1) ▲	11 (1.1) ▲	11 (1.1) ▲	11 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
	MAT	—	—	—	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲
	SCI	—	—	—	8 (1.0) ▲	8 (1.1) ▲	8 (1.0) ▲	8 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	15 (3.8) ▲	14 (3.6) ▲	13 (3.2) ▲	13 (3.0) ▲
	MAT	—	—	—	17 (5.9) ▲	16 (5.6) ▲	15 (5.0) ▲	15 (4.8) ▲
	SCI	—	—	—	14 (5.7) ▲	12 (5.3) ▲	13 (4.7) ▲	12 (4.5) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	5 (4.6)	3 (5.0)	3 (4.6)	2 (4.6)
	MAT	—	—	—	-13 (8.8)	-14 (8.7)	-15 (8.7)	-16 (8.4)
	SCI	—	—	—	-7 (6.3)	-7 (6.5)	-9 (6.5)	-9 (6.2)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (18%)	26	26	40	28	44	50	57
Within Schools (82%)	—	—	—	15	15	15	15
Total	4	5	7	17	20	21	22
Mathematics							
Between Schools (38%)	15	21	29	15	24	33	37
Within Schools (62%)	—	—	—	15	15	15	15
Total	6	8	11	15	18	22	23
Science							
Between Schools (34%)	19	23	33	11	23	31	37
Within Schools (66%)	—	—	—	14	14	14	14
Total	6	8	11	13	17	20	22

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.27: School Effectiveness Models for Reading, Mathematics, and Science – Qatar

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	25 (6.6) ▲	—	18 (6.4) ▲	—	19 (4.4) ▲	—	17 (4.5) ▲
	MAT	18 (6.8) ▲	—	12 (6.7)	—	12 (4.5) ▲	—	11 (4.6) ▲
	SCI	26 (7.9) ▲	—	20 (7.9) ▲	—	19 (6.1) ▲	—	19 (6.1) ▲
Schools Support Academic Success	REA	12 (4.2) ▲	—	10 (4.0) ▲	—	5 (3.3)	—	4 (3.2)
	MAT	10 (4.6) ▲	—	9 (4.5) ▲	—	3 (3.5)	—	2 (3.5)
	SCI	12 (5.1) ▲	—	10 (5.1)	—	4 (4.3)	—	3 (4.3)
Adequate Environment and Resources	REA	8 (2.7) ▲	—	8 (2.5) ▲	—	4 (1.7) ▲	—	4 (1.6) ▲
	MAT	11 (3.0) ▲	—	10 (2.9) ▲	—	5 (2.0) ▲	—	5 (1.9) ▲
	SCI	8 (3.2) ▲	—	8 (3.1) ▲	—	4 (2.4)	—	4 (2.3)
School Instruction								
Early Emphasis on Reading Skills	REA	—	7 (2.9) ▲	3 (2.2)	—	—	1 (2.1)	-1 (1.8)
	MAT	—	7 (3.1) ▲	4 (2.4)	—	—	0 (2.2)	-1 (2.0)
	SCI	—	5 (3.6)	2 (2.9)	—	—	-1 (3.1)	-3 (2.7)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	47 (8.5) ▲	30 (7.8) ▲	—	—	29 (7.5) ▲	19 (6.8) ▲
	MAT	—	36 (8.7) ▲	22 (8.2) ▲	—	—	20 (7.5) ▲	12 (7.2)
	SCI	—	49 (10.9) ▲	31 (9.7) ▲	—	—	27 (10.3) ▲	16 (9.6)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	14 (1.4) ▲	14 (1.4) ▲	14 (1.4) ▲	14 (1.4) ▲
	MAT	—	—	—	11 (1.4) ▲	11 (1.4) ▲	11 (1.4) ▲	11 (1.4) ▲
	SCI	—	—	—	15 (1.3) ▲	15 (1.3) ▲	15 (1.3) ▲	15 (1.3) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	16 (1.3) ▲	16 (1.3) ▲	16 (1.3) ▲	16 (1.3) ▲
	MAT	—	—	—	13 (1.3) ▲	13 (1.3) ▲	13 (1.3) ▲	13 (1.3) ▲
	SCI	—	—	—	18 (1.4) ▲	18 (1.4) ▲	18 (1.4) ▲	18 (1.4) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	69 (5.9) ▲	57 (5.2) ▲	64 (6.1) ▲	56 (5.4) ▲
	MAT	—	—	—	71 (5.1) ▲	61 (5.4) ▲	68 (5.5) ▲	61 (5.5) ▲
	SCI	—	—	—	70 (6.8) ▲	58 (6.7) ▲	67 (7.5) ▲	59 (7.2) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	31 (11.2) ▲	28 (9.5) ▲	16 (10.2)	18 (9.5)
	MAT	—	—	—	18 (11.0)	17 (9.8)	8 (10.1)	11 (9.7)
	SCI	—	—	—	48 (14.2) ▲	45 (12.2) ▲	33 (12.7) ▲	36 (12.0) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (38%)	37	22	44	60	71	65	73
Within Schools (62%)	—	—	—	11	11	11	11
Total	14	8	17	29	34	31	35
Mathematics							
Between Schools (45%)	30	15	35	61	68	63	69
Within Schools (55%)	—	—	—	9	9	9	9
Total	14	7	16	32	36	34	36
Science							
Between Schools (42%)	29	16	34	50	59	53	60
Within Schools (58%)	—	—	—	12	12	12	12
Total	12	7	14	28	32	29	32

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.28: School Effectiveness Models for Reading, Mathematics, and Science – Romania

TIMSS & PIRLS 2011 4th Grade

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	11 (7.5)	—	6 (8.0)	—	9 (7.4)	—	7 (7.5)
	MAT	11 (9.9)	—	10 (10.7)	—	11 (10.0)	—	12 (10.3)
	SCI	13 (9.5)	—	8 (10.2)	—	10 (9.1)	—	9 (9.1)
Schools Support Academic Success	REA	10 (4.8)	—	11 (5.2) ▲	—	2 (5.2)	—	2 (5.3)
	MAT	12 (6.4)	—	13 (6.7)	—	8 (7.2)	—	7 (6.9)
	SCI	12 (5.8) ▲	—	13 (6.2) ▲	—	6 (6.8)	—	7 (6.6)
Adequate Environment and Resources	REA	1 (4.3)	—	1 (4.1)	—	-3 (4.0)	—	-3 (4.1)
	MAT	1 (5.0)	—	1 (5.0)	—	-3 (4.7)	—	-3 (4.8)
	SCI	1 (4.8)	—	1 (4.6)	—	-3 (4.5)	—	-3 (4.6)
School Instruction								
Early Emphasis on Reading Skills	REA	—	3 (6.3)	5 (6.0)	—	—	-2 (4.9)	-1 (5.1)
	MAT	—	0 (7.2)	2 (6.9)	—	—	-4 (6.0)	-2 (6.0)
	SCI	—	3 (7.0)	5 (6.6)	—	—	0 (5.5)	1 (5.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	19 (7.8) ▲	15 (8.4)	—	—	8 (7.7)	4 (7.4)
	MAT	—	12 (9.8)	6 (10.2)	—	—	2 (11.0)	-4 (9.9)
	SCI	—	19 (9.7) ▲	14 (10.2)	—	—	8 (9.5)	4 (8.6)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	16 (1.6) ▲	16 (1.6) ▲	16 (1.5) ▲	16 (1.6) ▲
	MAT	—	—	—	14 (2.1) ▲	14 (2.1) ▲	14 (2.1) ▲	14 (2.1) ▲
	SCI	—	—	—	16 (1.8) ▲	16 (1.8) ▲	16 (1.8) ▲	16 (1.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	9 (1.5) ▲	9 (1.5) ▲	9 (1.5) ▲	9 (1.5) ▲
	MAT	—	—	—	10 (2.5) ▲	10 (2.4) ▲	10 (2.5) ▲	10 (2.4) ▲
	SCI	—	—	—	10 (1.7) ▲	10 (1.7) ▲	10 (1.7) ▲	10 (1.7) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	25 (4.8) ▲	25 (4.9) ▲	24 (4.8) ▲	25 (4.7) ▲
	MAT	—	—	—	21 (6.6) ▲	19 (7.1) ▲	21 (6.7) ▲	20 (6.7) ▲
	SCI	—	—	—	23 (5.7) ▲	21 (6.3) ▲	21 (5.5) ▲	20 (5.9) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	3 (7.0)	1 (7.1)	4 (7.2)	2 (7.4)
	MAT	—	—	—	-1 (10.2)	-3 (10.0)	1 (9.8)	-2 (9.9)
	SCI	—	—	—	-1 (9.3)	-3 (9.0)	0 (9.1)	-3 (9.0)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (35%)	14	10	20	41	45	43	46
Within Schools (65%)	—	—	—	21	21	21	21
Total	5	3	7	28	30	29	30
Mathematics							
Between Schools (38%)	14	3	16	13	20	14	20
Within Schools (62%)	—	—	—	24	24	24	24
Total	6	1	6	19	22	20	22
Science							
Between Schools (37%)	15	8	20	23	30	25	30
Within Schools (63%)	—	—	—	23	23	23	23
Total	6	3	7	23	25	24	25

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.29: School Effectiveness Models for Reading, Mathematics, and Science – Russian Federation

Variables		HLM Regression Coefficients: School Explanatory Models – School Environment	School Explanatory Models – School Instruction	School Explanatory Models – School Environment and Instruction	Home Background Control Model	School Explanatory with Home Background Control Models – School Environment	School Explanatory with Home Background Control Models – School Instruction	School Explanatory with Home Background Control Models – School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	3 (4.2)	—	4 (4.5)	—	6 (3.7)	—	5 (4.1)
	MAT	6 (5.3)	—	8 (5.5)	—	8 (4.6)	—	8 (4.6)
	SCI	5 (5.2)	—	5 (5.4)	—	7 (4.6)	—	6 (4.7)
Schools Support Academic Success	REA	3 (3.2)	—	3 (3.3)	—	-2 (2.9)	—	-3 (2.8)
	MAT	0 (3.3)	—	0 (3.4)	—	-5 (2.9)	—	-5 (2.9)
	SCI	2 (3.6)	—	1 (3.6)	—	-4 (3.2)	—	-4 (3.2)
Adequate Environment and Resources	REA	3 (2.2)	—	3 (2.3)	—	1 (2.1)	—	2 (2.1)
	MAT	1 (2.3)	—	2 (2.4)	—	0 (2.3)	—	1 (2.3)
	SCI	3 (2.5)	—	3 (2.5)	—	2 (2.4)	—	2 (2.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (1.7)	-2 (1.8)	—	—	-2 (1.6)	-2 (1.6)
	MAT	—	-2 (2.4)	-4 (2.4)	—	—	-2 (2.2)	-3 (2.2)
	SCI	—	-1 (2.3)	-2 (2.4)	—	—	-1 (2.1)	-2 (2.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	1 (3.4)	0 (3.6)	—	—	5 (3.0)	4 (3.2)
	MAT	—	1 (4.2)	-1 (4.4)	—	—	4 (3.8)	2 (4.0)
	SCI	—	2 (4.4)	1 (4.7)	—	—	5 (3.9)	3 (4.1)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	10 (1.2) ▲	10 (1.2) ▲	10 (1.2) ▲	10 (1.2) ▲
	MAT	—	—	—	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲
	SCI	—	—	—	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲
	MAT	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
	SCI	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	24 (4.2) ▲	25 (4.2) ▲	24 (4.1) ▲	25 (4.1) ▲
	MAT	—	—	—	23 (5.4) ▲	25 (5.2) ▲	22 (5.4) ▲	24 (5.2) ▲
	SCI	—	—	—	24 (5.0) ▲	25 (5.0) ▲	23 (5.0) ▲	25 (5.0) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	2 (4.8)	2 (4.6)	4 (4.8)	3 (4.7)
	MAT	—	—	—	4 (7.2)	3 (6.9)	5 (7.3)	4 (7.0)
	SCI	—	—	—	2 (6.7)	1 (6.4)	3 (6.6)	3 (6.4)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained: School Explanatory Models – School Environment	School Explanatory Models – School Instruction	School Explanatory Models – School Environment and Instruction	Home Background Control Model	School Explanatory with Home Background Control Models – School Environment	School Explanatory with Home Background Control Models – School Instruction	School Explanatory with Home Background Control Models – School Environment and Instruction
Reading							
Between Schools (25%)	4	0	5	40	42	42	43
Within Schools (75%)	—	—	—	16	16	16	16
Total	1	0	1	22	22	22	22
Mathematics							
Between Schools (34%)	2	1	4	20	22	21	24
Within Schools (66%)	—	—	—	12	12	12	12
Total	1	0	1	15	16	16	16
Science							
Between Schools (33%)	3	0	4	25	27	26	28
Within Schools (67%)	—	—	—	13	13	13	13
Total	1	0	1	16	17	17	18

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.30: School Effectiveness Models for Reading, Mathematics, and Science – Saudi Arabia

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	5 (4.1)	—	-1 (3.7)	—	5 (3.8)	—	0 (3.6)
	MAT	2 (5.1)	—	-1 (5.2)	—	1 (5.1)	—	0 (5.3)
	SCI	4 (4.8)	—	-1 (4.6)	—	5 (4.4)	—	1 (4.5)
Schools Support Academic Success	REA	18 (3.2) ▲	—	15 (3.2) ▲	—	14 (3.4) ▲	—	12 (3.4) ▲
	MAT	13 (4.7) ▲	—	12 (4.7) ▲	—	10 (4.6) ▲	—	9 (4.7)
	SCI	18 (4.1) ▲	—	15 (4.1) ▲	—	13 (3.9) ▲	—	12 (3.9) ▲
Adequate Environment and Resources	REA	5 (4.5)	—	5 (3.8)	—	3 (4.1)	—	4 (3.7)
	MAT	0 (5.6)	—	0 (5.5)	—	-1 (5.8)	—	-1 (5.7)
	SCI	4 (5.4)	—	3 (5.1)	—	1 (5.4)	—	2 (5.2)
School Instruction								
Early Emphasis on Reading Skills	REA	—	3 (2.8)	1 (2.4)	—	—	0 (2.6)	0 (2.4)
	MAT	—	1 (3.6)	0 (3.5)	—	—	-1 (3.4)	-1 (3.3)
	SCI	—	3 (3.3)	1 (3.0)	—	—	-1 (3.1)	-1 (2.8)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	41 (7.4) ▲	31 (7.4) ▲	—	—	33 (6.4) ▲	26 (6.8) ▲
	MAT	—	21 (7.6) ▲	14 (7.6)	—	—	14 (7.3)	10 (7.9)
	SCI	—	38 (7.1) ▲	28 (7.0) ▲	—	—	30 (6.9) ▲	23 (7.5) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	5 (1.1) ▲	5 (1.1) ▲	5 (1.1) ▲	5 (1.1) ▲
	MAT	—	—	—	5 (1.4) ▲	5 (1.4) ▲	5 (1.4) ▲	5 (1.4) ▲
	SCI	—	—	—	8 (1.4) ▲	8 (1.4) ▲	8 (1.4) ▲	8 (1.4) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	11 (1.1) ▲	11 (1.1) ▲	11 (1.1) ▲	11 (1.1) ▲
	MAT	—	—	—	10 (1.1) ▲	10 (1.1) ▲	10 (1.1) ▲	10 (1.1) ▲
	SCI	—	—	—	10 (1.4) ▲	10 (1.4) ▲	10 (1.3) ▲	10 (1.3) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	18 (5.6) ▲	9 (6.0)	16 (5.1) ▲	9 (5.7)
	MAT	—	—	—	11 (6.7)	6 (7.2)	10 (6.8)	6 (7.2)
	SCI	—	—	—	19 (6.4) ▲	10 (6.8)	17 (6.2) ▲	11 (6.6)
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	18 (6.4) ▲	16 (6.0) ▲	9 (5.3)	9 (5.2)
	MAT	—	—	—	15 (6.9) ▲	13 (6.6)	11 (6.9)	11 (6.9)
	SCI	—	—	—	20 (6.3) ▲	17 (5.8) ▲	11 (5.7) ▲	11 (5.6)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (36%)	34	31	47	27	44	41	51
Within Schools (64%)	—	—	—	6	6	6	6
Total	12	11	17	13	20	19	22
Mathematics							
Between Schools (37%)	13	7	15	9	17	12	17
Within Schools (63%)	—	—	—	6	6	6	6
Total	5	3	6	7	10	8	10
Science							
Between Schools (37%)	26	21	35	19	33	28	38
Within Schools (63%)	—	—	—	8	7	8	8
Total	10	8	13	12	17	15	19

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.31: School Effectiveness Models for Reading, Mathematics, and Science – Singapore

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	7 (4.8)	—	8 (4.7)	—	1 (1.9)	—	2 (1.9)
	MAT	6 (4.4)	—	6 (4.3)	—	1 (2.2)	—	1 (2.2)
	SCI	6 (4.8)	—	6 (4.7)	—	0 (2.1)	—	0 (2.1)
Schools Support Academic Success	REA	13 (2.8) ▲	—	14 (2.8) ▲	—	1 (1.4)	—	2 (1.4)
	MAT	12 (2.7) ▲	—	12 (2.6) ▲	—	1 (1.5)	—	2 (1.5)
	SCI	14 (2.9) ▲	—	15 (2.8) ▲	—	2 (1.4)	—	2 (1.4)
Adequate Environment and Resources	REA	-5 (2.5)	—	-4 (2.4)	—	1 (1.0)	—	1 (1.0)
	MAT	-5 (2.2) ▼	—	-4 (2.2)	—	0 (1.0)	—	0 (1.0)
	SCI	-5 (2.4) ▼	—	-4 (2.4)	—	1 (0.9)	—	1 (1.0)
School Instruction								
Early Emphasis on Reading Skills	REA	—	0 (2.3)	-2 (2.0)	—	—	-1 (0.8)	-1 (0.8)
	MAT	—	0 (2.0)	-1 (1.8)	—	—	-1 (0.9)	-1 (0.9)
	SCI	—	0 (2.3)	-2 (2.0)	—	—	-1 (0.8)	-1 (0.8)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	9 (7.7)	12 (6.9)	—	—	6 (3.4)	6 (3.4)
	MAT	—	10 (6.9)	13 (6.2) ▲	—	—	7 (3.5) ▲	7 (3.5) ▲
	SCI	—	7 (7.6)	10 (6.8)	—	—	4 (3.4)	5 (3.4)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	15 (0.7) ▲	15 (0.7) ▲	15 (0.7) ▲	15 (0.7) ▲
	MAT	—	—	—	12 (0.8) ▲	12 (0.8) ▲	12 (0.8) ▲	12 (0.8) ▲
	SCI	—	—	—	17 (0.8) ▲	17 (0.8) ▲	17 (0.8) ▲	17 (0.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	16 (1.1) ▲	16 (1.1) ▲	16 (1.1) ▲	16 (1.1) ▲
	MAT	—	—	—	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲
	SCI	—	—	—	16 (1.1) ▲	16 (1.1) ▲	16 (1.1) ▲	16 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	29 (2.6) ▲	27 (3.1) ▲	30 (2.7) ▲	28 (3.1) ▲
	MAT	—	—	—	25 (2.6) ▲	23 (3.2) ▲	26 (2.6) ▲	23 (3.2) ▲
	SCI	—	—	—	32 (2.5) ▲	30 (3.0) ▲	32 (2.5) ▲	30 (3.0) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	51 (4.4) ▲	52 (4.5) ▲	50 (4.5) ▲	51 (4.6) ▲
	MAT	—	—	—	48 (4.4) ▲	49 (4.6) ▲	46 (4.5) ▲	48 (4.6) ▲
	SCI	—	—	—	47 (4.3) ▲	48 (4.5) ▲	46 (4.4) ▲	47 (4.6) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (25%)	23	1	25	88	88	88	89
Within Schools (75%)	—	—	—	22	22	22	22
Total	6	0	6	38	38	38	38
Mathematics							
Between Schools (25%)	22	1	24	84	84	84	85
Within Schools (75%)	—	—	—	21	21	21	21
Total	5	0	6	37	37	37	37
Science							
Between Schools (25%)	24	1	25	88	88	88	89
Within Schools (75%)	—	—	—	24	24	24	24
Total	6	0	6	40	41	41	41

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.32: School Effectiveness Models for Reading, Mathematics, and Science – Slovak Republic

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	8 (3.8) ▲	—	8 (3.7) ▲	—	8 (4.0)	—	7 (3.7)
	MAT	14 (5.0) ▲	—	13 (4.9) ▲	—	13 (5.2) ▲	—	12 (4.9) ▲
	SCI	12 (4.6) ▲	—	11 (4.6) ▲	—	12 (4.9) ▲	—	10 (4.6) ▲
Schools Support Academic Success	REA	9 (3.1) ▲	—	9 (3.2) ▲	—	3 (2.6)	—	3 (2.7)
	MAT	10 (4.3) ▲	—	11 (4.3) ▲	—	5 (3.6)	—	5 (3.4)
	SCI	9 (4.0) ▲	—	10 (4.0) ▲	—	4 (3.3)	—	4 (3.2)
Adequate Environment and Resources	REA	-2 (2.8)	—	-2 (2.8)	—	-2 (2.6)	—	-2 (2.6)
	MAT	-4 (3.2)	—	-4 (3.1)	—	-4 (3.2)	—	-4 (3.1)
	SCI	-4 (3.4)	—	-4 (3.3)	—	-3 (3.2)	—	-4 (3.1)
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (2.2)	1 (1.9)	—	—	0 (1.8)	0 (1.6)
	MAT	—	2 (2.7)	1 (2.4)	—	—	2 (2.4)	2 (2.2)
	SCI	—	1 (2.6)	1 (2.3)	—	—	1 (2.2)	1 (2.1)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	0 (4.6)	0 (4.1)	—	—	3 (5.1)	2 (4.7)
	MAT	—	4 (6.2)	5 (5.6)	—	—	9 (6.5)	8 (5.9)
	SCI	—	3 (5.2)	4 (4.7)	—	—	7 (5.8)	6 (5.2)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	16 (0.8) ▲	16 (0.8) ▲	16 (0.8) ▲	16 (0.8) ▲
	MAT	—	—	—	17 (0.9) ▲	17 (0.9) ▲	17 (0.9) ▲	17 (0.9) ▲
	SCI	—	—	—	17 (1.0) ▲	17 (1.0) ▲	17 (1.0) ▲	17 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲
	MAT	—	—	—	8 (0.9) ▲	8 (0.9) ▲	8 (0.9) ▲	8 (0.9) ▲
	SCI	—	—	—	7 (0.8) ▲	7 (0.8) ▲	7 (0.8) ▲	7 (0.8) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	17 (4.7) ▲	15 (4.6) ▲	18 (4.6) ▲	15 (4.5) ▲
	MAT	—	—	—	19 (5.7) ▲	15 (5.4) ▲	20 (5.5) ▲	16 (5.2) ▲
	SCI	—	—	—	18 (5.2) ▲	15 (5.0) ▲	19 (4.9) ▲	16 (4.8) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	-6 (7.5)	-5 (6.7)	-7 (7.2)	-6 (6.6)
	MAT	—	—	—	-13 (9.4)	-12 (8.1)	-16 (8.8)	-14 (7.8)
	SCI	—	—	—	-12 (8.7)	-11 (7.5)	-14 (8.2)	-12 (7.2)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (18%)	19	0	20	29	35	30	35
Within Schools (82%)	—	—	—	18	18	18	18
Total	4	0	4	20	21	20	21
Mathematics							
Between Schools (27%)	20	1	21	16	26	19	29
Within Schools (73%)	—	—	—	20	20	20	20
Total	5	0	6	19	21	19	22
Science							
Between Schools (26%)	17	1	18	17	25	20	27
Within Schools (74%)	—	—	—	19	19	19	19
Total	4	0	5	18	20	19	21

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.33: School Effectiveness Models for Reading, Mathematics, and Science – Slovenia

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	1 (2.8)	—	2 (3.0)	—	1 (2.6)	—	2 (2.5)
	MAT	1 (2.4)	—	2 (2.6)	—	1 (2.2)	—	1 (2.2)
	SCI	2 (2.9)	—	3 (2.9)	—	1 (2.6)	—	2 (2.5)
Schools Support Academic Success	REA	3 (1.9)	—	4 (1.8) ▲	—	0 (1.8)	—	0 (1.8)
	MAT	4 (1.7) ▲	—	4 (1.7) ▲	—	0 (1.7)	—	1 (1.8)
	SCI	3 (2.0)	—	3 (1.9)	—	-1 (1.9)	—	-1 (2.0)
Adequate Environment and Resources	REA	0 (1.5)	—	0 (1.5)	—	2 (1.2)	—	2 (1.2)
	MAT	0 (1.5)	—	-1 (1.6)	—	1 (1.2)	—	1 (1.3)
	SCI	0 (1.7)	—	0 (1.7)	—	1 (1.4)	—	1 (1.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-1 (1.2)	-1 (1.3)	—	—	0 (1.2)	0 (1.2)
	MAT	—	-1 (1.4)	-2 (1.4)	—	—	-1 (1.3)	-1 (1.3)
	SCI	—	-1 (1.6)	-2 (1.7)	—	—	-1 (1.5)	-1 (1.5)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-3 (3.9)	-4 (3.8)	—	—	-1 (3.7)	-2 (3.6)
	MAT	—	-5 (4.7)	-6 (4.7)	—	—	-4 (4.6)	-4 (4.6)
	SCI	—	-5 (4.5)	-6 (4.4)	—	—	-4 (4.5)	-4 (4.5)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	21 (0.9) ▲	21 (0.9) ▲	21 (0.9) ▲	21 (0.9) ▲
	MAT	—	—	—	19 (1.2) ▲	19 (1.2) ▲	19 (1.2) ▲	19 (1.2) ▲
	SCI	—	—	—	22 (1.3) ▲	22 (1.3) ▲	22 (1.3) ▲	22 (1.3) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲
	MAT	—	—	—	11 (0.8) ▲	11 (0.8) ▲	11 (0.8) ▲	11 (0.7) ▲
	SCI	—	—	—	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	26 (2.9) ▲	26 (3.1) ▲	26 (2.8) ▲	25 (3.1) ▲
	MAT	—	—	—	26 (3.0) ▲	25 (3.2) ▲	25 (2.9) ▲	25 (3.1) ▲
	SCI	—	—	—	29 (3.5) ▲	29 (3.8) ▲	28 (3.4) ▲	28 (3.7) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	7 (3.8)	8 (3.9)	7 (3.8)	8 (3.9)
	MAT	—	—	—	8 (4.6)	9 (4.6)	8 (4.5)	9 (4.6)
	SCI	—	—	—	2 (5.2)	3 (5.2)	2 (5.2)	3 (5.2)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (5%)	5	1	8	52	54	52	55
Within Schools (95%)	—	—	—	23	23	23	23
Total	0	0	0	25	25	25	25
Mathematics							
Between Schools (8%)	4	3	10	44	45	46	47
Within Schools (92%)	—	—	—	26	26	26	26
Total	0	0	1	28	28	28	28
Science							
Between Schools (8%)	3	3	8	44	45	45	46
Within Schools (92%)	—	—	—	24	24	24	24
Total	0	0	1	26	26	26	26

( ) Percentage of available variance shown in parentheses.

Exhibit 3.34: School Effectiveness Models for Reading, Mathematics, and Science – Spain

TIMSS & PIRLS 2011 4th Grade

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	5 (3.3)	—	5 (3.1)	—	5 (2.9)	—	5 (2.8)
	MAT	7 (3.5) ▲	—	6 (3.3) ▲	—	7 (2.8) ▲	—	6 (2.7) ▲
	SCI	6 (3.6)	—	5 (3.5)	—	6 (3.2)	—	5 (3.1)
Schools Support Academic Success	REA	8 (3.0) ▲	—	8 (2.6) ▲	—	0 (2.9)	—	1 (2.6)
	MAT	9 (2.7) ▲	—	10 (2.4) ▲	—	1 (2.2)	—	2 (2.1)
	SCI	8 (2.9) ▲	—	8 (2.6) ▲	—	1 (2.7)	—	1 (2.5)
Adequate Environment and Resources	REA	-2 (2.0)	—	-2 (1.9)	—	0 (1.7)	—	0 (1.7)
	MAT	-3 (2.0)	—	-3 (1.9)	—	-1 (1.7)	—	0 (1.6)
	SCI	-3 (2.2)	—	-2 (2.2)	—	0 (2.0)	—	0 (2.0)
School Instruction								
Early Emphasis on Reading Skills	REA	—	-3 (1.6)	-4 (1.6) ▼	—	—	-1 (1.3)	-2 (1.3)
	MAT	—	-1 (1.5)	-3 (1.5) ▼	—	—	0 (1.2)	-1 (1.4)
	SCI	—	-2 (1.7)	-3 (1.7)	—	—	-1 (1.4)	-1 (1.5)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	9 (4.6)	7 (3.7)	—	—	6 (3.9)	5 (3.7)
	MAT	—	10 (4.3) ▲	8 (3.3) ▲	—	—	8 (3.2) ▲	6 (2.8) ▲
	SCI	—	8 (4.7)	5 (3.9)	—	—	5 (4.0)	4 (3.7)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲
	MAT	—	—	—	11 (0.9) ▲	11 (0.9) ▲	11 (0.9) ▲	11 (0.9) ▲
	SCI	—	—	—	13 (1.0) ▲	13 (1.0) ▲	13 (1.0) ▲	13 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲
	MAT	—	—	—	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲	12 (1.0) ▲
	SCI	—	—	—	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	17 (2.7) ▲	16 (3.0) ▲	17 (2.8) ▲	15 (3.0) ▲
	MAT	—	—	—	21 (2.9) ▲	19 (2.9) ▲	20 (2.8) ▲	18 (2.9) ▲
	SCI	—	—	—	17 (3.1) ▲	15 (3.1) ▲	16 (3.1) ▲	14 (3.1) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	22 (5.3) ▲	20 (5.7) ▲	22 (5.2) ▲	20 (5.5) ▲
	MAT	—	—	—	22 (4.8) ▲	19 (4.7) ▲	23 (4.6) ▲	19 (4.4) ▲
	SCI	—	—	—	25 (5.2) ▲	22 (5.8) ▲	25 (5.1) ▲	23 (5.7) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (18%)	23	6	29	40	45	44	48
Within Schools (82%)	—	—	—	15	15	15	15
Total	4	1	5	20	21	20	21
Mathematics							
Between Schools (21%)	34	7	39	55	62	58	64
Within Schools (79%)	—	—	—	18	18	18	18
Total	7	1	8	26	27	26	28
Science							
Between Schools (19%)	24	4	28	42	47	44	49
Within Schools (81%)	—	—	—	18	18	18	18
Total	5	1	5	23	24	23	24

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.35: School Effectiveness Models for Reading, Mathematics, and Science – Sweden

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	11 (2.7) ▲	—	11 (2.8) ▲	—	2 (2.1)	—	2 (2.2)
	MAT	9 (2.4) ▲	—	9 (2.3) ▲	—	2 (1.9)	—	2 (1.9)
	SCI	14 (3.1) ▲	—	14 (3.1) ▲	—	4 (2.4)	—	4 (2.5)
Schools Support Academic Success	REA	2 (2.1)	—	2 (2.1)	—	-1 (1.6)	—	-1 (1.6)
	MAT	5 (1.7) ▲	—	5 (1.7) ▲	—	3 (1.3)	—	2 (1.4)
	SCI	3 (2.1)	—	3 (2.2)	—	0 (1.5)	—	0 (1.6)
Adequate Environment and Resources	REA	3 (2.0)	—	3 (2.0)	—	1 (1.6)	—	1 (1.5)
	MAT	1 (1.9)	—	1 (1.9)	—	0 (1.5)	—	0 (1.5)
	SCI	2 (2.1)	—	2 (2.1)	—	1 (1.7)	—	1 (1.7)
School Instruction								
Early Emphasis on Reading Skills	REA	—	1 (1.7)	0 (1.6)	—	—	1 (1.1)	1 (1.2)
	MAT	—	2 (1.4)	0 (1.2)	—	—	2 (1.0)	1 (0.9)
	SCI	—	2 (1.8)	0 (1.9)	—	—	1 (1.2)	1 (1.3)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-3 (4.6)	-3 (3.7)	—	—	1 (3.0)	1 (3.0)
	MAT	—	-5 (3.9)	-5 (3.0)	—	—	-2 (3.0)	-2 (2.8)
	SCI	—	-5 (5.6)	-5 (4.4)	—	—	1 (3.6)	0 (3.5)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲
	MAT	—	—	—	11 (0.9) ▲	11 (0.9) ▲	11 (0.9) ▲	11 (0.9) ▲
	SCI	—	—	—	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲
	MAT	—	—	—	14 (1.1) ▲	14 (1.1) ▲	14 (1.1) ▲	14 (1.1) ▲
	SCI	—	—	—	10 (1.1) ▲	10 (1.1) ▲	10 (1.1) ▲	10 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	29 (2.2) ▲	28 (2.6) ▲	29 (2.3) ▲	28 (2.8) ▲
	MAT	—	—	—	24 (1.9) ▲	21 (2.0) ▲	24 (1.9) ▲	21 (2.1) ▲
	SCI	—	—	—	35 (2.6) ▲	32 (2.8) ▲	35 (2.7) ▲	32 (2.9) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	0 (5.0)	0 (5.0)	-1 (4.9)	-1 (5.0)
	MAT	—	—	—	9 (4.0) ▲	8 (4.0) ▲	9 (4.0) ▲	9 (4.1) ▲
	SCI	—	—	—	-7 (5.3)	-8 (5.6)	-8 (5.1)	-8 (5.5)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (13%)	29	2	29	76	77	76	77
Within Schools (87%)	—	—	—	18	18	18	18
Total	4	0	4	25	25	25	25
Mathematics							
Between Schools (12%)	39	4	41	77	80	79	81
Within Schools (88%)	—	—	—	21	21	21	21
Total	4	0	5	28	28	28	28
Science							
Between Schools (15%)	35	2	37	78	80	78	80
Within Schools (85%)	—	—	—	19	19	19	19
Total	5	0	5	28	28	28	28

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.36: School Effectiveness Models for Reading, Mathematics, and Science – United Arab Emirates

TIMSS & PIRLS 2011 4th Grade

Variables		HLM Regression Coefficients: School Explanatory Models – School Environment	School Explanatory Models – School Instruction	School Explanatory Models – School Environment and Instruction	Home Background Control Model	School Explanatory with Home Background Control Models – School Environment	School Explanatory with Home Background Control Models – School Instruction	School Explanatory with Home Background Control Models – School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	17 (3.6) ▲	—	10 (3.4) ▲	—	12 (3.1) ▲	—	6 (2.9) ▲
	MAT	12 (3.5) ▲	—	7 (3.4)	—	7 (3.2) ▲	—	3 (3.1)
	SCI	14 (3.7) ▲	—	7 (3.5)	—	9 (3.4) ▲	—	3 (3.1)
Schools Support Academic Success	REA	12 (3.1) ▲	—	9 (2.9) ▲	—	6 (2.4) ▲	—	5 (2.3) ▲
	MAT	10 (2.9) ▲	—	8 (2.7) ▲	—	6 (2.4) ▲	—	4 (2.3)
	SCI	13 (3.1) ▲	—	11 (2.9) ▲	—	8 (2.7) ▲	—	7 (2.5) ▲
Adequate Environment and Resources	REA	7 (2.4) ▲	—	6 (2.4) ▲	—	-1 (2.1)	—	-1 (2.2)
	MAT	6 (2.2) ▲	—	5 (2.3)	—	-1 (2.1)	—	-1 (2.2)
	SCI	6 (2.3) ▲	—	4 (2.4)	—	-1 (2.2)	—	-1 (2.3)
School Instruction								
Early Emphasis on Reading Skills	REA	—	13 (1.6) ▲	10 (1.6) ▲	—	—	5 (1.4) ▲	4 (1.3) ▲
	MAT	—	12 (1.5) ▲	10 (1.5) ▲	—	—	5 (1.5) ▲	5 (1.4) ▲
	SCI	—	11 (1.6) ▲	9 (1.6) ▲	—	—	4 (1.6) ▲	4 (1.5) ▲
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	28 (5.6) ▲	20 (5.6) ▲	—	—	26 (5.0) ▲	22 (5.0) ▲
	MAT	—	20 (5.2) ▲	15 (5.3) ▲	—	—	19 (4.8) ▲	16 (4.9) ▲
	SCI	—	30 (5.5) ▲	24 (5.5) ▲	—	—	27 (5.0) ▲	24 (5.1) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲
	MAT	—	—	—	9 (0.7) ▲	9 (0.7) ▲	9 (0.7) ▲	9 (0.7) ▲
	SCI	—	—	—	13 (1.0) ▲	13 (1.0) ▲	13 (1.0) ▲	13 (1.0) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (0.6) ▲	11 (0.6) ▲	11 (0.6) ▲	11 (0.6) ▲
	MAT	—	—	—	10 (0.6) ▲	10 (0.6) ▲	10 (0.6) ▲	10 (0.6) ▲
	SCI	—	—	—	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲	13 (0.8) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	48 (2.8) ▲	44 (2.9) ▲	43 (2.8) ▲	42 (3.0) ▲
	MAT	—	—	—	42 (2.6) ▲	39 (2.9) ▲	37 (2.7) ▲	36 (3.0) ▲
	SCI	—	—	—	41 (2.8) ▲	37 (3.1) ▲	37 (3.0) ▲	36 (3.3) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	17 (6.1) ▲	16 (6.5) ▲	11 (6.3)	11 (6.7)
	MAT	—	—	—	9 (6.3)	8 (6.6)	6 (6.5)	6 (6.8)
	SCI	—	—	—	22 (6.4) ▲	20 (6.8) ▲	15 (6.6) ▲	13 (6.9)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained: School Explanatory Models – School Environment	School Explanatory Models – School Instruction	School Explanatory Models – School Environment and Instruction	Home Background Control Model	School Explanatory with Home Background Control Models – School Environment	School Explanatory with Home Background Control Models – School Instruction	School Explanatory with Home Background Control Models – School Environment and Instruction
Reading							
Between Schools (43%)	21	25	34	48	54	58	60
Within Schools (57%)	—	—	—	10	10	10	10
Total	9	10	14	26	29	30	31
Mathematics							
Between Schools (45%)	16	21	28	40	44	48	49
Within Schools (55%)	—	—	—	9	9	9	9
Total	7	9	12	23	24	26	27
Science							
Between Schools (41%)	19	23	31	38	44	49	51
Within Schools (59%)	—	—	—	11	11	11	11
Total	8	9	13	22	24	26	27

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.37: School Effectiveness Models for Reading, Mathematics, and Science – Botswana

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	15 (4.8) ▲	—	7 (4.7)	—	12 (3.1) ▲	—	7 (3.3) ▲
	MAT	15 (3.7) ▲	—	8 (3.6) ▲	—	13 (3.0) ▲	—	8 (3.1) ▲
	SCI	20 (5.7) ▲	—	9 (5.4)	—	17 (4.1) ▲	—	9 (4.1) ▲
Schools Support Academic Success	REA	19 (2.4) ▲	—	15 (2.6) ▲	—	7 (2.1) ▲	—	5 (1.9) ▲
	MAT	14 (2.1) ▲	—	11 (2.1) ▲	—	7 (2.2) ▲	—	5 (1.9) ▲
	SCI	22 (2.8) ▲	—	17 (2.9) ▲	—	10 (2.9) ▲	—	7 (2.3) ▲
Adequate Environment and Resources	REA	2 (3.3)	—	3 (2.6)	—	0 (2.5)	—	2 (1.9)
	MAT	1 (2.7)	—	3 (1.9)	—	1 (2.4)	—	2 (1.9)
	SCI	2 (4.1)	—	4 (2.9)	—	1 (3.5)	—	3 (2.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	0 (2.2)	0 (1.9)	—	—	2 (1.2)	2 (1.2)
	MAT	—	0 (1.7)	0 (1.5)	—	—	1 (1.2)	1 (1.1)
	SCI	—	0 (2.5)	0 (2.2)	—	—	2 (1.5)	2 (1.5)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	55 (7.6) ▲	37 (6.5) ▲	—	—	34 (5.0) ▲	28 (4.8) ▲
	MAT	—	47 (5.9) ▲	32 (5.0) ▲	—	—	34 (4.4) ▲	27 (4.1) ▲
	SCI	—	75 (8.5) ▲	54 (7.6) ▲	—	—	52 (6.0) ▲	44 (5.6) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	6 (1.0) ▲	6 (1.0) ▲	6 (1.0) ▲	6 (1.0) ▲
	MAT	—	—	—	3 (0.9) ▲	3 (0.9) ▲	3 (0.9) ▲	3 (0.9) ▲
	SCI	—	—	—	6 (1.2) ▲	6 (1.2) ▲	6 (1.2) ▲	6 (1.2) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲	10 (0.9) ▲
	MAT	—	—	—	9 (1.0) ▲	9 (1.0) ▲	9 (1.0) ▲	9 (1.0) ▲
	SCI	—	—	—	14 (1.1) ▲	14 (1.1) ▲	14 (1.1) ▲	14 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	37 (4.8) ▲	30 (5.2) ▲	37 (5.0) ▲	32 (5.2) ▲
	MAT	—	—	—	26 (4.9) ▲	19 (5.3) ▲	27 (4.8) ▲	21 (5.1) ▲
	SCI	—	—	—	39 (6.4) ▲	30 (6.9) ▲	40 (6.4) ▲	33 (6.6) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	9 (6.7)	9 (5.4)	-1 (5.6)	1 (4.7)
	MAT	—	—	—	9 (6.4)	8 (5.5)	-2 (4.8)	-1 (4.5)
	SCI	—	—	—	19 (8.8) ▲	17 (7.3) ▲	2 (6.4)	4 (5.6)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (38%)	44	36	58	68	77	80	84
Within Schools (62%)	—	—	—	7	7	7	7
Total	17	13	22	30	33	35	36
Mathematics							
Between Schools (31%)	46	40	62	56	70	74	80
Within Schools (69%)	—	—	—	4	4	4	4
Total	14	12	19	20	25	26	28
Science							
Between Schools (35%)	44	43	63	62	72	79	84
Within Schools (65%)	—	—	—	6	6	6	6
Total	15	15	22	25	29	31	33

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.38: School Effectiveness Models for Reading, Mathematics, and Science – Honduras

TIMSS & PIRLS 2011 4th Grade

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	7 (5.2)	—	6 (5.0)	—	8 (4.5)	—	6 (4.4)
	MAT	4 (5.1)	—	4 (5.2)	—	4 (5.0)	—	3 (5.0)
	SCI	6 (5.3)	—	6 (5.3)	—	6 (4.9)	—	5 (4.9)
Schools Support Academic Success	REA	-3 (3.7)	—	-5 (3.7)	—	-5 (3.2)	—	-5 (3.1)
	MAT	-2 (3.9)	—	-3 (3.9)	—	-4 (3.6)	—	-4 (3.5)
	SCI	-2 (4.1)	—	-4 (4.1)	—	-5 (3.7)	—	-5 (3.7)
Adequate Environment and Resources	REA	6 (4.1)	—	5 (3.8)	—	1 (3.4)	—	0 (3.4)
	MAT	8 (4.0)	—	7 (3.8)	—	3 (3.3)	—	2 (3.4)
	SCI	6 (4.2)	—	5 (3.9)	—	0 (3.5)	—	0 (3.5)
School Instruction								
Early Emphasis on Reading Skills	REA	—	9 (4.0) ▲	8 (3.8) ▲	—	—	4 (3.1)	4 (3.1)
	MAT	—	6 (4.3)	5 (4.0)	—	—	1 (3.3)	1 (3.3)
	SCI	—	8 (4.0)	7 (4.0)	—	—	2 (3.2)	2 (3.3)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	-6 (8.2)	-8 (8.0)	—	—	12 (7.8)	10 (7.5)
	MAT	—	-4 (9.3)	-5 (9.3)	—	—	9 (8.0)	8 (8.0)
	SCI	—	-9 (9.2)	-11 (9.0)	—	—	9 (8.7)	7 (8.4)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	-2 (1.2)	-2 (1.3)	-2 (1.2)	-2 (1.2)
	MAT	—	—	—	-3 (1.4) ▼	-3 (1.4) ▼	-3 (1.4) ▼	-3 (1.4) ▼
	SCI	—	—	—	-2 (1.3)	-2 (1.4)	-2 (1.3)	-2 (1.4)
Early Literacy/Numeracy Tasks	REA	—	—	—	8 (1.8) ▲	8 (1.8) ▲	8 (1.8) ▲	8 (1.8) ▲
	MAT	—	—	—	5 (1.6) ▲	5 (1.6) ▲	5 (1.6) ▲	5 (1.6) ▲
	SCI	—	—	—	4 (1.4) ▲	4 (1.4) ▲	4 (1.4) ▲	4 (1.3) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	22 (4.3) ▲	22 (4.5) ▲	22 (4.4) ▲	22 (4.6) ▲
	MAT	—	—	—	17 (4.8) ▲	16 (4.9) ▲	18 (4.9) ▲	17 (5.0) ▲
	SCI	—	—	—	22 (4.2) ▲	22 (4.4) ▲	23 (4.3) ▲	23 (4.5) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	7 (6.5)	8 (6.0)	8 (6.4)	9 (6.0)
	MAT	—	—	—	9 (7.8)	10 (7.6)	10 (7.8)	11 (7.6)
	SCI	—	—	—	13 (7.2)	13 (6.9)	14 (7.1)	14 (6.8) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (43%)	6	8	12	32	35	35	37
Within Schools (57%)	—	—	—	7	7	7	7
Total	3	3	5	18	19	19	20
Mathematics							
Between Schools (47%)	6	4	9	23	25	26	27
Within Schools (53%)	—	—	—	6	6	6	6
Total	3	2	4	14	15	15	16
Science							
Between Schools (52%)	4	6	9	32	33	34	35
Within Schools (48%)	—	—	—	5	5	5	5
Total	2	3	5	19	20	20	21

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 3.39: School Effectiveness Models for Reading, Mathematics, and Science – Quebec, Canada

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	4 (2.4)	—	3 (2.3)	—	3 (2.0)	—	3 (2.0)
	MAT	4 (2.6)	—	4 (2.5)	—	3 (2.3)	—	3 (2.3)
	SCI	3 (3.0)	—	3 (2.9)	—	2 (2.6)	—	2 (2.6)
Schools Support Academic Success	REA	7 (1.9) ▲	—	7 (1.9) ▲	—	2 (1.7)	—	2 (1.6)
	MAT	8 (1.9) ▲	—	8 (1.9) ▲	—	4 (1.8) ▲	—	5 (1.8) ▲
	SCI	8 (1.9) ▲	—	8 (1.9) ▲	—	3 (1.7)	—	3 (1.7)
Adequate Environment and Resources	REA	1 (2.0)	—	2 (1.9)	—	1 (1.6)	—	1 (1.5)
	MAT	1 (2.2)	—	1 (2.2)	—	1 (2.0)	—	1 (2.0)
	SCI	0 (1.9)	—	0 (1.8)	—	0 (1.6)	—	0 (1.6)
School Instruction								
Early Emphasis on Reading Skills	REA	—	0 (1.1)	-1 (0.9)	—	—	0 (0.8)	-1 (0.7)
	MAT	—	-1 (1.5)	-2 (1.3)	—	—	-1 (1.2)	-1 (1.2)
	SCI	—	-1 (1.3)	-2 (1.1)	—	—	-1 (0.9)	-1 (0.9)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	11 (3.9) ▲	8 (3.8) ▲	—	—	6 (3.0) ▲	5 (3.0)
	MAT	—	5 (4.4)	2 (3.9)	—	—	2 (3.8)	0 (3.6)
	SCI	—	10 (3.7) ▲	7 (3.5)	—	—	6 (2.8) ▲	5 (2.8)
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲	12 (0.9) ▲
	MAT	—	—	—	10 (1.0) ▲	10 (1.0) ▲	10 (1.0) ▲	10 (1.0) ▲
	SCI	—	—	—	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲	12 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲	9 (0.9) ▲
	MAT	—	—	—	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲	8 (1.0) ▲
	SCI	—	—	—	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲	8 (0.7) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	25 (3.1) ▲	21 (3.1) ▲	25 (3.0) ▲	21 (3.0) ▲
	MAT	—	—	—	22 (3.5) ▲	16 (3.4) ▲	22 (3.5) ▲	15 (3.3) ▲
	SCI	—	—	—	26 (3.3) ▲	22 (3.4) ▲	26 (3.2) ▲	22 (3.3) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	13 (4.8) ▲	13 (4.8) ▲	10 (4.9)	10 (5.0) ▲
	MAT	—	—	—	6 (5.9)	5 (5.7)	5 (6.1)	5 (5.9)
	SCI	—	—	—	7 (5.4)	6 (5.4)	4 (5.5)	4 (5.5)

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (11%)	31	7	35	58	62	60	64
Within Schools (89%)	—	—	—	12	12	12	12
Total	3	1	4	17	17	17	17
Mathematics							
Between Schools (15%)	29	2	31	32	40	33	41
Within Schools (85%)	—	—	—	10	10	10	10
Total	4	0	5	14	15	14	15
Science							
Between Schools (14%)	29	6	33	53	57	55	59
Within Schools (86%)	—	—	—	13	13	13	13
Total	4	1	5	19	19	19	19

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 3.40: School Effectiveness Models for Reading, Mathematics, and Science – Abu Dhabi, UAE

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	14 (5.8) ▲	—	7 (6.0)	—	13 (5.0) ▲	—	8 (5.0)
	MAT	12 (6.0) ▲	—	7 (6.1)	—	11 (5.2) ▲	—	8 (5.1)
	SCI	13 (6.2) ▲	—	6 (6.3)	—	11 (5.4) ▲	—	7 (5.3)
Schools Support Academic Success	REA	15 (4.9) ▲	—	16 (4.7) ▲	—	7 (4.1)	—	8 (4.0)
	MAT	13 (4.5) ▲	—	13 (4.3) ▲	—	5 (3.9)	—	6 (3.9)
	SCI	16 (4.7) ▲	—	16 (4.5) ▲	—	8 (4.4)	—	9 (4.2) ▲
Adequate Environment and Resources	REA	7 (3.5)	—	6 (3.8)	—	-1 (3.5)	—	-1 (3.5)
	MAT	6 (3.3)	—	5 (3.6)	—	-1 (3.5)	—	-1 (3.5)
	SCI	6 (3.3)	—	6 (3.4)	—	-1 (3.5)	—	0 (3.4)
School Instruction								
Early Emphasis on Reading Skills	REA	—	7 (2.8) ▲	6 (2.5) ▲	—	—	2 (2.3)	3 (2.1)
	MAT	—	7 (2.5) ▲	6 (2.3) ▲	—	—	3 (2.0)	3 (1.9)
	SCI	—	7 (2.7) ▲	6 (2.4) ▲	—	—	2 (2.2)	3 (2.0)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	26 (7.8) ▲	21 (7.5) ▲	—	—	21 (6.3) ▲	17 (6.1) ▲
	MAT	—	17 (7.7) ▲	13 (7.4)	—	—	12 (6.4)	9 (6.2)
	SCI	—	28 (7.8) ▲	23 (7.4) ▲	—	—	21 (6.6) ▲	18 (6.3) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	11 (1.5) ▲	11 (1.5) ▲	11 (1.5) ▲	11 (1.5) ▲
	MAT	—	—	—	8 (1.4) ▲	8 (1.4) ▲	8 (1.3) ▲	8 (1.3) ▲
	SCI	—	—	—	10 (1.8) ▲	10 (1.8) ▲	10 (1.8) ▲	10 (1.8) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲	12 (1.2) ▲
	MAT	—	—	—	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲	11 (1.2) ▲
	SCI	—	—	—	14 (1.3) ▲	14 (1.3) ▲	14 (1.3) ▲	14 (1.3) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	44 (5.3) ▲	40 (5.8) ▲	43 (5.7) ▲	39 (6.1) ▲
	MAT	—	—	—	40 (4.6) ▲	37 (5.5) ▲	38 (4.7) ▲	35 (5.6) ▲
	SCI	—	—	—	38 (5.3) ▲	33 (6.2) ▲	37 (5.5) ▲	32 (6.3) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	32 (9.9) ▲	29 (10.3) ▲	24 (10.4) ▲	24 (10.6) ▲
	MAT	—	—	—	25 (9.7) ▲	24 (10.0) ▲	22 (9.9) ▲	22 (10.0) ▲
	SCI	—	—	—	39 (9.8) ▲	36 (10.2) ▲	31 (10.1) ▲	30 (10.3) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▼ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (40%)	23	14	32	49	55	55	59
Within Schools (60%)	—	—	—	10	10	10	10
Total	9	6	13	25	28	28	30
Mathematics							
Between Schools (42%)	19	11	26	44	49	48	51
Within Schools (58%)	—	—	—	9	9	9	9
Total	8	5	11	24	26	26	27
Science							
Between Schools (38%)	23	15	32	43	50	50	55
Within Schools (62%)	—	—	—	10	10	10	10
Total	8	6	12	22	25	25	27

( ) Percentage of available variance shown in parentheses.

Exhibit 3.40: School Effectiveness Models for Reading, Mathematics, and Science – Dubai, UAE

Variables		HLM Regression Coefficients						
		School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
		School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
School Explanatory Variables								
School Environment								
Schools Are Safe and Orderly	REA	27 (7.6) ▲	—	17 (6.2) ▲	—	9 (4.9)	—	2 (5.1)
	MAT	23 (6.7) ▲	—	14 (5.5) ▲	—	7 (4.2)	—	1 (4.7)
	SCI	26 (7.5) ▲	—	14 (6.0) ▲	—	9 (4.8)	—	1 (5.2)
Schools Support Academic Success	REA	8 (4.7)	—	4 (4.4)	—	6 (2.6) ▲	—	6 (2.7) ▲
	MAT	7 (4.2)	—	4 (4.0)	—	6 (2.3) ▲	—	5 (2.4)
	SCI	8 (4.6)	—	5 (4.2)	—	7 (2.6) ▲	—	6 (2.7) ▲
Adequate Environment and Resources	REA	9 (3.9) ▲	—	10 (3.3) ▲	—	3 (2.5)	—	5 (2.7)
	MAT	8 (3.6) ▲	—	9 (3.1) ▲	—	3 (2.4)	—	4 (2.6)
	SCI	8 (4.0) ▲	—	10 (3.4) ▲	—	3 (2.8)	—	5 (2.9)
School Instruction								
Early Emphasis on Reading Skills	REA	—	17 (2.4) ▲	15 (2.3) ▲	—	—	3 (1.8)	3 (1.8)
	MAT	—	15 (2.2) ▲	14 (2.2) ▲	—	—	3 (1.7)	3 (1.7)
	SCI	—	16 (2.4) ▲	15 (2.4) ▲	—	—	3 (1.9)	3 (1.9)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	—	48 (13.4) ▲	35 (10.0) ▲	—	—	36 (8.3) ▲	33 (7.1) ▲
	MAT	—	39 (12.2) ▲	29 (9.7) ▲	—	—	30 (7.8) ▲	27 (7.4) ▲
	SCI	—	50 (13.1) ▲	39 (10.2) ▲	—	—	40 (8.6) ▲	36 (7.9) ▲
Home Background Control Variables								
Students within Schools								
Home Resources for Learning	REA	—	—	—	15 (1.2) ▲	15 (1.2) ▲	15 (1.2) ▲	15 (1.2) ▲
	MAT	—	—	—	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲	11 (1.0) ▲
	SCI	—	—	—	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲	15 (1.1) ▲
Early Literacy/Numeracy Tasks	REA	—	—	—	10 (0.8) ▲	10 (0.8) ▲	10 (0.8) ▲	10 (0.8) ▲
	MAT	—	—	—	9 (0.8) ▲	9 (0.8) ▲	9 (0.8) ▲	9 (0.8) ▲
	SCI	—	—	—	10 (1.1) ▲	10 (1.1) ▲	10 (1.1) ▲	10 (1.1) ▲
Between Schools								
School Average of Home Resources for Learning	REA	—	—	—	67 (3.3) ▲	61 (3.3) ▲	61 (4.0) ▲	56 (4.1) ▲
	MAT	—	—	—	60 (3.2) ▲	54 (3.2) ▲	54 (3.9) ▲	50 (4.0) ▲
	SCI	—	—	—	64 (3.5) ▲	57 (3.6) ▲	57 (4.2) ▲	52 (4.3) ▲
School Average of Early Literacy/Numeracy Tasks	REA	—	—	—	32 (10.8) ▲	33 (10.7) ▲	22 (10.5) ▲	24 (10.3) ▲
	MAT	—	—	—	23 (10.2) ▲	24 (10.3) ▲	14 (9.9)	16 (10.0)
	SCI	—	—	—	35 (11.9) ▲	37 (11.9) ▲	25 (11.3) ▲	27 (11.3) ▲

( ) Standard errors appear in parentheses.

REA - Reading
MAT - Mathematics
SCI - Science

▲ Coefficient significantly greater than zero.
▽ Coefficient significantly less than zero.

Source of Variance	Percentage of Variance Explained						
	School Explanatory Models			Home Background Control Model	School Explanatory with Home Background Control Models		
	School Environment	School Instruction	School Environment and Instruction		School Environment	School Instruction	School Environment and Instruction
Reading							
Between Schools (51%)	25	35	49	70	74	76	79
Within Schools (49%)	—	—	—	9	9	9	9
Total	13	18	25	40	42	43	44
Mathematics							
Between Schools (52%)	24	33	46	68	72	73	76
Within Schools (48%)	—	—	—	8	8	8	8
Total	12	17	24	39	41	41	43
Science							
Between Schools (49%)	25	36	49	65	70	73	76
Within Schools (51%)	—	—	—	9	9	9	9
Total	12	18	24	37	39	41	42

( ) Percentage of available variance shown in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

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Chapter 4

Effects of Home Background on Student Achievement in Reading, Mathematics, and Science at the Fourth Grade

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Introduction

One of the most stable and consistently observed phenomena in the field of education is the impact of students' home background on achievement. Students whose parents have a higher level of education, a more prestigious occupation, or greater income tend to have higher achievement than students whose parents have a lower standing on such socio-economic status (SES) indicators (e.g., Sirin, 2005). Many theories have been proposed to account for this phenomenon, but there is little consensus about which explanation is the most powerful. One reason is that, in spite of the stability of the phenomenon, there is also considerable variation in strength of effects across educational systems and learning domains (Barone, 2006). So far there has been little research on this variation, and on the mechanisms which give rise to it.

Gender is another student characteristic which tends to be related to achievement differences. However, here too considerable variation can be observed across learning domains, student age, and countries, and the nature and reasons for this variation is not well understood

Taking advantage of the opportunities offered by the data collected in TIMSS and PIRLS 2011 at the fourth grade, the main aim of the research reported in this chapter is twofold: first, to describe the patterns of variation across countries and domains of learning (i.e., reading, mathematics, and science) in the relationship between student background characteristics and achievement; and second, to gain insight into some of the mechanisms which generate these relationships. A crucial design characteristic of the TIMSS and PIRLS 2011 fourth grade data used in this study is that the students were assessed in all three domains of learning—reading, mathematics, and science—which allowed simultaneous analysis of outcomes in domains where both literacy and numeracy skills are essential. A second important design feature of these data is that the students' parents were asked to supply information in a Home Questionnaire about, among other things, different kinds of activities with the child, the child's numeracy and literacy skills, and resources in the home. Given that home factors are likely to exert much of their influence before the start of formal schooling, the information in the Home Questionnaire is essential for understanding the mechanisms through which factors such as parental education and student gender influence school achievement. A third important design feature of the TIMSS and PIRLS 2011 data is the number of countries that participated. Altogether, 34 countries and 3 benchmarking entities took part in the study, enabling investigation of differences in the impact of home background factors on student achievement across a wide variety of school systems and cultures.

In analyzing these data we have adopted a path modeling approach in order to investigate how the effect of parental education and gender on children's achievement is mediated via the availability of home resources, early literacy and numeracy activities in the home, and literacy and numeracy skills when beginning school. Based on theoretical expectations and previous empirical results, we have constructed a model in which these hypothesized determinants have been included in chronological order. By estimating the strength of the paths between these factors, and their direct and indirect effects on achievement in reading, mathematics and science at the fourth grade, this study seeks to gain a better understanding of the mechanisms through which educational inequalities are reproduced.

This study has two main aims: to investigate to what extent parental education and gender influence fourth grade student achievement in reading, mathematics, and science in different countries; and to investigate the mechanisms through which parental education and gender influence achievement via books in the home, literacy and numeracy activities, and the child's ability to carry out literacy and numeracy tasks when starting school.

Relationships Between Student Background Factors and Achievement

Typically, the correlation between SES and student achievement is about .30 at the individual student level (Sirin, 2005; White, 1982). However, SES is a complex and multidimensional concept. The term cultural capital has been used to label the most important dimension of SES-influence on achievement. In most countries, parents' formal educational level has been identified as the key component of cultural capital (Yang, 2003).

One theoretical framework which is often used to explain the effect of parental education on achievement is Bourdieu's Cultural Capital Theory (Bourdieu & Passeron, 1977). This theory basically argues that social classes preserve a strong cultural identity, and that social origins have a strong influence on students' cultural resources. Skills, attitudes, and use of language, to take a few examples, thus are differentiated according to class origins. Furthermore, pedagogical practices and assessment procedures are to a large extent related to the culture of the upper class, which contributes to making cultural capital the main determinant of school and occupational success.

Barone (2006) used PISA 2000 data from 25 countries to test the Cultural Capital Theory, using indices of cultural capital from the PISA questionnaire and SES and parental education as indicators of social class. Barone concluded that the indicators of family cultural capital had only modest explanatory power, and observed that the effects of these variables may be better interpreted as indirect signs of the importance of cognitive resources. He also suggested that the limited explanatory power of Cultural Capital Theory may be due to the existence of other causal mechanisms that mediate the influence of social origins, such as occupational ambitions.

Influences of Home Environment on Child Development

Much research has focused on what is important for developing children's language and cognitive skills that can ultimately lead to educational success (Park, 2008). One such factor is parental reading habits, which can create a favorable reading climate (De Graaf, De Graaf, & Kraaykamp, 2000). A great deal of research on child development, especially in the United States, also has highlighted the importance of home literacy environments that stimulate the development of the child's cognitive and language skills (e.g., Farkas & Beron, 2004). Researchers have found substantial differences in home literacy environments of children from high and low SES families, which in turn explain educational differences between the two groups of children (Brooks-Gunn, Klebanov, & Duncan, 1996; Duncan, Brooks-Gunn, & Klebanov, 1994). In the following section we review some of the main lines of research on development of literacy and numeracy skills.

HOME ENVIRONMENT AND THE ACQUISITION OF LITERACY SKILLS In order to understand how parental education and gender influence the development of early literacy and numeracy skills, it is useful to take as a starting point what is known about the general mechanisms and factors which are important for the acquisition of these skills. Much more research has been conducted on literacy than on numeracy skills, so we begin with the literacy research.

The U.S. National Early Literacy Panel (2008) has conducted a research synthesis in the form of multiple meta-analyses of approximately 500 empirical early literacy studies. The synthesis, titled *Developing Early Literacy*, identified six variables as being important precursors and predictors of reading skills, including the following: alphabet knowledge; phonological awareness (the ability to detect, manipulate, or analyze the auditory aspects of spoken language independent of meaning); ability to write letters in isolation or write one's name; phonological memory (the ability to remember spoken information for a short period of time); and rapid automatized naming of letters/digits and of objects/colors.

Additional meta-analyses included in *Developing Early Literacy* focused on the effects of different types of interventions in determining the effectiveness of instructional strategies, programs, or practices in teaching literacy skills or the precursor skills. For example, code-focused interventions are designed to teach skills related to cracking the alphabetic code, and typically included phonological awareness instruction. This type of intervention yielded moderate to large effects on the predictors of literacy and on conventional measures of literacy. Shared reading interventions basically involved reading books to children. Book-sharing interventions produced moderate-size effects on children's oral language skills and print knowledge. There were no differences in the effects of shared reading based on whether parents or teachers did the reading.

Parent and home programs interventions use parents as agents of intervention and include interventions that teach parents instructional techniques for use with their children at home. These interventions yielded a moderate to large effect on oral language outcomes and on general cognitive abilities. However, the design of the programs varied greatly, with some having general goals of improving children's health, behavior, or cognitive functioning, and others more specific goals such as improving children's oral language skills. Language enhancement interventions examined the effectiveness of instructional efforts aimed at improving young children's language development. These interventions succeeded in increasing children's oral language skills to a large degree.

There was little evidence that literacy interventions were differentially effective in terms of gender or SES. However, this may be because few studies reported the results of such interactions.

The findings from these meta-analyses of interventions suggest that parents and preschools can influence the literacy development of young children. These studies show that learning resulted from teaching children phonological awareness, reading to the child, involving parents in their children's learning, and teaching oral language skills. The fact that these effects have been demonstrated with experimental designs and systematic syntheses of findings is important, because this makes inferences about causality credible. The problem of explaining why parental education and gender is associated with educational achievement cannot easily be approached with experimental designs, but in cross-sectional surveys we can take advantage of results based on experimental studies. Thus, if it can be demonstrated that parents with a higher level of education to a larger extent are involved in activities and practices that have been shown through experimental work to have positive effects on literacy development than are parents with a lower level of education, this provides support for an explanation of the effects of parental education as being mediated by these activities and practices.

As has already been pointed out, a large body of literature has demonstrated strong effects of SES, in particular parental education, on the reading skills and academic achievements of the child (e. g. Davis-Kean, 2005; Hecht, Burgess, Torgesen, Wagner, & Rashotte, 2000; Lyster, 2002; Myrberg & Rosén, 2009; Raz & Bryant 1990; Sénéchal & LeFevre, 2002). In general, this relationship has been attributed to parents' beliefs, values, expectations, attitudes and behaviors: well educated parents appear to have high expectations of their children, while at the same time adapting their expectations to the performance of their children. In contrast, parents with little education tend to have lower, or sometimes unrealistically high, expectations of their children. Also, high parental education is related to a warm, social climate in the home (Duncan, Brooks-Gunn & Klebanov, 1994).

Along similar lines, parents with higher education tend to interact more verbally with their child; they use more abstract words, more complex syntax, and invite their child more often into decontextualized discourse (Bernstein, 1971), book-sharing, and dialogical reading (Jordan, Snow, & Porsche, 2000). These language practices mirror the language of books and school and foster good literacy skills (Tabors, Snow, & Dickinson, 2001).

Sénéchal and LeFevre (2002) found that informal shared reading of storybooks during preschool years seemed unrelated to parents' teaching of reading. The authors demonstrated in a longitudinal study that different types of activities also are associated with different outcomes. The link between parents' reports of teaching reading and reading storybooks with children was indirect and mediated through children's emergent literacy skills. The variables that were directly related to reading skills at the end of the first grade were those most closely tied to the mechanics of reading. However, the pathways for reading achievement in the third grade were different. Reading storybooks at home predicted children's receptive language skills both concurrently and longitudinally. Sénéchal and LeFevre found that children's exposure to storybooks at home began to show a strong link to reading performance once the mechanics of reading were under control and children were reading fluently. Their results thus indicate that children must acquire sufficiently fluent decoding skills before receptive language skills can exert their full influence.

As noted by Snow, Burns, and Griffin (1998), vocabulary knowledge has been shown in several studies to be a major correlate of reading comprehension, and comprehension is diminished by lack of relevant word knowledge. Hart and Risley (1995) studied vocabulary development of one- to three-year-olds as related to parental communication patterns. Parents with an academic background made use, on average, of three times as many words per hour as parents on welfare, and their children's vocabulary development appeared to mirror this difference: by age three the children in "the academic group" had a vocabulary of 1500 versus 500 in the "welfare group." The authors argued that differences in parental language pattern contributed to a "language gap" between children from high and low social classes of many thousands of words at later ages.

The meta-analyses included in *Developing Early Literacy* also suggest that phonological awareness is causally related to early reading acquisition. Raz and Bryant (1990) concluded on the basis of a longitudinal study that SES differences in decoding skills can be entirely explained by the influences of SES factors on phonological awareness. Hecht, Burgess, Torgesen, Wagner, and Rashotte (2000) also found that social class differences in early reading acquisition could partly be accounted for by differences in phonological abilities and that levels of print knowledge (i.e., knowledge about books and reading) to a large extent accounted for SES differences.

Based on the literature reviewed above, it is reasonable to hypothesize that SES effects on reading acquisition are mediated via both phonological and vocabulary skills, and that the SES effects are largely caused by variations in experiences of language and text (Noble, McCandless, & Farah, 2007). Taken together, these studies emphasize the importance of both the volume and quality of verbal activities and interactions in the home.

HOME ENVIRONMENT AND THE ACQUISITION OF NUMERACY SKILLS Compared to the number of research studies on early literacy, very few have been conducted on early numeracy, and even fewer have simultaneously investigated early literacy and early numeracy. One reason for this is that early numeracy (also referred to as quantitative literacy, or mathematical literacy) is more difficult to define than reading literacy. While there is consensus that number skills form an important aspect of numeracy, many researchers offer a broader view of the nature of numeracy. Thus, Diezman and Yelland (2000) argue that the foundational processes of numeracy are representation, manipulation, reasoning, and problem solving. Classification of objects and shapes, estimating, measuring, and reproducing number patterns are other examples of skills associated with numeracy (Ewers-Rogers & Cowan, 1996). Also, literacy and numeracy often are intertwined (Aiken, 1972). This may be a reason why there are few programs that are intended to support parental promoting of numeracy development for their children. Furthermore, it has been argued that any program developing language and problem-solving skills at young age will have consequential numeracy effects (Doig, McCrae, & Rowe, 2003).

Anders et al. (2012) report a study which investigated the domain specificity of numeracy and literacy stimulation in home and preschool settings in order to disentangle the effects of the two domains. They argued that it is reasonable to assume that numeracy-related activities and stimulation are especially beneficial for the development of numeracy skills. However, they also recognized that verbal and pre-reading related activities and stimulation may foster the development of numeracy skills. In a longitudinal study, they followed a sample of 532 children attending 97 preschools from ages 3 to 5. There were three waves of measurement at which information about the children's verbal and numeracy skills were collected, along with detailed information about, among other things, literacy- and numeracy-related activities in the home, and measures of preschool structural and process quality.

The study combined interviews and questionnaires with observations in the family setting. Using information from these sources, a literacy scale containing the following ten items was constructed: toys for free expression, number of children's books, books in the household, stimulation to learn the alphabet, stimulation to learn to read, questions in interaction, amount of free discussion, interactions regarding letters, phonological cues, and frequency of shared book reading. A numeracy scale consisting of the following ten items also was constructed: toys to teach colors and shapes, toys to teach numbers, stimulation to learn shapes, stimulation to learn colors, stimulation to learn spatial relationships, stimulation to learn digits, stimulation to learn counting, interaction regarding digits, interaction regarding shape and space, and interaction regarding comparing and classifying. The correlation between the two scales was $r = 0.62$, indicating a moderate degree of relationship.

The data were used to investigate several research questions, but this chapter focuses on results pertaining to effects of the home learning environment on numeracy development. Growth curve modeling was used as the main analytic method. First age, and a set of background variables, were included in the model, and then the literacy and numeracy indicators were included separately as additional predictors. The quality of the home learning environment explained substantial variance in numeracy at the first assessment, but there was no significant effect of home learning environment on development after the first assessment. The results also showed that the quality of the home environment in terms of promoting literacy skills was more strongly correlated with initial numeracy skills than was the quality of the home environment in terms of promoting numeracy skills.

In addition, the results showed that the influence of maternal educational level and SES decreased when home learning environment was included in the model, suggesting that part but not all of the relationship between family background and numeracy is explained by the quality of the home learning environment. This effect was more pronounced for literacy environment than for numeracy environment.

The study thus showed that the effect on numeracy skills was stronger for quality of literacy stimulation than it was for quality of numeracy stimulation. This was contrary to expectations, and Anders et al. (2012) observed that one reason for this may be that the assessment used to measure numeracy skills required not only numeracy but also language skills. They also argued that adequate language skills are a prerequisite for the acquisition of mathematical knowledge; thus, the quality of the home learning environment with respect to verbal literacy at this early age may have more impact than its quality to promote numeracy. Another possible interpretation was that the literacy scale captured more general beneficial characteristics of home learning environment (e.g., routines) than the numeracy scale. The relative rarity of numeracy-related resources and parental activities also was noted as a possible contributory factor.

GENDER DIFFERENCES The pattern of gender differences in achievement in mathematics and science varies as a function of the age of the students. In analyses of the TIMSS 1995 data, Mullis, Martin, Fierros, Goldberg, and Stemler (2000) found few differences in average mathematics achievement at the fourth and eighth grades, but substantial differences at the twelfth grade. A similar pattern of results was found for science, although gender differences already were present in many countries by the fourth grade.

Other studies also have demonstrated that a male performance advantage in mathematics and science achievement emerges only after elementary school and that it grows larger with increasing age (see Spelke, 2005, for a review). Furthermore, meta-analyses have revealed that most gender differences in cognitive abilities underpinning achievement in these areas are small (Hyde, 2005). In a review of the literature, Spelke (2005) concluded that male and female infants do not differ in the cognitive abilities that form the foundations of mathematical and scientific thinking, and that male and female children master the concepts and operations of elementary mathematics in the same way at the same time.

Baker and Jones (1993) proposed a gender stratification hypothesis to account for observed gender differences in mathematics and science achievement in the higher grades. The gender stratification hypothesis holds that, in patriarchal cultures, the achievement of male students is linked to their future opportunities. Female students see mathematics and science as less important for their future and are socialized into this mode of thinking by teachers, parents, and friends. Thus, according to the gender stratification hypothesis, opportunity structures shape socialization processes that shape performance. Furthermore, the hypothesis proposes that where there is more societal stratification based on gender, females will perform less well on mathematics and science achievement tests than will males.

Else-Quest, Hyde, and Linn (2010) describe various psychological theories that identify socialization processes accounting for the effects of gender stratification. One of these is the expectancy-value theoretical model proposed by Eccles (1994) to explain the gender gap in mathematics achievement, attitudes, and the underrepresentation of women in fields such as science and engineering. According to this model, people need to value a task to undertake it, and they need to have some expectation of success. Perceptions of the task's value are influenced by, among other things, the culture and cultural stereotypes related to gender and by the person's short-term and long-term goals. Expectations of success are influenced by self-concept, which in turn are influenced by parents' and teachers' attitudes and expectations, which often are gender stereotyped.

Bandura's (1986) cognitive social learning theory also identifies social processes that contribute to the development of gender-typed behavior. According to this theory, role models, socializing agents, and perceptions of gender-appropriate behavior influence an individual's actions and choices. Like the expectancy-value theory, this theory emphasizes the role of self-efficacy in gender-typed behaviors. The theory proposes that girls are attentive to the behaviors that women in their culture engage in, and thus feel efficacious in and model those behaviors. In its emphasis on observational learning and the internalization of cultural norms, the cognitive social learning theory provides an individual-level explanation of why girls act in ways that reproduce societal-level gender stratification.

Given that the students participating in the TIMSS and PIRLS 2011 fourth grade assessment were still quite young (around 10 years old), we do not expect any large gender differences to be seen in mathematics and science achievement. However, gender differences in reading achievement at this level have consistently been found in international assessments (see, e.g., Mullis, Martin, Gonzalez, & Kennedy, 2003; Mullis, Martin, & Kennedy, 2007; Mullis, Martin, Foy, & Drucker, 2012). Research also consistently identifies gender differences in attitudes to reading and in reading motivation. Ming Chui and McBride-Chang (2006) analyzed gender differences in reading comprehension in 43 countries participating in PISA with samples of 15-year-olds and concluded that girls outperformed boys in each and every country. However, even though the size of the gender difference varied across countries, it proved difficult to find variables that mediated the gender difference. Reading enjoyment did mediate the difference to some extent, but this variable could be seen as another outcome variable rather than as an explanatory variable.

It is reasonable to expect that gender differences in reading achievement are partly due to differential opportunities for boys and girls to acquire early literacy skills in the home and preschool. Thus, if it can be demonstrated that girls are more involved in activities and practices shown to have positive effects on literacy development than boys, this can explain some of the observed gender differences in reading achievement.

Results from Previous PIRLS Path Analyses

Given that a Home Questionnaire has been available since the first PIRLS assessment in 2001, there have previously been opportunities for analyzing determinants of reading literacy with path modeling techniques. Park (2008) used data from PIRLS 2001 to compare the ways in which home literacy environment influence reading achievement at the fourth grade in 25 countries. Three measures were used as indicators of home literacy environment: Early Home Literacy Activities Index, which is an average of six items; Number of Books at Home; and Parents Attitudes Toward Reading, which is an index based on four items. Ordinary least squares regression models were developed for each country separately, in which the effects on reading achievement of these three home literacy variables were estimated. A second series of OLS-models investigated the extent to which the home literacy variables mediated the effect of parental education by comparing the gap in reading score between students from high and low parental education groups in models with and without the three variables. Park reported small mediating effects of early home literacy activities, as it did not reduce the difference between students from the parental education groups by more than 10 percent in any country. The reduction remained modest (20–30%) for most countries also when all three home literacy environment variables were included in the model, even though the reduction exceeded 50 percent for some countries. Separate analyses indicated that Early Home Literacy Activities and Parental Attitudes toward Reading had smaller effects than did Number of Books at Home in 20 of 25 countries. One reason for this may be that the activities and attitudes indices were more influenced by errors of measurement than was the Books variable.

Myrberg and Rosén (2009) used data from the Swedish participation in PIRLS 2001 to estimate the effect of parents' education on children's reading achievement, and to estimate the indirect effects of different mediating factors. Effects of parental education were hypothesised to be mediated through the number of books in the home, via early reading activities with the children during the preschool years and via the children's early reading abilities.

The study made use of structural equation modelling with latent variables. In the first step, the measurement model was created, in which the latent variables were defined in terms of their relation to observed variables. The measurement model included four latent variables: Parental Education, with mother's education and father's education as indicators; Books at Home, measured by number of books in the home and by number of children's books in the home; Early Reading Activities, measured by two items from the Home Questionnaire (read with child, and tell stories to child); and Early Reading Abilities at School Start, measured by three items (recognize letters, read words and read sentences).

Based on the measurement model, the path model specified how the latent variables were expected to influence each other and the reading achievement outcome variable. The latent variables were ordered chronologically and logically as follows: Parental Education preceded Books at Home, which preceded the Early Reading Activities with the preschool child, which preceded Early Reading Abilities at School Start (the child's emergent literacy at the beginning of first grade), which preceded the PIRLS reading achievement score.

While the direct effect of Parental Education on reading achievement was modest (.17), the total effect was substantial (.34). This estimate agreed with what has been found in previous research (White, 1982; Yang, 2003). The total indirect effect, which is the difference between the total effect and direct effect, thus accounted for about 50 percent of the total effect. The strongest indirect effects went via Books at Home, of which the most important was directly from Books at Home to achievement. Two minor indirect effects were mediated through Early Reading Activities, one directly to reading achievement and one via Early Reading Abilities. Finally, there was an indirect effect of Parental Education via Early Reading Abilities. The model thus explains a part of the effect of parents' education on achievement in terms of books at home and use of those books for literacy purposes.

Method

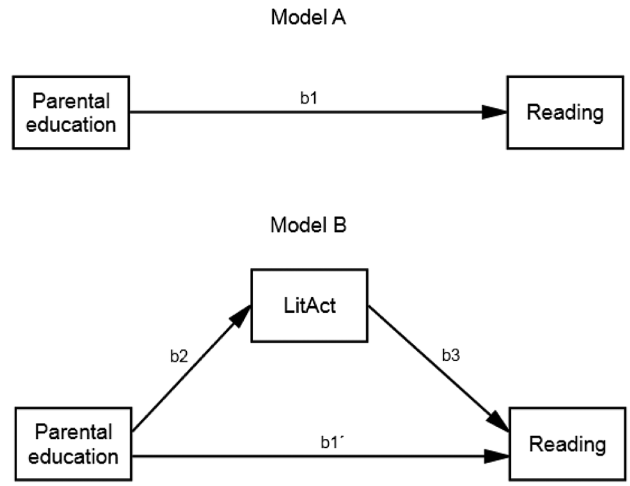
The model applied in this study is an extension of the Myrberg and Rosén (2009) model. Besides parental education, the present study includes gender as an independent variable. Also, the TIMSS and PIRLS 2011 Home Questionnaire inquired about numeracy *and* literacy activities in addition to numeracy *and* literacy skills when beginning primary school; therefore, in this extended model, the numeracy-literacy distinction is central. Furthermore, the extended model includes three outcome achievement variables: reading, mathematics, and science.

The Modeling Approach

This study aims to investigate the effects of the two independent variables—parental education and gender—on the three dependent variables—reading, mathematics, and science achievement—allowing for the possibility that there are both direct relationships between the independent variables and the dependent variables, and relationships involving other variables, which simultaneously behave as independent and dependent variables.

We may, for example, hypothesize that one reason why we observe a relationship between parental education and reading achievement is that the frequency of literacy activities (LitAct) is higher in homes with more highly educated parents than in homes where the parents have a lower level of education. Another way to express this is to say that parental education influences LitAct, which in turn influences reading achievement. In Exhibit 4.1, two simple models are shown: Model A, and Model B. In Model A, there is a direct relationship between Parental Education and Reading. The regression coefficient (b1) expresses the "direct" effect of Parental Education on Reading achievement. In this model, the direct effect also is the "total" effect because the regression expresses the maximum linear relationship between the independent and the dependent variables.

Exhibit 4.1: Two Path Models for Relationships between Parental Education and Reading Achievement



In Model B there is a path between Parental Education and LitAct, with regression coefficient b2, and also a path between LitAct and Reading (b3). These two relationships constitute an indirect relationship between Parental Education and Reading and the product of b2 and b3 represents the strength of this relationship. In Model B there also is a direct relationship between Parental Education and Reading achievement (b1´). The coefficient b1´ is not the same as coefficient b1 in Model A because b1 = b1´+ b2b3. This means that the total effect of Parental Education on Reading (i.e., b1) can be decomposed into one direct effect (b1´) and one indirect effect (b2b3). If b2 and b3 both are positive (which of course is not necessarily the case), b1´ will be smaller than b1. In substantive terms, Model B partially explains the relationship between Parental Education and Reading achievement in terms of a mediating mechanism, through which parents with higher levels of education involve their children in literacy activities to a larger extent than parents with lower levels of education, and these literacy activities in turn have a positive effect on reading achievement.

The mediating effect may account for only a part of the total effect, in which case further mediating variables and mechanisms might be sought for. It may also be that the indirect effect is as large as the total effect, so that there is no direct effect. This is referred to as "complete mediation."

This simple example describes the general principles for distinguishing between total, direct, and indirect effects, which we apply in this study in analyzing the effects of parental education and gender on fourth grade student achievement.

The extension of the Myrberg and Rosén (2009) model described above has guided the construction of the models that we have tested against the data in this study. The translation of a conceptual model to a path model that can be estimated and tested empirically involves several steps. The first step is to specify the variables to be included in the model and the second step is to propose a hypothesized path model. In the third step, the model is estimated from data and the goodness-of-fit of the model is evaluated. The fourth and final step is to compute the total and indirect effects, and to interpret these. Each of these steps are described in the following section.

Developing the Measurement Model

The Home Questionnaire inquires about both numeracy and literacy activities in the home, and about the child's abilities in performing numeracy and literacy tasks. The starting point for the selection of items to be included in the analysis was the items in the four TIMSS and PIRLS 2011 background scales: Early Literacy Activities Before Beginning Primary School (9 items), Early Numeracy Activities Before Beginning Primary School (6 items), Could Do Early Literacy Tasks When Began Primary School (5 items), and Could Do Early Numeracy Tasks When Began Primary School (6 items). The items in these scales are presented in Exhibit 4.2.

Exhibit 4.2: Items in the Scales Measuring Literacy and Numeracy Activities, and Literacy and Numeracy Skills at Start of School

Items in the Early Litreracy Activities Before Beginning Primary School Scale

Before your child began primary/elementary school, how often did you or someone else in your home do the following activities with him or her?

	Often	Sometimes	Never or almost never
1) Read books	◯	◯	◯
2) Tell stories	◯	◯	◯
3) Sing songs	◯	◯	◯
4) Play with alphabet toys (e.g., blocks with letters of the alphabet)	◯	◯	◯
5) Talk about things you had done	◯	◯	◯
6) Talk about what you had read	◯	◯	◯
7) Play word games	◯	◯	◯
8) Write letters or words	◯	◯	◯
9) Read aloud signs and labels	◯	◯	◯

Exhibit 4.2: Items in the Scales Measuring Literacy and Numeracy Activities, and Literacy and Numeracy Skills at Start of School (Continued)

Items in the Early Numeracy Activities Before Beginning Primary School Scale

Before your child began primary/elementary school, how often did you or someone else in your home do the following activities with him or her?

	Often	Sometimes	Never or almost never
1) Say counting rhymes or sing counting songs	◯	◯	◯
2) Play with number toys (e.g., blocks with numbers)	◯	◯	◯
3) Count different things	◯	◯	◯
4) Play games involving shapes (e.g., shape sorting toys, puzzles)	◯	◯	◯
5) Play with building blocks or construction toys	◯	◯	◯
6) Play board games or card games	◯	◯	◯

Items in the Could Do Early Literacy Tasks When Began Primary School Scale

How well could your child do the following when he/she began primary/elementary school?

	Very well	Moderately well	Not very well	Not at all
1) Recognize most of the letters of the alphabet	◯	◯	◯	◯
2) Read some words	◯	◯	◯	◯
3) Read sentences	◯	◯	◯	◯
4) Write letters of the alphabet	◯	◯	◯	◯
5) Write some words	◯	◯	◯	◯

Items in the Could Do Early Numeracy Tasks When Began Primary School Scale

Could your child do the following when he/she began primary/elementary school?

	Up to 100 or higher	Up to 20	Up to 10	Not at all
1) Count by himself/herself	◯	◯	◯	◯
	More than 4 shapes	3–4 shapes	1–2 shapes	None
2) Recognize different shapes (e.g., square, triangle, circle)	◯	◯	◯	◯
	All 10 numbers	5–9 numbers	1–4 numbers	None
3) Recognize the written numbers from 1–10	◯	◯	◯	◯
4) Write the numbers from 1–10	◯	◯	◯	◯
	Yes		No	
5) Do simple addition	◯		◯	
6) Do simple subtraction	◯		◯	

These scales have been carefully constructed and their psychometric properties are well documented (Martin, Mullis, Foy, & Arora, 2012). However, the relatively limited number of items in the scales causes their reliabilities, which vary between .66 and .90, to be somewhat too low to be used as manifest variables in a path model. One solution to this problem could have been to define error-free latent variables with the items in the scales as indicators. However, this would have required 26 variables for this part of the model alone, which would have caused the complete model to be unwieldy and tedious to estimate. Instead, a compromise solution was adopted, where "testlets" were created by dividing the items in each scale into two random halves and using these as indicators of latent variables.

A major advantage of using latent variables when investigating chains of relationships among different determinants is that the relationships are not affected by errors of measurement in the observed variables (see, e.g., Brown, 2006). However, latent variable models often are afflicted by other problems. A common problem encountered in application of latent variable models is multicollinearity, which occurs when two or more independent variables are highly correlated. In this situation, there is too little unique information available for each independent variable, making it impossible to achieve stable and interpretable estimates of the influence of these variables on the dependent variable.

The fact that variables are sometimes difficult to separate from one another is, however, above all a conceptual problem. A common reason for overlap between observed variables is that, to a large extent, they measure the same underlying variable. For example, when parents estimate how often literacy and numeracy activities have taken place in the home, it may be that their responses reflect a general level of educationally-oriented activities with the child, rather than specifically whether the activities were of literacy or numeracy kinds. If that is the case, the literacy and numeracy scales would be highly correlated and multicollinearity problems would occur if both were used as independent variables.

At the same time, because we may expect differences between families with respect to the general level of activities, it is also reasonable to expect that the balance of numeracy and literacy activities varies between families, such that in some families there is more of literacy activities than numeracy activities while in other families there is more of numeracy activities than literacy activities. There also may be differences between countries in these respects. A model with two correlated latent variables representing the amount of numeracy and literacy activity, respectively, allows us to determine the impact that the two types of activity have on educational achievement. These impacts are determined in such a way that the effect of literacy activity is determined with the level of numeracy kept constant, and vice versa. However, with this approach to measurement it is not possible to see the effect of differences in level of activity on achievement, because these differences only affect the correlation between the two variables. If this correlation is high, the analysis will be affected by multicollinearity and we still will not be able to determine any effects of general level of activity, because general level of activity is not represented by any variable.

While the traditional approach to measurement would suggest construction of two separate, but correlated, measures of literacy and numeracy activities, other approaches also are possible. In many fields of research, there is a need to identify both broader, more general aspects of phenomena, and more narrow or specific aspects (Gustafsson & Åberg-Bengtsson, 2010). Some examples of such fields are research on cognitive abilities, educational achievement, and personality, where it is easy to identify variables which have a broad scope of reference and variables which have a narrow scope of reference (Gustafsson, 2002).

Recently, special techniques have been developed for modeling data with latent variables of different degrees of generality. These modeling approaches are referred to as "bi-factor models" (e.g., Reise, 2012) or as "nested-factor models" (Gustafsson & Balke, 1993). With this approach, a general latent variable is typically identified for a domain of observations, along with narrow latent variables which account for observed differences on subsets of variables.

Such a bi-factor modeling approach is suitable in this case because we are interested in determining the effects both of the general level of activities in the home, and of the balance between numeracy and literacy activities. A latent variable model has therefore been constructed in such a manner that there is one general activity variable (Activity), which is taken to be positively related to the four manifest testlet variables, and there is one latent variable which represents a contrast between numeracy activities on the one hand and literacy activities on the other hand. This latent variable (NumLitAct) has fixed relationships of positive unity to the two testlets representing literacy activity (LITACT1 and LITACT2) and fixed relations of negative unity to the two testlets representing numeracy activity (NUMACT1 and NUMACT2). The NumLitAct variable thus represents the degree of balance between the two types of activity, with positive values indicating more literacy than numeracy activity and negative values indicating more numeracy than literacy activity.

A similar line of reasoning can be applied to the parents' reports of how well the child could do various numeracy and literacy tasks before beginning primary school. Here, too, there is reason to expect a high level of correlation between the measures from the two domains, suggesting that a more appropriate approach would be to define one latent variable representing ability to do both kinds of tasks (Ability), and a second latent variable representing ability to do literacy tasks better than numeracy tasks (NumLitAb). These two latent variables were constructed in the same manner as the two activity latent variables. Thus, the NumLitAb variable was specified to have fixed relations of unity to the two testlets representing literacy skills (LITAB1 and LITAB2) and fixed relations of negative unity to the two testlets representing numeracy skills (NUMAB1 and NUMAB2). The Ability variable was specified to be related to all these four testlets.

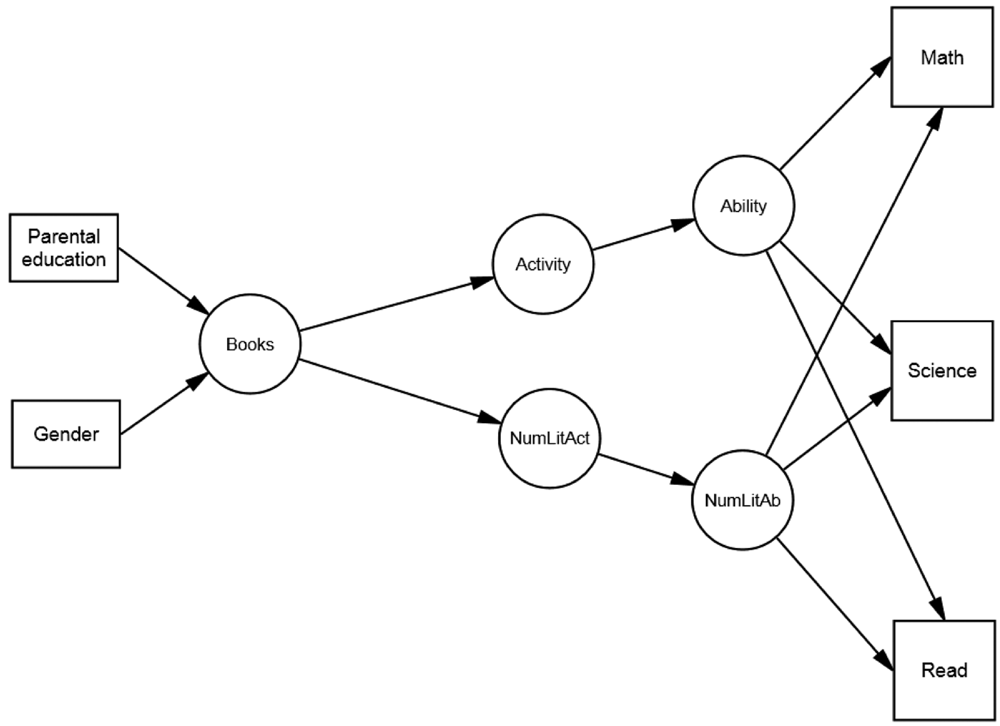
The measurement model included one additional latent variable representing literacy resources in the home. The Books latent variable had two indicators: the number of books in the home (NBOOK), and the number of children's books in the home (NCBOOK), as reported by the parents.

The model also included two independent variables, parental education and gender. Parental Education was defined as the highest level of education of either parent, and Gender was represented by a binary variable (boy = 0 and girl = 1).

The Hypothesized Path Model

Exhibit 4.3 presents a schematic and highly simplified version of the hypothesized path model.

Exhibit 4.3: A Schematic Description of the Hypothesized Path Model



While Exhibit 4.3 presents the two independent variables (Parental Education and Gender) and all of the latent variables in the model, as well as the three dependent variables (achievement in mathematics, science, and reading). For clarity, the observed variables that serve as indicators of the latent variables are not shown. According to this model, the latent variable Books influences Activity and NumLitAct, and these in turn influence Ability and NumLitAb, respectively. The latter two latent variables are assumed to influence the three achievement variables. This model thus formulates the hypothesis that Parental Education and Gender influence the extent to which Books are available in the home, and that these in turn influence both the general level of Activity of educational tasks in the home and the balance between numeracy and literacy activities, which in turn influence the child´s Abilities at the start of primary school.

Compared to the model that was actually estimated, the model shown in Exhibit 4.3 presents only a small subset of the relationships among variables. The estimated model was a “saturated” model in which each variable in the path model was related to every other variable to the right of it. Thus, each and every variable was predicted by Parental Education and Gender, Books predicted all the latent variables, and so on. Many of these direct effects were found to be non-significant, but no attempts were made to prune away non-significant relationships from the models.

In addition to estimation of the direct effect of one variable on another, total and indirect effects were computed. The total effect of an independent variable on a dependent variable is the sum of the direct effect and of all indirect effects. A specific indirect effect is a function of the product of the path coefficients encountered along a particular route from the independent variable to the dependent variable. The total indirect effect is the sum of all possible specific indirect effects.

Estimation

In the first step of estimation, a single model based on the combined data from all 37 participants was fitted. This Common model was estimated using the two-level modeling technique available in the Mplus program (Muthén & Muthén, 1998–2012), with country as the between-level, and students within country as the within-level. For the between-level, a saturated model was fitted which freely estimated the covariances among the country means. For the within-level, the saturated path model was fitted. This model thus was fitted to the pooled-within matrix for all the participating countries, which is not influenced by any mean differences across countries.

In the next step of analysis, a separate model was fitted for each country. These models were estimated with the Mplus 7.11 program (Muthén & Muthén, 1998–2012), using the MLR estimator. This estimator takes non-normality of the distributions of the observed variables into account, and corrects for the underestimation of standard errors that is caused by deviations from the assumption of multivariate normality that the maximum likelihood estimator is based upon. The so called "Complex option" in Mplus also was used, with school as the cluster variable, to correct for underestimated standard errors due to the cluster sampling techniques employed in drawing the samples in each country. In the analysis, individual student case weights (HOUWGT) were used.

The analyses took into account all five plausible values (PVs) available for each of the three achievement measures by relying on the Mplus Imputation facility, which computes one analysis for each PV and then combines these into a single parameter estimate and a single estimate of the standard error. However, this procedure was not available for the estimation of total and indirect effects; therefore, in order to obtain estimates based on all five PVs a special program written using the Model Constraints facility available in Mplus. All of the parameter estimates and standard errors presented in this chapter thus are based on five plausible values.

The fit of the model to the data was evaluated with a set of tests and indices computed by the Mplus program. One basic source of information about the degree of fit of a model to data is the chi-square goodness-of-fit test, which for a well-fitting model should be non-significant. Mplus computes the test once for each plausible value, and reports the mean and standard deviation of the five results. A difficulty with the chi-square test statistic is that it increases as a function of sample size; therefore, given the large number of observations in our data, the test is practically always significant, indicating that the model should be rejected as not fitting the data. However, this is because the large number of observations provides statistical power to detect even trivial deviations between the model and data. Thus, for these analyses there was a need for indices of fit that provide information about the degree of deviation between the model and data.

One such measure is the Root Mean Square Error of Approximation (RMSEA), which indicates the degree of deviation between model and data, taking into account both model complexity and sample size. RMSEA should be as low as possible, preferably lower than .05 (or .07-.08). Another useful measure is the Comparative Fit Index (CFI), which should be higher than .95 and as close to unity as possible. The Standardized Root Mean Square Residual (SRMR) measures the amount of deviation between the elements of the observed covariance matrix and the model-implied matrix, and according to the rules of thumb this measure should be lower than .08.

Descriptive Statistics

Exhibit 4.4 presents the means and standard deviations of the independent and mediating variables used in the analyses. The variables have been coded in such a way that higher values imply a higher level on the dimension measured, except for the dummy variable Gender where boys = 0 and girls = 1.

The Parental Education variable is based on the ISCED coding. The highest levels of Parental Education were reported for United Arab Emirates (Dubai), Norway, the Russian Federation, Canada (Quebec), Australia, Qatar, Finland, and Sweden, and the lowest levels were reported for Honduras, Morocco, Botswana, Iran, and Oman. The proportion of girls varied between .52 (Norway, Saudi Arabia, and Botswana) and .48 (Morocco, Poland, and Romania).

The highest means for number of Books at home were observed for Sweden, Norway, Australia, Germany, and Finland, while the lowest means were observed for Morocco, Honduras, Botswana, Iran, and Azerbaijan. For children's books the highest means were observed for Australia, Sweden, Finland, Malta, and Norway and the lowest means were observed for the same group of countries as had the smallest number of books at home. The country level correlation between the two measures of book availability in the home was 0.92.

The results for the two Activity variables have been computed from the IRT-scaled indices in the TIMSS and PIRLS 2011 International Database. The highest level of literacy activities was reported by Northern Ireland, the Russian Federation, Australia, Ireland, and Croatia, while the highest level of numeracy activities was reported by Northern Ireland, Hungary, the Slovak Republic, the Czech Republic, and the Russian Federation. There was a general tendency for countries that reported a high level of literacy activity to also report a high level of numeracy activity, with a correlation of .82.

For literacy skills the highest means were observed for Singapore, Honduras, Hong Kong SAR, and Qatar; for numeracy skills, the highest means were observed for Hong Kong SAR, Chinese Taipei, Singapore, and Finland. Here, too, there was quite a substantial correlation (.73) between the literacy and numeracy measures.

At the country level, there were negative correlations between the two activity variables on the one hand, and the two skills variables on the other hand, with correlations ranging between -.26 and -.51. The two measures of number of books in the home correlated positively with the two activity measures, and negatively with the measures of literacy skills, while there was no correlation with the numeracy skills measure. These results suggest that the pattern of interrelations among the variables at country level may be quite different from the pattern of intercorrelations within countries.

Exhibit 4.4: Descriptive Statistics

Country	Parental Education		Gender		Books at Home		Childrens Books	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Australia	5.16	0.90	0.49	0.50	3.68	1.17	3.91	1.07
Austria	4.55	0.92	0.49	0.50	3.43	1.21	3.33	1.18
Azerbaijan	4.56	1.11	0.47	0.50	2.14	1.07	1.64	0.85
Chinese Taipei	4.58	1.00	0.47	0.50	2.79	1.29	2.94	1.40
Croatia	4.53	0.88	0.50	0.50	2.74	1.18	2.38	1.10
Czech Republic	4.52	0.88	0.49	0.50	3.44	1.14	3.29	1.05
Finland	5.07	0.96	0.49	0.50	3.53	1.16	3.70	1.04
Georgia	4.97	1.00	0.48	0.50	3.28	1.32	2.26	1.15
Germany	4.45	1.28	0.49	0.50	3.55	1.22	3.46	1.11
Hong Kong, SAR	4.00	1.22	0.46	0.50	2.62	1.20	2.68	1.28
Hungary	4.08	1.39	0.49	0.50	3.43	1.33	3.10	1.27
Iran, Islamic Republic of	3.62	1.35	0.49	0.50	2.03	1.14	1.87	1.08
Ireland	4.87	1.10	0.49	0.50	3.23	1.26	3.48	1.21
Italy	4.24	1.10	0.50	0.50	2.99	1.26	2.67	1.14
Lithuania	4.78	1.09	0.48	0.50	2.91	1.24	2.49	1.14
Malta	3.99	1.22	0.49	0.50	3.21	1.26	3.70	1.05
Morocco	3.02	1.28	0.48	0.50	1.68	0.97	1.52	0.90
Northern Ireland	4.51	1.36	0.50	0.50	3.31	1.23	3.68	1.14
Norway	5.37	0.87	0.52	0.50	3.72	1.18	3.68	1.08
Oman	3.96	1.44	0.49	0.50	2.26	1.13	1.71	0.93
Poland	4.31	1.28	0.48	0.50	3.09	1.17	2.95	1.12
Portugal	4.08	1.39	0.49	0.50	2.84	1.27	2.91	1.22
Qatar	5.11	1.27	0.47	0.50	2.57	1.27	2.22	1.21
Romania	3.98	1.19	0.48	0.50	2.41	1.31	2.11	1.14
Russian Federation	5.29	0.82	0.49	0.50	3.23	1.16	2.96	1.13
Saudi Arabia	4.32	1.50	0.52	0.50	2.28	1.23	1.67	0.96
Singapore	4.78	1.17	0.49	0.50	2.80	1.21	3.24	1.22
Slovak Republic	4.51	0.98	0.49	0.50	3.01	1.17	2.74	1.09
Slovenia	4.65	0.89	0.48	0.50	3.13	1.15	3.06	1.11
Spain	4.41	1.35	0.49	0.50	3.30	1.23	3.07	1.18
Sweden	5.05	0.99	0.49	0.50	3.78	1.19	3.76	1.12
United Arab Emirates	5.01	1.29	0.50	0.50	2.43	1.23	2.14	1.17
Sixth Grade Countries								
Botswana	3.31	1.46	0.52	0.50	1.81	1.06	1.57	0.93
Honduras	2.91	1.40	0.51	0.50	1.76	1.05	1.42	0.84
Benchmarking Participants								
Quebec, Canada	5.24	0.85	0.50	0.50	3.11	1.21	3.39	1.13
Abu Dhabi, UAE	4.94	1.31	0.50	0.50	2.36	1.21	2.03	1.11
Dubai, UAE	5.38	1.07	0.47	0.50	2.71	1.28	2.62	1.31

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.4: Descriptive Statistics (Continued)

Country	Literacy Activities		Numeracy Activities		Literacy Skills		Numeracy Skills	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Australia	10.87	2.09	10.66	1.93	9.74	1.72	9.23	1.84
Austria	10.02	1.74	10.45	1.64	9.22	1.87	9.39	1.85
Azerbaijan	9.50	1.83	9.09	1.81	9.61	2.16	9.43	2.20
Chinese Taipei	8.69	1.91	9.18	2.18	10.70	1.48	11.65	1.41
Croatia	10.75	1.76	10.53	1.70	10.66	1.71	10.37	1.67
Czech Republic	10.29	1.62	11.02	1.53	9.79	1.83	9.97	1.71
Finland	9.78	1.51	9.50	1.43	10.22	1.98	10.64	1.77
Georgia	10.70	1.93	9.46	2.08	9.64	2.18	9.99	1.92
Germany	10.20	1.72	10.43	1.64	9.23	1.79	9.74	1.77
Hong Kong, SAR	8.70	1.72	9.15	1.92	11.06	1.57	11.66	1.33
Hungary	10.29	1.69	11.11	1.70	8.89	2.08	9.69	1.89
Iran, Islamic Republic of	8.91	1.87	9.25	1.97	9.71	2.18	9.40	2.19
Ireland	10.80	2.02	10.90	1.94	–	–	–	–
Italy	10.50	1.74	10.30	1.72	9.42	1.74	9.04	1.82
Lithuania	10.05	1.72	9.94	1.64	10.19	1.54	9.90	1.86
Malta	10.43	1.94	10.34	2.01	10.36	1.77	10.14	1.78
Morocco	8.42	2.70	8.19	2.33	10.20	2.29	9.22	2.52
Northern Ireland	11.19	2.04	11.20	1.89	9.31	1.69	8.59	1.74
Norway	10.08	1.78	9.81	1.61	9.22	1.91	9.49	1.81
Oman	9.25	1.70	8.93	1.88	10.86	1.75	10.47	1.87
Poland	10.41	1.76	10.76	1.64	10.08	1.86	9.67	1.88
Portugal	10.00	1.88	9.86	1.82	9.46	1.70	9.40	1.79
Qatar	9.69	1.88	9.76	2.05	11.02	1.79	10.61	1.87
Romania	9.95	2.52	9.74	2.48	9.24	2.15	9.90	2.34
Russian Federation	11.09	1.95	10.90	1.86	9.92	1.94	10.36	1.86
Saudi Arabia	9.55	1.84	9.46	1.96	10.76	2.05	10.32	1.94
Singapore	9.44	2.07	9.70	2.14	11.19	1.60	11.37	1.50
Slovak Republic	10.52	1.83	11.08	1.78	8.62	1.86	9.32	2.01
Slovenia	10.62	1.78	10.41	1.65	9.34	2.01	9.30	1.86
Spain	10.38	1.77	9.96	1.73	10.97	1.81	10.33	1.80
Sweden	9.99	1.78	9.43	1.69	10.39	1.77	10.24	1.78
United Arab Emirates	9.64	1.78	9.91	1.90	10.61	1.82	10.26	1.90
Sixth Grade Countries								
Botswana	8.68	2.05	8.26	2.19	10.17	2.04	9.05	2.25
Honduras	9.63	2.24	8.15	2.44	11.13	1.83	10.33	1.94
Benchmarking Participants								
Quebec, Canada	10.18	1.80	10.38	1.74	9.61	1.71	9.39	1.83
Abu Dhabi, UAE	9.53	1.74	9.79	1.87	10.60	1.85	10.40	1.87
Dubai, UAE	9.97	1.86	10.17	1.92	10.64	1.78	9.99	1.91

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Results from the Common Model for Pooled Data

The path model for the pooled data was estimated as a two-level model, using the procedures described above. The model involved the 34 participating countries and 3 benchmarking entities, which represented the between level, and 185,475 students. For each variable and each observation, the deviation from the international mean was used to compute the pooled within covariance matrix, to which the model was fitted.

As expected, the chi-square test was highly significant, with a mean across the five estimations of 1512.86 (df = 78) and a standard deviation of 10.77. From a strict statistical point of view this would imply that the model should be rejected as not fitting the data. However the mean estimate of RMSEA was 0.01 with a standard deviation across replications of 0, which indicates excellent fit. The CFI estimate was .986, again with a standard deviation of 0. Thus, this index also indicates an excellent fit between model and data. Finally, the Standardized Root Mean Square Residual (SRMR) for the within level was only 0.012, which again indicates a well-fitting model. Thus, we may conclude that the model provides an adequate representation of the data.

The Measurement Model for Pooled Data

As was described in the Method section, two testlets were built from the items included in each of the scales constructed to measure numeracy activities (NUMACT1, NUMACT2) and literacy activities (LITACT1, LITACT2), in addition to numeracy skills (NUMAB1, NUMAB2) and literacy skills (LITAB1, LITAB2) at the start of school. Given that these four scales comprise a relatively limited number of items, each of the eight testlets only included between two and five items. The small number of items makes the two testlets in each pair less than perfectly comparable as indicators of the latent variable. This was apparent in the form of some rather large modification indices for the relationships between the observed and latent variables. However, no attempt was made to adjust for this, for example by moving items from one testlet to another.

It will be remembered that one general latent Activity variable was hypothesized; with positive relationship with NUMACT1, NUMACT2, LITACT1 and LITACT2, and also that a general latent Ability variable was hypothesized, with a positive relationship with NUMAB1, NUMAB2, LITAB1 and LITAB2. It also was hypothesized that there would be a bipolar NumLitAct latent variable, with a negative relationship with NUMACT1 and NUMACT2 and a positive relationship with LITACT1 and LITACT2, as well as a bipolar

NumLitAb latent variable with a negative relationship with NUMAB1 and NUMAB2 and a positive relationship with LITAB1 and LITAB2. When estimating the model, the bipolar factors were defined by assigning fixed values of -1 and 1 to the unstandardized factor loadings, while for the two general factors one of the indicators was assigned a fixed value of unity and the loadings for the other three indicators were freely estimated. The standardized factor loadings are easier to interpret, however, so discussion focuses on these (see Exhibit 4.5).

Exhibit 4.5: Standardized Factor Loadings in the Measurement Model for the Common Model

	Activity		NumLitAct		Ability		NumLitAb		Books	
Indicator	Beta	t-value	Beta	t-value	Beta	t-value	Beta	t-value	Beta	t-value
LITACT1	0.78	95.69	0.23	56.97						
LITACT2	0.78	99.35	0.22	52.95						
NUMACT1	0.78	82.01	-0.20	-57.63						
NUMACT2	0.77	100.88	-0.19	-47.87						
LITAB1					0.90	234.47	0.29	79.81		
LITAB2					0.88	169.87	0.28	85.77		
NUMAB1					0.75	79.62	-0.47	-45.05		
NUMAB2					0.74	73.67	-0.43	-51.70		
NBOOK									0.80	58.12
NCBOOK									0.80	66.03

For the latent variable Activity, all four indicators had large positive loading of equal magnitude (0.78). The loadings were smaller for the bipolar NumLitAct variable, with absolute values of around .20, meaning that this latent variable accounted for only around 4 percent of the observed variance in each testlet. Positive values on this bipolar latent variable indicate more literacy than numeracy activities, while negative values indicate more numeracy than literacy activities.

For the latent variable Ability, there also were large positive loadings for the four indicators. However, loadings were larger for the two indicators of literacy abilities (around .90) than for the two indicators of numeracy abilities (around .75). For the latent variable NumLitAb, the bipolar pattern was evident, and this latent variable had stronger relationships with the testlets than had the bipolar activity factor, and particularly so with respect to the numeracy testlets. These patterns of relationships indicate that the literacy skills are of greater importance as indicators of a general ability, while the numeracy skills tend to be a narrower dimension. Nevertheless, the interpretation of the NumLitAb factor is that positive values indicate relatively higher literacy than numeracy skills, while negative values indicate relatively higher numeracy skills.

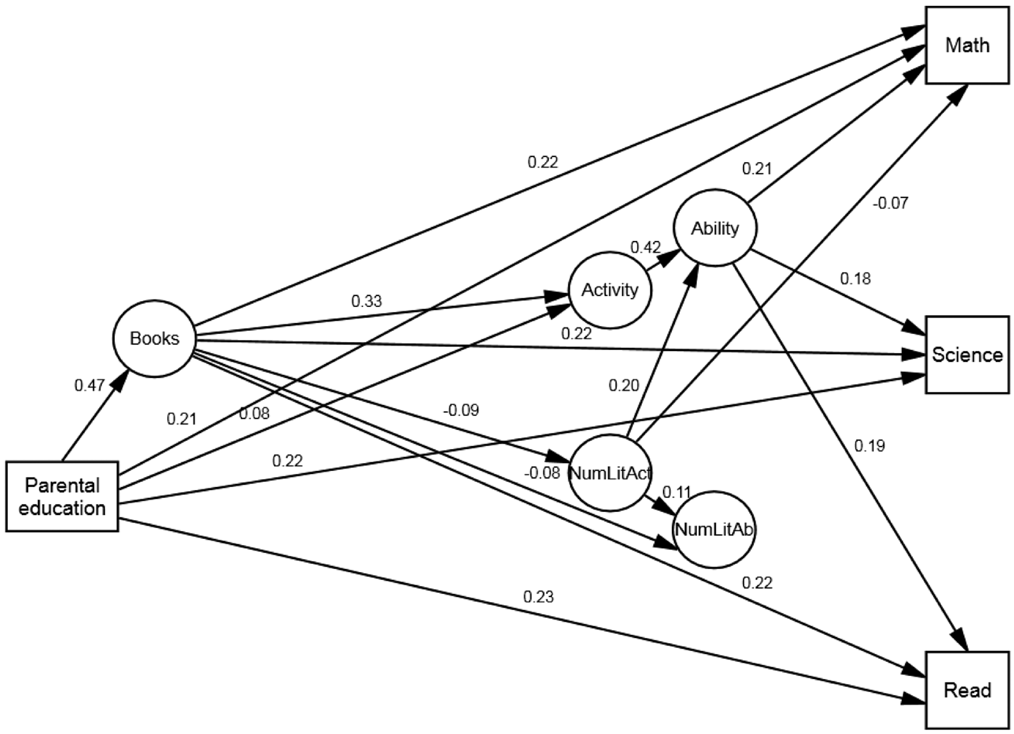
For the latent variable Books, there were two indicators: number of books in the home (NBOOK), and number of children's books in the home (NCBOOK). Both of these indicators had strong and equal relations (.80) to the latent variable.

The Path Model for Pooled Data

Given the complexity of the full path model and the large number of relationships estimated, it was necessary to simplify the presentation of results. This was accomplished by presenting the results for Gender and Parental Education separately. Because there was no correlation between these two variables, this does not cause any loss of information.

EFFECTS OF PARENTAL EDUCATION The total effects of Parental Education were .33, .35, and .35 for mathematics, science, and reading, respectively. While these estimates were computed from the direct and indirect effects in the model, we could also have computed a correlation between Parental Education and each of the three achievement variables to obtain the same results. According to the model, the total indirect effects were .12, .12, and .13 for mathematics, science, and reading, respectively. The difference between the total effect and the total indirect effect is the direct effect. Exhibit 4.6 presents all standardized direct effects larger than .05.

Exhibit 4.6: Path Diagram for Relations between Parental Education and Achievement (All Participants, Pooled Data)



As may be seen from this Exhibit, the direct effects of Parental Education on the three achievement variables agree, within rounding errors, with our expectations. These direct effects represent effects of Parental Education that the path model cannot account for via mediating variables. It is obvious from the model, however, that Books is an important mediating variable, with a strong relationship (0.47) between Parental Education and Books, and a direct effect of Books on the achievement variables of 0.22, similar to that of Parental Education.

Parental Education also had an indirect effect via the sequence Books, Activity, and Ability to achievement. All links in this chain were fairly strong and this indirect effect agrees with the theoretical expectations and with findings in previous empirical research. Thus, this path is theoretically and empirically important and it will be referred to as the Main Path of influence of Parental Education on achievement. There also was another important path, overlapping the Main Path to a great extent, which went directly from Parental Education to Activity, circumventing Books. It should also be pointed out that there was no direct effect of Activity on achievement in the Main Path, the entire effect being mediated via Ability.

In the Common model there was no direct effect of Parental Education on NumLitAct, and only a very weak indirect effect via Books, which was negative. Thus, NumLitAct did not mediate effects of Parental Education on achievement.

There was, however, a pattern of indirect effects of NumLitAct on the three achievement variables that went via Ability. There also was a negative direct effect of NumLitAct on Mathematics achievement. These results mean that homes which reported a stronger emphasis on literacy activities than on numeracy activities also reported a higher level of Ability, which in turn had a positive direct effect on achievement in all three domains. This is an interesting result, and one possible interpretation is that emphasis on literacy activities has a positive effect on development of both literacy and numeracy skills. A partially different interpretation is that numeracy skills at the beginning of primary school tend to involve both reading and writing, because expression of numeracy skills often requires use of literacy skills.

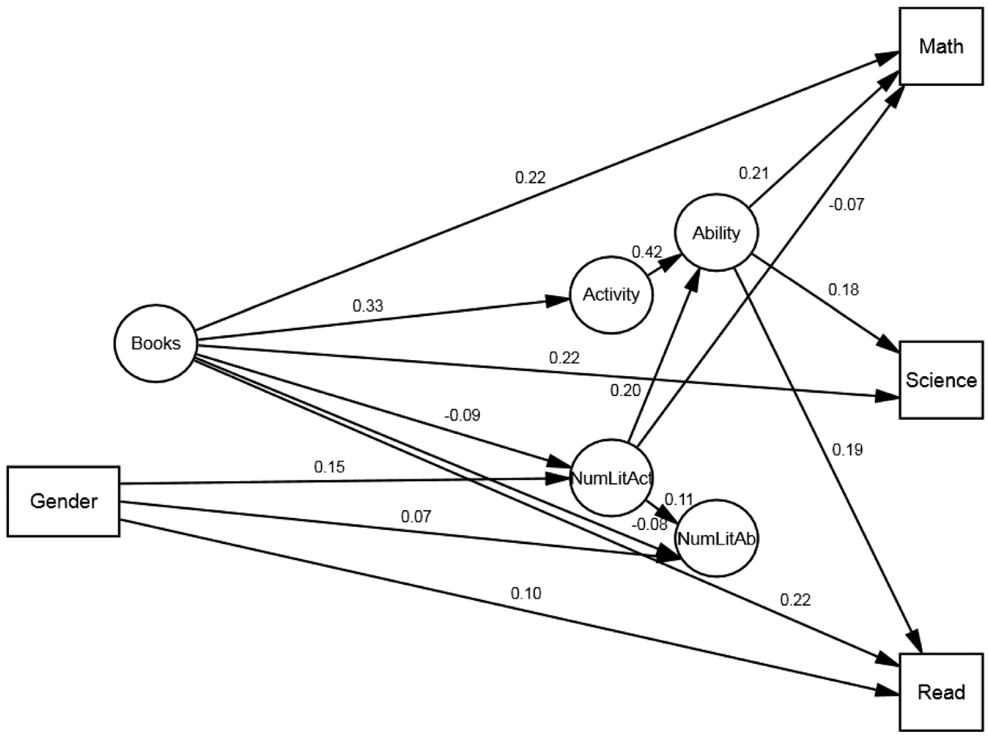
It may seem strange that there was a negative direct effect of NumLitAct on mathematics achievement. However, there was a positive indirect effect of NumLitAct on mathematics achievement, which was mediated via Ability. This positive indirect effect of NumLitAct on mathematics achievement thus partially balances out the negative direct effect of NumLitAct. Because there was no negative direct effect of NumLitAct on science or reading achievement, the net effect is that the emphasis on literacy activity will cause a profile of achievement with a relative strength in reading and science compared to mathematics.

Thus, even though NumLitAct did not mediate effects of Parental Education on achievement in the current model, the NumLitAct variable does seem to be involved in interesting patterns of relations.

EFFECTS OF GENDER The total effects of Gender were .00, .02 and .12 on mathematics, science, and reading, respectively. These results imply that in the pooled data there was essentially no gender difference in mathematics or science, but a rather substantial Gender difference in favor of girls with respect to reading achievement. The total indirect effects of Gender were .01, .01 and .02 on mathematics, science, and reading, respectively, so only a small part of the Gender effect was mediated via the variables in the model.

Exhibit 4.7 presents the path diagram in which Gender is the independent variable in focus.

Exhibit 4.7: **Path Diagram for Relations between Gender and Achievement (All Participants, Pooled Data)**



As may be expected from the total and indirect effects, there was a direct effect of .10 on reading. There was no direct effect of Gender on Books or Activity so the Main Path did not mediate any of the effect of Gender on achievement.

There was an effect of Gender on NumLitAct, which implies that for girls activities in the home tended to be more oriented towards literacy than numeracy. NumLitAct in turn influenced Ability, which had direct effects on all three fourth grade student achievement variables, so there were indirect effects of NumLitAct on achievement. There also was a weaker direct effect of Gender on NumLitAb, as well as an indirect effect via NumLitAct. However, because there was no direct effect of NumLitAb on any of the three achievement variables, NumLitAb did not mediate much of the total Gender effect.

Discussion of Results from the Common Model for Pooled Data

The analyses of indirect effects of Parental Education on achievement provide strong support for the hypothesized chain of influence via Books, Activity, and Ability to achievement. While this Main Path is important theoretically and empirically it may be noted that important indirect effects went through other paths. Thus, Books was an important variable through which Parental Education exerted influence, and was not only part of the Main Path but also had substantial direct effects on the three achievement variables. These direct effects may be assumed to be mediated via variables not included in the model, such as parental expectations, and parents' function as role models with respect to reading activities.

It was expected that NumLitAct would affect NumLitAb, which it did, albeit to a limited extent. However, NumLitAct was more strongly related to Ability, and because Ability had effects on achievement, the mediating effect of NumLitAct on achievement went via Ability, causing similar effects on all three domains of achievement. There was, however, some differential effect because of the negative direct effect of NumLitAct on mathematics achievement.

Overall Description of Results from Country by Country Analyses

The Common model discussed in the previous section provides a synopsis of the general pattern of relationships among the variables, but it does not give any information about differences in the pattern of relationships among the variables across countries. In order to investigate such differences, we have fitted the path model separately to the data for each of the 37 participants. This section provides an overview of the results, while the next section presents the models country by country.

Total, Direct, and Total Indirect Effects of Parental Education and Gender on Achievement

This section reports the pattern of outcomes across countries with respect to total, direct, and total indirect effects.

TOTAL EFFECTS OF PARENTAL EDUCATION AND GENDER ON ACHIEVEMENT Exhibit 4.8 presents estimates of the total effects of Parental Education and Gender on the three fourth grade student achievement variables.

Parental Education had an average effect on achievement across countries of around .34. These estimates agree almost perfectly with those obtained in the analysis of the pooled data. But here we can see that there was a considerable variation across countries, and also across the three achievement domains.

For Hungary, Iran, Romania, Poland, and Botswana Parental Education had total effects which exceeded .40 in all three domains. The lowest impact of Parental Education was observed for Azerbaijan and Hong Kong SAR, where

Exhibit 4.8: Estimates of Total Standardized Effects

Country	Total Effect of Parental Education			Total Effect of Gender		
	Mathematics	Science	Reading	Mathematics	Science	Reading
Australia	0.333 (0.024)	0.351 (0.025)	0.330 (0.023)	−0.025 (0.020)	−0.001 (0.021)	0.122 (0.019)
Austria	0.307 (0.019)	0.334 (0.021)	0.317 (0.019)	−0.069 (0.019)	−0.086 (0.019)	0.063 (0.018)
Azerbaijan	0.109 (0.024)	0.137 (0.024)	0.148 (0.023)	0.036 (0.023)	0.032 (0.023)	0.099 (0.019)
Chinese Taipei	0.370 (0.022)	0.387 (0.019)	0.335 (0.019)	0.014 (0.018)	−0.046 (0.019)	0.100 (0.016)
Croatia	0.309 (0.023)	0.318 (0.024)	0.305 (0.022)	−0.084 (0.021)	−0.038 (0.019)	0.123 (0.022)
Czech Republic	0.306 (0.024)	0.289 (0.023)	0.285 (0.024)	−0.08 (0.019)	−0.094 (0.021)	0.061 (0.019)
Finland	0.289 (0.023)	0.280 (0.023)	0.275 (0.020)	−0.062 (0.021)	−0.012 (0.019)	0.166 (0.018)
Georgia	0.282 (0.024)	0.289 (0.022)	0.313 (0.021)	0.044 (0.020)	0.057 (0.023)	0.153 (0.019)
Germany	0.359 (0.020)	0.380 (0.019)	0.361 (0.018)	−0.068 (0.017)	−0.088 (0.025)	0.064 (0.018)
Hong Kong SAR	0.160 (0.028)	0.150 (0.027)	0.116 (0.026)	−0.054 (0.021)	−0.069 (0.020)	0.131 (0.019)
Hungary	0.549 (0.020)	0.550 (0.021)	0.530 (0.021)	−0.026 (0.018)	−0.03 (0.019)	0.099 (0.015)
Iran, Islamic Rep. of	0.441 (0.025)	0.446 (0.024)	0.433 (0.023)	−0.023 (0.029)	−0.034 (0.028)	0.112 (0.026)
Ireland	0.334 (0.020)	0.341 (0.021)	0.343 (0.023)	−0.02 (0.027)	−0.001 (0.028)	0.113 (0.022)
Italy	0.238 (0.025)	0.275 (0.022)	0.298 (0.021)	−0.063 (0.022)	−0.053 (0.018)	0.033 (0.018)
Lithuania	0.356 (0.022)	0.352 (0.022)	0.345 (0.023)	−0.007 (0.019)	−0.008 (0.019)	0.148 (0.019)
Malta	0.339 (0.023)	0.449 (0.022)	0.444 (0.022)	−0.041 (0.022)	−0.037 (0.023)	0.095 (0.024)
Morocco	0.185 (0.036)	0.193 (0.032)	0.241 (0.033)	0.029 (0.019)	0.040 (0.019)	0.132 (0.018)
Northern Ireland	0.378 (0.029)	0.387 (0.029)	0.361 (0.028)	0.016 (0.023)	0.018 (0.025)	0.130 (0.021)
Norway	0.253 (0.027)	0.278 (0.026)	0.263 (0.023)	−0.04 (0.022)	−0.006 (0.024)	0.133 (0.023)
Oman	0.304 (0.023)	0.305 (0.024)	0.319 (0.024)	0.131 (0.016)	0.138 (0.017)	0.204 (0.014)
Poland	0.427 (0.018)	0.441 (0.017)	0.431 (0.016)	−0.059 (0.024)	−0.024 (0.018)	0.109 (0.019)
Portugal	0.303 (0.031)	0.298 (0.029)	0.314 (0.023)	−0.042 (0.022)	−0.032 (0.021)	0.111 (0.017)
Qatar	0.394 (0.025)	0.383 (0.028)	0.395 (0.024)	0.061 (0.030)	0.105 (0.033)	0.144 (0.027)
Romania	0.430 (0.035)	0.466 (0.031)	0.490 (0.028)	−0.017 (0.018)	−0.006 (0.018)	0.079 (0.018)
Russian Federation	0.265 (0.026)	0.269 (0.024)	0.298 (0.022)	0.008 (0.018)	−0.008 (0.020)	0.137 (0.017)
Saudi Arabia	0.176 (0.032)	0.248 (0.029)	0.243 (0.028)	0.064 (0.051)	0.199 (0.046)	0.274 (0.041)
Singapore	0.393 (0.019)	0.437 (0.017)	0.408 (0.017)	0.020 (0.017)	−0.028 (0.017)	0.101 (0.016)
Slovak Republic	0.371 (0.028)	0.375 (0.028)	0.376 (0.024)	−0.045 (0.015)	−0.046 (0.016)	0.079 (0.018)
Slovenia	0.376 (0.019)	0.386 (0.024)	0.347 (0.020)	−0.061 (0.022)	−0.016 (0.024)	0.123 (0.021)
Spain	0.373 (0.022)	0.333 (0.027)	0.314 (0.027)	−0.082 (0.019)	−0.071 (0.019)	0.034 (0.018)
Sweden	0.324 (0.025)	0.340 (0.026)	0.339 (0.025)	−0.046 (0.019)	−0.027 (0.021)	0.108 (0.020)
United Arab Emirates	0.386 (0.017)	0.402 (0.016)	0.415 (0.015)	0.040 (0.023)	0.090 (0.023)	0.136 (0.023)
Sixth Grade Countries						
Botswana	0.405 (0.037)	0.445 (0.035)	0.478 (0.035)	0.101 (0.019)	0.061 (0.019)	0.148 (0.018)
Honduras	0.343 (0.058)	0.355 (0.054)	0.338 (0.056)	−0.08 (0.023)	−0.064 (0.026)	0.071 (0.025)
Benchmarking Participants						
Quebec, Canada	0.252 (0.026)	0.293 (0.025)	0.273 (0.023)	−0.082 (0.021)	−0.061 (0.023)	0.107 (0.018)
Abu Dhabi, UAE	0.399 (0.024)	0.392 (0.024)	0.397 (0.024)	0.077 (0.032)	0.144 (0.030)	0.185 (0.028)
Dubai, UAE	0.405 (0.025)	0.420 (0.025)	0.421 (0.025)	−0.01 (0.035)	0.020 (0.037)	0.071 (0.039)
International Avg.	0.326 (0.024)	0.340 (0.024)	0.335 (0.023)	0.042 (0.022)	0.085 (0.022)	0.116 (0.020)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

effects were lower than .16 in all three achievement domains. Thus, there were considerable differences in the amount of relationship between Parental Education and achievement across countries, even though it also may be noted that for many countries effects were between .30 and .40. From the list of countries with high and low impact it is not possible to determine any simple and clear grouping of countries which may explain the differences. Among participants with high impact, some were East European countries. However, the Russian Federation was among the countries with lowest impact, thus the pattern is far from clear. Among East Asian countries there were both examples of countries with the highest impact (Singapore) and the lowest impact (Hong Kong SAR). Similarly among developing countries, there were examples of high impact of Parental Education (Botswana) and low impact (e.g., Morocco). These examples indicate that the amount of effect of Parental Education on educational achievement cannot be accounted for in simple terms.

In addition, results presented in Exhibit 4.8 indicate that there was no significant average effect of Gender on achievement in mathematics or science, while there was an average effect of .12 on reading. This average agrees with the estimate obtained in the analysis of the pooled data, and it agrees with previous findings of consistent differences in favor of girls on reading literacy.

However, even though there were no overall average gender differences in mathematics and science, there were countries were either boys or girls excelled. Significant differences in mathematics achievement in favor of girls were observed for five participants: Oman, Botswana, the Emirate of Abu Dhabi, Saudi Arabia, and Qatar. Among these participants, there also were significant differences for girls in science achievement. This same group of participants, with a few exceptions, also had considerable differences in reading achievement, with standardized coefficients as high as around .20. Finland also had a considerable advantage for girls in reading achievement.

For about a dozen participants, there were significant differences in favor of boys in mathematics, but in no case larger than 0.08 (e.g., Croatia, the Canadian province of Quebec, Spain, the Czech Republic, Hungary, Austria, and Germany). Most of these countries had a similar pattern of differences in science achievement. For only two countries (Spain and Italy) a non-significant gender difference was observed for reading achievement. For the countries with small differences in favor of girls for reading, there tended to be a significant advantage for boys in mathematics and science.

DIRECT EFFECTS OF PARENTAL EDUCATION AND GENDER ON ACHIEVEMENT The total effects presented above arise from direct effects and indirect effects. In order to understand the composition of the total effect in the different countries, it is useful to examine these two sources of effects separately. This section first discusses the direct effects, and then investigates the indirect effects. Exhibit 4.9 presents the direct effects of Parental Education on the other variables in the path model.

The mean standardized regression coefficient (β) for the direct effect of Parental Education on mathematics achievement was 0.19 (sd = 0.07), as compared to 0.33 for the total effect. Countries with the smallest direct effects of Parental Education on mathematics achievement ($\beta < .13$) were Azerbaijan, Hong Kong SAR, Saudi Arabia, Austria, Portugal, and Sweden. Countries with the largest direct effects of Parental Education on mathematics achievement ($\beta > .27$) included Botswana, Honduras, Qatar, Poland, and Hungary. There was a very high level of agreement between the pattern of results for mathematics and science achievement; the correlation between the parameter estimates for mathematics and science was 0.92.

The mean direct effect of Parental Education on reading achievement was about the same as for mathematics and science (mean = 0.20, sd = 0.07). The correlation between the parameter estimates for reading and mathematics was 0.89, while the correlation was 0.97 for reading and science. Thus, there was more agreement in the pattern of outcomes for reading and science than for reading and mathematics. For reading, particularly small direct effects of Parental Education were observed for Hong Kong SAR and for the Nordic countries.

The mean effect of Gender on mathematics achievement was small (mean = -0.03, sd = 0.05). However, in about half of the countries, there were significant direct effects in favor of boys. The countries with the largest direct effects included Slovenia, Sweden, Croatia, Spain, and the Czech Republic. For two countries (Botswana and Oman) there was a significant direct effect in favor of girls.

For science, too, the mean direct effect of Gender was small (mean = -0.02, sd = 0.07), although the pattern of direct effects of gender differed across countries. For about half of the countries, there was a significant direct effect in favor of boys, and was largest in Hong Kong SAR, Sweden, the Czech Republic, the Canadian province of Quebec, Spain, and Germany. For seven countries, there was a significant direct effect in favor of girls, and was largest in Saudi Arabia, Oman, the Emirate of Abu Dhabi, Qatar, and United Arab Emirates.

Exhibit 4.9: **Standardized Direct Effects of Parental Education and Gender on Achievement, Grade 4**

Country	Parental Education			Gender		
	Mathematics	Science	Reading	Mathematics	Science	Reading
Australia	0.225 (0.027)	0.216 (0.028)	0.212 (0.026)	–0.021 (0.020)	–0.006 (0.021)	0.115 (0.019)
Austria	0.092 (0.021)	0.100 (0.023)	0.095 (0.021)	–0.046 (0.021)	–0.082 (0.018)	0.051 (0.017)
Azerbaijan	0.060 (0.028)	0.078 (0.027)	0.114 (0.026)	0.031 (0.025)	0.032 (0.025)	0.100 (0.021)
Chinese Taipei	0.200 (0.022)	0.220 (0.021)	0.200 (0.021)	–0.004 (0.018)	–0.068 (0.018)	0.068 (0.017)
Croatia	0.173 (0.024)	0.169 (0.028)	0.161 (0.025)	–0.095 (0.022)	–0.054 (0.020)	0.085 (0.023)
Czech Republic	0.166 (0.023)	0.129 (0.025)	0.129 (0.022)	–0.085 (0.018)	–0.1 (0.021)	0.048 (0.019)
Finland	0.160 (0.024)	0.130 (0.027)	0.117 (0.022)	–0.076 (0.020)	–0.037 (0.020)	0.108 (0.020)
Georgia	0.148 (0.024)	0.146 (0.023)	0.174 (0.022)	0.042 (0.021)	0.051 (0.023)	0.140 (0.020)
Germany	0.169 (0.022)	0.150 (0.026)	0.152 (0.023)	–0.048 (0.019)	–0.086 (0.026)	0.052 (0.020)
Hong Kong SAR	0.072 (0.025)	0.051 (0.029)	0.038 (0.025)	–0.084 (0.020)	–0.11 (0.020)	0.091 (0.020)
Hungary	0.272 (0.027)	0.264 (0.025)	0.288 (0.024)	–0.006 (0.016)	–0.018 (0.017)	0.103 (0.014)
Iran, Islamic Rep. of	0.248 (0.025)	0.251 (0.026)	0.251 (0.024)	–0.013 (0.029)	–0.023 (0.027)	0.122 (0.025)
Ireland	0.165 (0.023)	0.156 (0.025)	0.158 (0.027)	–0.037 (0.027)	–0.014 (0.028)	0.089 (0.021)
Italy	0.146 (0.025)	0.139 (0.023)	0.163 (0.024)	–0.059 (0.023)	–0.064 (0.020)	0.009 (0.020)
Lithuania	0.187 (0.020)	0.175 (0.022)	0.159 (0.022)	–0.044 (0.021)	–0.063 (0.022)	0.077 (0.019)
Malta	0.208 (0.027)	0.303 (0.026)	0.299 (0.027)	–0.062 (0.022)	–0.058 (0.020)	0.073 (0.021)
Morocco	0.181 (0.027)	0.162 (0.031)	0.191 (0.027)	0.023 (0.017)	0.030 (0.019)	0.118 (0.017)
Northern Ireland	0.247 (0.036)	0.225 (0.033)	0.219 (0.033)	–0.014 (0.026)	–0.017 (0.029)	0.090 (0.025)
Norway	0.155 (0.033)	0.109 (0.027)	0.107 (0.025)	–0.04 (0.025)	–0.04 (0.025)	0.078 (0.023)
Oman	0.214 (0.023)	0.222 (0.023)	0.225 (0.023)	0.107 (0.016)	0.114 (0.017)	0.178 (0.014)
Poland	0.273 (0.023)	0.282 (0.019)	0.288 (0.020)	–0.077 (0.026)	–0.06 (0.020)	0.070 (0.018)
Portugal	0.127 (0.039)	0.128 (0.040)	0.138 (0.036)	–0.029 (0.023)	–0.028 (0.022)	0.109 (0.020)
Qatar	0.307 (0.026)	0.302 (0.028)	0.316 (0.026)	0.047 (0.028)	0.084 (0.030)	0.122 (0.025)
Romania	0.213 (0.034)	0.227 (0.033)	0.251 (0.032)	–0.031 (0.018)	–0.02 (0.018)	0.063 (0.018)
Russian Federation	0.154 (0.025)	0.143 (0.024)	0.166 (0.021)	–0.013 (0.019)	–0.029 (0.019)	0.108 (0.017)
Saudi Arabia	0.086 (0.041)	0.151 (0.037)	0.159 (0.030)	0.025 (0.051)	0.164 (0.048)	0.230 (0.042)
Singapore	0.247 (0.017)	0.267 (0.016)	0.243 (0.015)	–0.01 (0.015)	–0.065 (0.015)	0.061 (0.014)
Slovak Republic	0.161 (0.027)	0.162 (0.026)	0.162 (0.023)	–0.046 (0.015)	–0.059 (0.017)	0.067 (0.017)
Slovenia	0.228 (0.021)	0.213 (0.027)	0.176 (0.020)	–0.1 (0.022)	–0.065 (0.024)	0.069 (0.022)
Spain	0.206 (0.027)	0.143 (0.028)	0.155 (0.029)	–0.089 (0.023)	–0.088 (0.018)	0.003 (0.018)
Sweden	0.128 (0.030)	0.095 (0.028)	0.119 (0.029)	–0.096 (0.021)	–0.103 (0.022)	0.009 (0.020)
United Arab Emirates	0.248 (0.016)	0.269 (0.015)	0.261 (0.015)	0.028 (0.022)	0.074 (0.022)	0.118 (0.021)
Sixth Grade Countries						
Botswana	0.316 (0.034)	0.341 (0.031)	0.375 (0.031)	0.085 (0.020)	0.046 (0.018)	0.138 (0.018)
Honduras	0.312 (0.054)	0.307 (0.050)	0.291 (0.052)	–0.082 (0.024)	–0.062 (0.026)	0.072 (0.025)
Benchmarking Participants						
Quebec, Canada	0.175 (0.027)	0.183 (0.027)	0.170 (0.025)	–0.075 (0.022)	–0.095 (0.027)	0.055 (0.021)
Abu Dhabi, UAE	0.267 (0.024)	0.270 (0.023)	0.251 (0.023)	0.052 (0.030)	0.113 (0.028)	0.152 (0.026)
Dubai, UAE	0.247 (0.024)	0.259 (0.024)	0.252 (0.024)	–0.039 (0.031)	–0.015 (0.032)	0.032 (0.034)
International Avg.	0.183 (0.026)	0.181 (0.026)	0.184 (0.025)	0.043 (0.022)	0.078 (0.022)	0.088 (0.020)
International Std. Dev.	0.060 (0.006)	0.067 (0.005)	0.066 (0.005)	0.029 (0.006)	0.048 (0.006)	0.046 (0.005)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

The direct effect of Gender on reading achievement was positive (mean = 0.09, sd = 0.05). In no country was there a direct effect in favor of boys; however, for four countries (Spain, Italy, Sweden, and the Emirate of Dubai) there was no significant effect. For all other countries, there was a significant direct effect of Gender in favor of girls.

TOTAL INDIRECT EFFECTS OF PARENTAL EDUCATION AND GENDER ON ACHIEVEMENT The total indirect effect is due to the sum of all the indirect effects, and Exhibit 4.10 presents the total indirect effects for Parental Education and Gender. This Exhibit also presents the percentage that the total indirect effect amounts to of the total effect. It should be observed, however, that for Gender the percentages are only presented for reading, because the total effect was in many cases close to zero or negative for Gender with respect to mathematics and science.

The average of the total indirect effect of Parental Education on mathematics was 0.14 (sd = 0.06). On average internationally, 41 percent of the total effect was indirect (sd = 13). The largest proportions of indirect effects were observed for Austria, Sweden, Portugal, the Slovak Republic, and Hong Kong, where in all cases 55 percent or more of the total effect was indirect. The relatively smallest indirect effects were observed for Morocco, Honduras, Botswana, and Qatar, where in all cases less than 22 percent of the total effect was indirect.

For science, the average total indirect effect of Parental Education was 0.15 (sd = 0.06). On average internationally, 45 percent of the total effect was indirect (sd = 14). The proportions of the total effects accounted for by the indirect effects where similar to those observed for mathematics. For reading, the pattern of results was highly similar to the pattern observed for science.

For the effects of Gender on mathematics and science, as mentioned above, generally it is not meaningful to compute the percentage of indirect effects out of the total effect, because the latter in many cases was close to zero. There were, however, significant indirect effects of Gender on both mathematics and science achievement for eleven participants: Hong Kong SAR, Lithuania, Oman, Saudi Arabia, Singapore, Slovenia, Sweden, United Arab Emirates, the Emirates of Dubai and Abu Dhabi, and Northern Ireland.

For a majority of the countries, the indirect effect of Gender on reading achievement was significant. The average total indirect effect was 0.03 (sd = 0.02), which indicates considerable variation across countries. The indirect effect comprised more than 90 percent of the total effect for Sweden and Spain, and it comprised more than 40 percent for Italy, the Emirate of Dubai, Lithuania, the Canadian province of Quebec, Slovenia, Norway, and Singapore. The indirect effect was close to zero for Iran, Hungary, Honduras, Azerbaijan, Portugal, Australia, Botswana, and Georgia.

Exhibit 4.10: Total Indirect Standardized Effects

Country	Total Indirect Effect of Parental Education					
	Mathematics		Science		Reading	
	Effect	% of Total	Effect	% of Total	Effect	% of Total
Australia	0.107 (0.014)	32	0.135 (0.014)	38	0.117 (0.015)	35
Austria	0.216 (0.016)	70	0.234 (0.015)	70	0.223 (0.013)	70
Azerbaijan	0.049 (0.015)	45	0.060 (0.015)	44	0.034 (0.014)	23
Chinese Taipei	0.170 (0.013)	46	0.167 (0.014)	43	0.134 (0.013)	40
Croatia	0.136 (0.016)	44	0.149 (0.016)	47	0.144 (0.015)	47
Czech Republic	0.140 (0.013)	46	0.160 (0.015)	55	0.156 (0.014)	55
Finland	0.129 (0.020)	45	0.150 (0.016)	54	0.158 (0.013)	57
Georgia	0.134 (0.022)	48	0.143 (0.022)	49	0.138 (0.019)	44
Germany	0.189 (0.017)	53	0.230 (0.020)	61	0.210 (0.016)	58
Hong Kong SAR	0.088 (0.019)	55	0.100 (0.019)	67	0.078 (0.017)	67
Hungary	0.277 (0.025)	50	0.286 (0.023)	52	0.242 (0.023)	46
Iran, Islamic Rep. of	0.193 (0.025)	44	0.195 (0.024)	44	0.182 (0.023)	42
Ireland	0.169 (0.015)	51	0.185 (0.018)	54	0.185 (0.016)	54
Italy	0.091 (0.014)	38	0.136 (0.016)	49	0.135 (0.013)	45
Lithuania	0.170 (0.016)	48	0.177 (0.016)	50	0.186 (0.015)	54
Malta	0.131 (0.018)	39	0.146 (0.016)	33	0.145 (0.017)	33
Morocco	0.004 (0.022)	2	0.031 (0.020)	16	0.050 (0.019)	21
Northern Ireland	0.131 (0.023)	35	0.162 (0.025)	42	0.142 (0.023)	39
Norway	0.098 (0.020)	39	0.169 (0.020)	61	0.156 (0.020)	59
Oman	0.090 (0.008)	30	0.083 (0.009)	27	0.094 (0.009)	29
Poland	0.154 (0.016)	36	0.159 (0.014)	36	0.143 (0.015)	33
Portugal	0.177 (0.028)	58	0.170 (0.029)	57	0.176 (0.028)	56
Qatar	0.087 (0.018)	22	0.081 (0.016)	21	0.079 (0.015)	20
Romania	0.216 (0.026)	50	0.238 (0.024)	51	0.240 (0.023)	49
Russian Federation	0.111 (0.014)	42	0.125 (0.014)	46	0.132 (0.013)	44
Saudi Arabia	0.090 (0.025)	51	0.097 (0.023)	39	0.085 (0.023)	35
Singapore	0.146 (0.012)	37	0.170 (0.012)	39	0.165 (0.012)	40
Slovak Republic	0.209 (0.020)	56	0.214 (0.019)	57	0.214 (0.019)	57
Slovenia	0.148 (0.016)	39	0.173 (0.016)	45	0.171 (0.016)	49
Spain	0.167 (0.019)	45	0.190 (0.020)	57	0.160 (0.019)	51
Sweden	0.196 (0.018)	60	0.245 (0.017)	72	0.220 (0.017)	65
United Arab Emirates	0.137 (0.011)	35	0.134 (0.011)	33	0.154 (0.011)	37
Sixth Grade Countries						
Botswana	0.089 (0.018)	22	0.104 (0.016)	23	0.103 (0.016)	22
Honduras	0.031 (0.017)	9	0.048 (0.017)	14	0.047 (0.017)	14
Benchmarking Participants						
Quebec, Canada	0.078 (0.015)	31	0.111 (0.014)	38	0.103 (0.014)	38
Abu Dhabi, UAE	0.132 (0.020)	33	0.122 (0.021)	31	0.146 (0.022)	37
Dubai, UAE	0.158 (0.017)	39	0.161 (0.016)	38	0.169 (0.016)	40
International Avg.	0.142 (0.018)	43	0.159 (0.018)	47	0.152 (0.017)	46
International Std. Dev.	0.054 (0.005)	12	0.056 (0.004)	13	0.052 (0.004)	13

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.10: Total Indirect Standardized Effects (Continued)

Country	Total Indirect Effect of Gender			
	Mathematics Effect	Science Effect	Reading	
			Effect	% of Total
Australia	–0.003 (0.012)	0.005 (0.012)	0.007 (0.011)	6
Austria	–0.023 (0.014)	–0.005 (0.012)	0.012 (0.013)	19
Azerbaijan	0.005 (0.013)	0.000 (0.013)	0.000 (0.012)	0
Chinese Taipei	0.017 (0.010)	0.022 (0.009)	0.032 (0.008)	32
Croatia	0.011 (0.010)	0.016 (0.008)	0.038 (0.009)	31
Czech Republic	0.005 (0.010)	0.006 (0.010)	0.012 (0.009)	20
Finland	0.014 (0.014)	0.025 (0.013)	0.059 (0.013)	36
Georgia	0.002 (0.008)	0.006 (0.008)	0.012 (0.007)	8
Germany	–0.019 (0.015)	–0.001 (0.014)	0.012 (0.013)	19
Hong Kong SAR	0.029 (0.008)	0.040 (0.008)	0.040 (0.008)	31
Hungary	–0.02 (0.008)	–0.012 (0.008)	–0.004 (0.007)	-4
Iran, Islamic Rep. of	–0.01 (0.012)	–0.011 (0.012)	–0.01 (0.012)	-9
Ireland	0.018 (0.009)	0.013 (0.011)	0.024 (0.010)	21
Italy	–0.004 (0.009)	0.011 (0.010)	0.024 (0.010)	73
Lithuania	0.037 (0.014)	0.055 (0.014)	0.071 (0.012)	48
Malta	0.021 (0.008)	0.021 (0.009)	0.022 (0.009)	23
Morocco	0.006 (0.009)	0.009 (0.008)	0.014 (0.007)	11
Northern Ireland	0.031 (0.014)	0.036 (0.015)	0.039 (0.013)	30
Norway	–0.001 (0.017)	0.034 (0.016)	0.056 (0.015)	42
Oman	0.024 (0.006)	0.024 (0.006)	0.025 (0.006)	12
Poland	0.018 (0.010)	0.037 (0.011)	0.039 (0.009)	36
Portugal	–0.014 (0.010)	–0.004 (0.009)	0.001 (0.010)	1
Qatar	0.014 (0.009)	0.021 (0.008)	0.022 (0.007)	15
Romania	0.014 (0.007)	0.014 (0.007)	0.016 (0.007)	20
Russian Federation	0.021 (0.007)	0.021 (0.008)	0.030 (0.007)	22
Saudi Arabia	0.039 (0.014)	0.035 (0.014)	0.044 (0.014)	16
Singapore	0.029 (0.007)	0.038 (0.008)	0.040 (0.007)	40
Slovak Republic	0.002 (0.009)	0.013 (0.009)	0.012 (0.009)	15
Slovenia	0.039 (0.011)	0.049 (0.010)	0.055 (0.009)	45
Spain	0.008 (0.012)	0.017 (0.012)	0.031 (0.010)	91
Sweden	0.050 (0.015)	0.076 (0.016)	0.099 (0.016)	92
United Arab Emirates	0.012 (0.005)	0.016 (0.006)	0.018 (0.006)	13
Sixth Grade Countries				
Botswana	0.016 (0.007)	0.015 (0.007)	0.010 (0.007)	7
Honduras	0.001 (0.007)	–0.003 (0.008)	–0.001 (0.007)	-1
Benchmarking Participants				
Quebec, Canada	–0.007 (0.014)	0.034 (0.015)	0.051 (0.016)	48
Abu Dhabi, UAE	0.026 (0.008)	0.031 (0.008)	0.033 (0.009)	18
Dubai, UAE	0.029 (0.012)	0.035 (0.011)	0.040 (0.011)	56
International Avg.	0.019 (0.011)	0.024 (0.010)	0.030 (0.010)	27
International Std. Dev.	0.013 (0.003)	0.017 (0.003)	0.022 (0.003)	24

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

RELATIONSHIPS AMONG DIRECT AND TOTAL INDIRECT EFFECTS The results presented above suggest that the strength of the direct and the total indirect effects of Parental Education are more or less independent on a particular subject matter domain while the effects seem similar across the three domains. In order to obtain more precise information about the pattern of relations among direct and total indirect effects across domains, correlations among the effect estimates for the 37 participants have been computed (see Exhibit 4.11).

Exhibit 4.11: Correlations among Direct and Total Indirect Effects of Parental Education on Mathematics, Science, and Reading

	Direct Effects			Total Indirect Effects		
Direct Effects	**Mathematics**	**Science**	**Reading**	**Mathematics**	**Science**	**Reading**
Mathematics	1.00					
Science	0.88	1.00				
Reading	0.88	0.98	1.00			
Indirect Effects						
Mathematics	0.18	0.06	0.08	1.00		
Science	0.15	0.06	0.08	0.94	1.00	
Reading	0.23	0.13	0.16	0.90	0.95	1.00

The correlations among the direct effects were very large, and particularly so for science and reading (r = 0.98). The correlations between the direct effect of Parental Education on mathematics and the effects on science and reading were somewhat smaller (0.88). The correlations among the total indirect effects showed a similar pattern, with the correlation for reading and science being the largest (r = 0.95) and the correlation for mathematics and reading being the smallest (r = 0.90). The correlation among the total indirect effects for mathematics and science also was large (r = 0.94).

The correlations among the direct and indirect effects of Parental Education were all close to zero, and none of these was significant. The absence of correlations between direct and total indirect effects implies that countries can have all possible combinations of large and small estimates of direct and indirect effects. These results indicate that there are different mechanisms at work behind the direct effects and the indirect effects. The direct effects are effects for which no testable explanatory mechanism has yet been proposed. It is, however, interesting to note the very high correlation between the direct effects for science and reading, which suggests that reading skills are important for achievement in the science domain.

Direct Effects of Parental Education and Gender on the Mediating Variables

This section will primarily focus on the indirect effects, because a closer analysis of these effects can inform us about the mechanisms through which Parental Education and Gender influence the achievement outcomes in the three domains.

The indirect effects are created by two or more direct effects, linking the independent variables Parental Education and Gender and the dependent variables (i.e., the fourth grade student achievement measures). Because the indirect effect is a function of the product of the path coefficients involved in the path, a description of which direct relations are small and which are large is important for understanding the indirect effects. In the description of indirect effects we are, in particular, interested in the relations among variables which build what we have labeled the Main Path, i.e., the path from Parental Education to achievement via Books, Activity, and Ability.

Below, we analyze the direct effects of Parental Education and Gender on the mediating variables of the path model (i.e., Books, Activity, NumLitAct, Ability and NumLitAb), and then we analyze the pattern of interrelations among these mediating variables. Estimated direct effects of Parental Education on the mediating variables are presented first, followed by the results for Gender.

DIRECT EFFECTS OF PARENTAL EDUCATION Exhibit 4.12 presents the estimated standardized direct effects of Parental Education on the mediating variables in the path model. Discussion begins by focusing on the relation between Parental Education and Books, which is the first link in the Main Path.

As indicated in this Exhibit, the mean standardized regression coefficient (β) was 0.48 (sd = 0.09). This is a substantial relationship, though there was variation across countries. The highest relationships were observed in Hungary, Romania, Portugal, Iran, Spain, and the Slovak Republic, and the lowest relationships were observed in Qatar, the Emirate of Dubai, the Canadian province of Quebec, and Oman. There does seem to be an over-representation of East European countries in the group with high relationships, though there are exceptions; for example, the Russian Federation and the Czech Republic both had values below the mean (β = 0.41 and β = 0.45, respectively).

The mean β coefficient for the relationship between Parental Education and Activity was 0.05 (sd = 0.08) (see Exhibit 4.12). This is a small estimate, which suggests that the effects of Parental Education only to a small extent are due to direct effects of Parental Education on Activity. There were, however, differences across countries. While non-significant relationships were observed for many countries, two had significant negative relationships (Botswana and Morocco) and 16 had significant positive relationships, the highest of which were observed for Malta, Oman, Finland, Italy, Hong Kong SAR, and Sweden.

It will be remembered that the NumLitAct variable is bipolar, such that positive values represent a relatively stronger emphasis on literacy activities than on numeracy while negative values represent a stronger emphasis on numeracy activities than on literacy activities. The mean direct effect of Parental Education on NumLitAct across the 37 participants was 0.01 (sd = 0.07). Thus, as was observed also in the Common model, there is no general effect that holds across countries. There were, however, substantial country differences. Four countries had significant negative relations: Iran, Honduras, Oman, and Chinese Taipei. In other words, in these countries, highly educated parents tended to put more emphasis on numeracy than on literacy activities. Seven countries had significant positive relations: Sweden, Finland, Slovenia, Norway, Morocco, the Czech Republic, and Saudi Arabia. In these countries, that is, highly educated parents placed more emphasis on literacy-oriented activities than on activities that were numeracy-oriented.

The mean of the β coefficients for the regression of Ability on Parental Education was .02 (sd = 0.05). For one country (Hong Kong SAR) there was

Exhibit 4.12: Standardized Direct Effects of Parental Education on the Mediating Variables

Country	Books	Activity	NumLitAct	Ability	NumLitAb
Australia	0.401 (0.027)	0.025 (0.031)	0.025 (0.055)	0.045 (0.026)	–0.044 (0.028)
Austria	0.508 (0.016)	–0.004 (0.021)	0.039 (0.050)	0.041 (0.025)	–0.008 (0.025)
Azerbaijan	0.385 (0.025)	0.113 (0.029)	–0.047 (0.044)	0.063 (0.024)	–0.088 (0.027)
Chinese Taipei	0.549 (0.016)	0.091 (0.022)	–0.093 (0.033)	0.015 (0.020)	–0.024 (0.029)
Croatia	0.525 (0.020)	–0.016 (0.024)	0.010 (0.040)	–0.012 (0.021)	–0.024 (0.024)
Czech Republic	0.452 (0.021)	–0.096 (0.026)	0.095 (0.044)	–0.004 (0.023)	–0.018 (0.024)
Finland	0.406 (0.022)	–0.039 (0.023)	0.122 (0.050)	0.099 (0.024)	–0.005 (0.024)
Georgia	0.521 (0.022)	–0.008 (0.025)	–0.019 (0.043)	–0.016 (0.023)	–0.104 (0.029)
Germany	0.545 (0.019)	–0.016 (0.026)	–0.003 (0.053)	–0.009 (0.027)	–0.064 (0.028)
Hong Kong SAR	0.540 (0.023)	0.041 (0.025)	0.017 (0.030)	–0.073 (0.025)	0.059 (0.030)
Hungary	0.688 (0.015)	–0.067 (0.025)	–0.016 (0.044)	0.028 (0.025)	–0.086 (0.028)
Iran, Islamic Rep. of	0.621 (0.022)	0.032 (0.025)	–0.22 (0.054)	–0.038 (0.026)	–0.104 (0.029)
Ireland	0.473 (0.022)	–0.015 (0.025)	0.010 (0.042)	0.024 (0.025)	–0.083 (0.028)
Italy	0.487 (0.016)	0.000 (0.024)	–0.008 (0.034)	–0.039 (0.021)	–0.016 (0.024)
Lithuania	0.507 (0.021)	–0.026 (0.023)	0.039 (0.039)	0.073 (0.021)	0.047 (0.024)
Malta	0.511 (0.023)	0.069 (0.026)	–0.059 (0.035)	–0.018 (0.025)	0.113 (0.028)
Morocco	0.417 (0.030)	0.142 (0.028)	0.095 (0.032)	0.092 (0.017)	–0.026 (0.027)
Northern Ireland	0.506 (0.028)	–0.007 (0.035)	–0.057 (0.050)	–0.03 (0.030)	–0.09 (0.036)
Norway	0.471 (0.022)	0.037 (0.029)	0.101 (0.047)	–0.026 (0.024)	–0.064 (0.033)
Oman	0.361 (0.019)	0.150 (0.024)	–0.101 (0.042)	0.032 (0.017)	0.073 (0.023)
Poland	0.564 (0.017)	–0.012 (0.029)	0.060 (0.037)	0.030 (0.024)	–0.048 (0.030)
Portugal	0.639 (0.020)	–0.026 (0.030)	0.020 (0.063)	–0.037 (0.039)	–0.078 (0.042)
Qatar	0.301 (0.033)	0.135 (0.027)	–0.056 (0.045)	0.049 (0.020)	–0.044 (0.025)
Romania	0.649 (0.021)	0.272 (0.036)	0.077 (0.052)	0.070 (0.027)	–0.125 (0.033)
Russian Federation	0.405 (0.022)	0.075 (0.027)	0.005 (0.040)	0.099 (0.020)	–0.032 (0.031)
Saudi Arabia	0.405 (0.025)	0.086 (0.035)	0.093 (0.045)	0.049 (0.027)	–0.1 (0.031)
Singapore	0.423 (0.018)	0.142 (0.016)	–0.007 (0.025)	0.090 (0.018)	0.043 (0.019)
Slovak Republic	0.569 (0.021)	0.036 (0.037)	–0.067 (0.034)	–0.002 (0.021)	–0.015 (0.027)
Slovenia	0.495 (0.020)	–0.012 (0.026)	0.109 (0.042)	–0.037 (0.024)	–0.063 (0.027)
Spain	0.570 (0.020)	–0.022 (0.028)	–0.019 (0.044)	0.040 (0.025)	0.049 (0.027)
Sweden	0.486 (0.019)	0.088 (0.027)	0.128 (0.049)	0.088 (0.031)	–0.053 (0.029)
United Arab Emirates	0.413 (0.014)	0.119 (0.015)	0.041 (0.022)	0.028 (0.013)	0.117 (0.019)
Sixth Grade Countries					
Botswana	0.392 (0.033)	0.224 (0.024)	–0.069 (0.040)	0.122 (0.022)	–0.116 (0.028)
Honduras	0.363 (0.053)	0.193 (0.038)	–0.136 (0.046)	0.007 (0.024)	–0.124 (0.035)
Benchmarking Participants					
Quebec, Canada	0.358 (0.026)	0.015 (0.023)	0.079 (0.042)	0.008 (0.025)	–0.106 (0.025)
Abu Dhabi, UAE	0.441 (0.022)	0.116 (0.026)	0.061 (0.039)	0.061 (0.022)	0.097 (0.029)
Dubai, UAE	0.343 (0.026)	0.126 (0.019)	0.022 (0.035)	–0.014 (0.015)	0.147 (0.027)
International Avg.	0.494 (0.021)	0.092 (0.027)	0.060 (0.042)	0.056 (0.024)	0.072 (0.028)
International Std. Dev.	0.089 (0.004)	0.064 (0.005)	0.042 (0.009)	0.028 (0.005)	0.031 (0.005)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

a significant negative relationships between Ability and Parental Education, while for a dozen countries there were significant positive relations. The highest relationships were observed for Botswana, the Russian Federation, Finland, Morocco, Singapore, and Sweden.

One would expect that students with more highly educated parents also are better able to perform numeracy and literacy tasks at school start. There may, however, be many reasons for why this relationship does not appear for all countries. One reason may be that the effect of Parental Education only is indirect, via Books and Activity. Another reason may be that parents with more education evaluate their children's task performance against stricter standards. Yet another reason may be that, in some educational systems, school begins at such an early age that the students have not yet developed much of the numeracy and literacy skills asked about. The latter hypothesis may be tested by investigating how the level of relationship between Parental Education and Ability varies as a function of the age of the students, given that the students in almost all cases were assessed at the fourth grade (exceptions were Botswana and Honduras where students were assessed at Grade 6, and Malta, where students were assessed at Grade 5). The relationship between student mean age at country level and the β coefficient was .40, which supports the hypothesis that student age at the time of beginning primary school is of importance, with respect to the level of numeracy and literacy skills that can be demonstrated at that time.

The mean of the β coefficients for the relationship between Parental Education and NumLitAb (i.e., the tendency for the parents to assess the child as relatively stronger in literacy tasks then numeracy tasks on the one hand) was -0.03 (sd = 0.07). For about a dozen countries, the parents with a high level of education rated numeracy skills higher than literacy skills. This was most pronounced in Romania, Honduras, Botswana, the Canadian province of Quebec, Georgia, and Iran. For about half a dozen countries, the parents with a high level of education rated literacy skills higher than numeracy skills. This was most pronounced in the United Arab Emirates, Malta, and Oman.

In summary, there was a very strong direct effect of Parental Education on Books. For no other variable in the path model was there a noteworthy general effect of Parental Education. Judging from the results obtained in the Common model, the main reason for this is that the effect of Parental Education on the variables further down the chain is mediated via Books. However, it also may be noted that, for the majority of the relationships investigated, there was heterogeneity in the pattern of results for different countries, which will be discussed in the analyses of models for different countries.

DIRECT EFFECTS OF GENDER Exhibit 4.13 presents estimates of direct effects of Gender on the mediating variables in the path model.

In comparison with Parental Education, there were fewer direct effects of Gender, indicating that parents tend to interact in similar ways with boys and girls. There were, however, several interesting exceptions to this pattern.

First, there was a weak significant positive effect of Gender on Books in about a dozen countries (e.g., Lithuania, Ireland, the Emirate of Dubai, Malta, Sweden, Singapore, Slovenia, and Iran). Thus, in these countries, the parents reported a somewhat higher frequency of books when the child is a girl than when the child is a boy. The significant effects were between .05 and .07.

For the Activity variable, a significant Gender effect also was found in some cases. For example, in Malta, a higher level of activity was reported when the child was a boy; however, for about ten countries, a higher level of activity was reported for girls (e.g., Saudi Arabia, the Emirate of Abu Dhabi, Morocco, Oman, and Austria).

In most countries, there was a considerable effect of Gender for the NumLitAct variable, in such a way that more emphasis on literacy activities than on numeracy activities was reported for girls than for boys. The mean effect was 0.16 (sd = 07). For two countries only (Morocco and Saudi Arabia) was there no significant effect. The countries with the strongest direct effect of gender ($\beta > .24$) were Norway, Lithuania, Sweden, the Canadian province of Quebec, Germany, Finland, and Poland.

For the Ability variable, there was only a small mean effect of 0.03 (sd = 0.04), but there were a small number of countries where boys were rated higher in ability (Austria and Azerbaijan), and about a dozen countries were girls were rated as having better skills in doing literacy and numeracy tasks. Countries with the largest gender effect were Northern Ireland, Saudi Arabia, Hong Kong SAR, Chinese Taipei, Finland, Norway, and Singapore.

For the NumLitAb variable, there was a direct effect of Gender, the mean effect being 0.07 (sd = 0.05). The positive effect implies that girls were assessed as being relatively better at doing literacy tasks than at doing numeracy tasks. There was a significant positive effect in most countries, with the largest effects being observed for Sweden, Croatia, the Canadian province of Quebec, Slovenia, and Norway.

In summary, the results show fewer and smaller direct effects of Gender than of Parental Education. However, in almost all countries, the parents reported a stronger emphasis on literacy activities than on numeracy activities

Exhibit 4.13: Standardized Direct Effects of Gender on the Mediating Variables

Country	Books	Activity	NumLitAct	Ability	NumLitAb
Australia	−0.016 (0.025)	0.031 (0.026)	0.153 (0.042)	0.035 (0.024)	0.134 (0.027)
Austria	0.036 (0.017)	0.046 (0.016)	0.227 (0.035)	−0.054 (0.023)	0.129 (0.026)
Azerbaijan	−0.012 (0.019)	−0.001 (0.019)	0.215 (0.036)	−0.048 (0.022)	0.032 (0.026)
Chinese Taipei	0.015 (0.015)	0.022 (0.015)	0.177 (0.025)	0.079 (0.020)	0.070 (0.022)
Croatia	0.036 (0.015)	0.012 (0.017)	0.195 (0.033)	0.051 (0.019)	0.158 (0.019)
Czech Republic	0.009 (0.021)	0.043 (0.021)	0.074 (0.035)	0.024 (0.020)	0.042 (0.022)
Finland	0.017 (0.019)	0.032 (0.021)	0.243 (0.033)	0.077 (0.021)	0.114 (0.021)
Georgia	−0.002 (0.018)	0.013 (0.018)	0.084 (0.035)	0.064 (0.016)	0.095 (0.022)
Germany	0.025 (0.018)	0.028 (0.019)	0.257 (0.041)	−0.005 (0.023)	0.089 (0.029)
Hong Kong SAR	0.007 (0.022)	−0.004 (0.019)	0.147 (0.021)	0.083 (0.016)	0.008 (0.020)
Hungary	0.003 (0.014)	0.027 (0.016)	0.138 (0.024)	−0.003 (0.017)	0.055 (0.020)
Iran, Islamic Rep. of	0.046 (0.023)	−0.016 (0.024)	0.161 (0.038)	0.038 (0.020)	0.037 (0.022)
Ireland	0.066 (0.023)	−0.029 (0.021)	0.146 (0.032)	0.031 (0.020)	0.130 (0.031)
Italy	0.025 (0.017)	0.032 (0.018)	0.196 (0.030)	−0.013 (0.019)	0.097 (0.023)
Lithuania	0.075 (0.017)	0.028 (0.022)	0.307 (0.031)	0.041 (0.023)	0.130 (0.024)
Malta	0.061 (0.019)	−0.046 (0.020)	0.138 (0.031)	0.047 (0.021)	0.055 (0.024)
Morocco	0.019 (0.018)	0.060 (0.026)	−0.011 (0.030)	0.036 (0.017)	0.014 (0.025)
Northern Ireland	0.055 (0.029)	0.042 (0.029)	0.212 (0.037)	0.098 (0.026)	0.053 (0.033)
Norway	0.020 (0.021)	0.024 (0.028)	0.323 (0.038)	0.068 (0.025)	0.138 (0.029)
Oman	0.003 (0.015)	0.055 (0.015)	0.133 (0.025)	0.023 (0.015)	0.068 (0.016)
Poland	0.030 (0.017)	0.042 (0.017)	0.236 (0.029)	0.005 (0.018)	0.049 (0.023)
Portugal	0.018 (0.021)	0.037 (0.021)	0.160 (0.038)	−0.011 (0.021)	0.058 (0.022)
Qatar	0.040 (0.023)	0.030 (0.021)	0.084 (0.038)	0.026 (0.019)	0.029 (0.027)
Romania	0.031 (0.014)	0.023 (0.016)	0.076 (0.027)	0.047 (0.016)	0.004 (0.026)
Russian Federation	0.023 (0.017)	0.044 (0.018)	0.120 (0.029)	0.035 (0.017)	0.051 (0.022)
Saudi Arabia	0.070 (0.041)	0.134 (0.027)	0.033 (0.035)	0.093 (0.030)	0.070 (0.026)
Singapore	0.050 (0.018)	0.016 (0.013)	0.117 (0.019)	0.067 (0.013)	0.040 (0.015)
Slovak Republic	0.040 (0.016)	0.039 (0.018)	0.153 (0.031)	−0.022 (0.015)	0.059 (0.018)
Slovenia	0.049 (0.017)	0.009 (0.017)	0.181 (0.034)	0.046 (0.023)	0.144 (0.025)
Spain	−0.007 (0.018)	0.016 (0.017)	0.204 (0.033)	−0.001 (0.020)	0.107 (0.021)
Sweden	0.050 (0.021)	0.035 (0.021)	0.281 (0.039)	0.063 (0.025)	0.177 (0.030)
United Arab Emirates	0.008 (0.015)	0.032 (0.012)	0.107 (0.020)	0.023 (0.012)	0.028 (0.020)
Sixth Grade Countries					
Botswana	−0.002 (0.020)	0.039 (0.019)	0.152 (0.029)	0.028 (0.018)	0.006 (0.022)
Honduras	0.000 (0.023)	−0.02 (0.022)	0.113 (0.038)	0.000 (0.027)	−0.009 (0.031)
Benchmarking Participants					
Quebec, Canada	0.017 (0.023)	0.012 (0.019)	0.267 (0.030)	0.011 (0.020)	0.150 (0.026)
Abu Dhabi, UAE	0.018 (0.023)	0.076 (0.021)	0.127 (0.035)	0.031 (0.021)	0.048 (0.029)
Dubai, UAE	0.065 (0.026)	0.024 (0.013)	0.150 (0.030)	0.034 (0.021)	−0.005 (0.031)
International Avg.	0.033 (0.019)	0.035 (0.020)	0.170 (0.032)	0.050 (0.020)	0.077 (0.024)
International Std. Dev.	0.021 (0.005)	0.023 (0.004)	0.070 (0.006)	0.024 (0.004)	0.047 (0.004)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

when their child was a girl than when their child was a boy. Furthermore, in most countries, the parents assessed girls' literacy skills to be stronger than their numeracy skills. There also was a tendency for the parents to report more books in the home for girls, and also a tendency towards a higher level of activity with girls.

Direct Effects Among the Mediating Variables

This section looks closer at the relationships among the mediating variables: Books, and the Activity and Ability variables. These relationships are, of course, the same when we investigate effects of Parental Education and Gender.

EFFECTS OF BOOKS Exhibit 4.14 presents standardized direct effects of Books on the variables in the path model.

As is presented in Exhibit 4.14, there was a large direct effect of Books on Activity, the mean β being 0.34 (sd = 0.07). There also was a sizeable variation in the strength of the relationship across countries. The smallest effects were around .20 and were observed for Honduras, Botswana, Morocco, the Czech Republic, Italy, and Azerbaijan. The largest effects were higher than 0.40 and were observed for Portugal, Chinese Taipei, Malta, Austria, Georgia, and Ireland.

For the direct effect of Books on the variable NumLitAct, the mean was 0.09 (sd = 0.09), indicating that parents who reported a larger number of books in the home also tended to report that activities were more literacy oriented than numeracy oriented. For two countries (Georgia and Hungary) the effect was negative and significant, while for around 20 countries the effect was positive and significant. The largest positive effects were observed for Italy, Chinese Taipei, Lithuania, Germany, and Sweden.

The mean direct effect of Books on Ability was 0.0, but there was large variability across countries (sd = 0.10). For eight countries the effect was negative and significant, most markedly so in Austria, Ireland, Germany, and Australia. For ten countries the effect was positive and significant, with the strongest relationships in Singapore, Russian Federation and Lithuania.

For the direct effect of Books on the variable NumLitAb, the mean estimate of β was close to 0, and for only one country (Portugal) was there a weak significant positive effect.

The Books variable had strong direct effects on the three achievement variables: 0.22 for mathematics, 0.24 for science and 0.23 for reading. However, there also was considerable variation across countries (sd between .09 and .10).

Exhibit 4.14: Standardized Direct Effect of Books on the Variables in the Path Model

Country	Activity	NumLitAct	Ability	NumLitAb	Mathematics	Science	Reading
Australia	0.381 (0.028)	0.118 (0.060)	−0.147 (0.030)	0.036 (0.027)	0.226 (0.033)	0.270 (0.034)	0.233 (0.034)
Austria	0.417 (0.020)	0.082 (0.061)	−0.245 (0.029)	0.034 (0.026)	0.441 (0.035)	0.447 (0.031)	0.422 (0.029)
Azerbaijan	0.262 (0.034)	0.073 (0.046)	0.069 (0.026)	0.031 (0.026)	0.083 (0.038)	0.095 (0.039)	0.061 (0.036)
Chinese Taipei	0.440 (0.020)	0.213 (0.038)	0.069 (0.029)	0.036 (0.022)	0.227 (0.023)	0.237 (0.028)	0.179 (0.023)
Croatia	0.329 (0.024)	0.081 (0.039)	0.055 (0.022)	0.026 (0.019)	0.221 (0.023)	0.255 (0.027)	0.246 (0.024)
Czech Republic	0.257 (0.026)	0.109 (0.051)	−0.001 (0.028)	0.034 (0.022)	0.280 (0.024)	0.317 (0.026)	0.297 (0.026)
Finland	0.328 (0.021)	0.149 (0.060)	0.078 (0.035)	0.037 (0.021)	0.194 (0.035)	0.264 (0.032)	0.237 (0.031)
Georgia	0.415 (0.028)	−0.177 (0.045)	0.086 (0.027)	0.033 (0.022)	0.208 (0.038)	0.222 (0.042)	0.220 (0.036)
Germany	0.312 (0.027)	0.192 (0.059)	−0.16 (0.030)	0.038 (0.029)	0.375 (0.034)	0.412 (0.037)	0.373 (0.033)
Hong Kong SAR	0.392 (0.025)	0.133 (0.037)	0.080 (0.028)	0.031 (0.020)	0.154 (0.033)	0.165 (0.031)	0.119 (0.032)
Hungary	0.381 (0.027)	−0.157 (0.054)	−0.04 (0.030)	0.031 (0.020)	0.324 (0.030)	0.366 (0.027)	0.307 (0.029)
Iran, Islamic Rep. of	0.371 (0.022)	0.027 (0.068)	0.004 (0.026)	0.036 (0.022)	0.223 (0.034)	0.215 (0.029)	0.201 (0.030)
Ireland	0.396 (0.024)	0.157 (0.056)	−0.169 (0.027)	0.042 (0.031)	0.348 (0.029)	0.368 (0.039)	0.378 (0.028)
Italy	0.258 (0.028)	0.221 (0.038)	−0.09 (0.027)	0.030 (0.023)	0.203 (0.028)	0.267 (0.033)	0.261 (0.026)
Lithuania	0.277 (0.027)	0.195 (0.041)	0.126 (0.029)	0.033 (0.024)	0.207 (0.025)	0.220 (0.028)	0.229 (0.026)
Malta	0.418 (0.029)	0.087 (0.045)	−0.012 (0.031)	0.034 (0.024)	0.201 (0.033)	0.226 (0.029)	0.193 (0.030)
Morocco	0.243 (0.031)	0.093 (0.040)	0.062 (0.022)	0.034 (0.025)	0.032 (0.028)	0.056 (0.028)	0.034 (0.026)
Northern Ireland	0.331 (0.036)	0.168 (0.059)	−0.131 (0.035)	0.049 (0.033)	0.268 (0.042)	0.332 (0.047)	0.268 (0.040)
Norway	0.350 (0.032)	0.085 (0.055)	−0.035 (0.029)	0.042 (0.029)	0.227 (0.038)	0.304 (0.033)	0.291 (0.034)
Oman	0.310 (0.022)	0.079 (0.036)	0.028 (0.020)	0.022 (0.016)	0.130 (0.021)	0.096 (0.021)	0.126 (0.022)
Poland	0.357 (0.033)	0.164 (0.045)	−0.028 (0.027)	0.031 (0.023)	0.212 (0.028)	0.211 (0.027)	0.179 (0.029)
Portugal	0.489 (0.025)	0.085 (0.072)	0.027 (0.037)	0.045 (0.022)	0.269 (0.044)	0.236 (0.049)	0.259 (0.045)
Qatar	0.278 (0.029)	0.138 (0.035)	−0.054 (0.029)	0.027 (0.027)	0.228 (0.046)	0.173 (0.043)	0.193 (0.042)
Romania	0.385 (0.033)	−0.077 (0.057)	0.062 (0.034)	0.038 (0.026)	0.228 (0.036)	0.220 (0.036)	0.229 (0.035)
Russian Federation	0.378 (0.022)	0.026 (0.041)	0.154 (0.023)	0.027 (0.022)	0.144 (0.029)	0.177 (0.029)	0.186 (0.025)
Saudi Arabia	0.354 (0.041)	0.040 (0.043)	0.090 (0.027)	0.032 (0.026)	0.138 (0.053)	0.155 (0.047)	0.103 (0.042)
Singapore	0.336 (0.018)	0.147 (0.029)	0.195 (0.019)	0.025 (0.015)	0.208 (0.020)	0.251 (0.020)	0.235 (0.018)
Slovak Republic	0.318 (0.031)	0.101 (0.045)	0.023 (0.022)	0.030 (0.018)	0.358 (0.032)	0.366 (0.032)	0.348 (0.027)
Slovenia	0.324 (0.025)	0.060 (0.045)	0.038 (0.027)	0.029 (0.025)	0.295 (0.026)	0.327 (0.023)	0.309 (0.022)
Spain	0.378 (0.028)	0.140 (0.051)	0.075 (0.031)	0.031 (0.021)	0.214 (0.033)	0.249 (0.035)	0.191 (0.033)
Sweden	0.267 (0.028)	0.189 (0.049)	−0.051 (0.034)	0.039 (0.030)	0.315 (0.035)	0.404 (0.032)	0.310 (0.031)
United Arab Emirates	0.325 (0.014)	0.114 (0.025)	−0.037 (0.019)	0.018 (0.020)	0.241 (0.024)	0.203 (0.024)	0.252 (0.023)
Sixth Grade Countries							
Botswana	0.212 (0.031)	−0.036 (0.038)	0.061 (0.022)	0.023 (0.022)	0.054 (0.024)	0.047 (0.023)	0.055 (0.023)
Honduras	0.162 (0.042)	−0.011 (0.037)	−0.02 (0.025)	0.028 (0.031)	0.041 (0.030)	0.064 (0.029)	0.062 (0.031)
Benchmarking Participants							
Quebec, Canada	0.368 (0.027)	0.149 (0.051)	−0.067 (0.030)	0.033 (0.026)	0.206 (0.031)	0.257 (0.034)	0.183 (0.030)
Abu Dhabi, UAE	0.302 (0.026)	0.102 (0.044)	−0.02 (0.036)	0.032 (0.029)	0.183 (0.045)	0.129 (0.047)	0.193 (0.048)
Dubai, UAE	0.354 (0.021)	0.108 (0.043)	−0.091 (0.026)	0.026 (0.031)	0.356 (0.030)	0.335 (0.029)	0.353 (0.026)
International Avg.	0.346 (0.027)	0.120 (0.048)	0.073 (0.028)	0.033 (0.024)	0.232 (0.032)	0.253 (0.032)	0.233 (0.030)
International Std. Dev.	0.060 (0.006)	0.054 (0.011)	0.047 (0.005)	0.006 (0.004)	0.084 (0.008)	0.094 (0.007)	0.088 (0.006)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

The correlations between the βs for the three relations were from .94 to .96. For the following countries a strong direct effect of Books on achievement in all three domains was observed: Austria, Germany, the Slovak Republic, Ireland, Sweden, the Emirate of Dubai, and Hungary.

In summary, the results show, as expected, a substantial positive direct effect of Books on Activity, but also a large variation across countries. For the majority of countries there also was a positive effect of Books on NumLitAct, which implies that homes with many books tended to be engaged in more literacy than numeracy activities. There was no overall effect of Books on Ability, though there were differences across country.

EFFECTS OF THE ACTIVITY VARIABLES Exhibit 4.15 presents the standardized direct effects of the activity variables on the other variables in the path model.

As noted in Exhibit 4.15, the Activity variable had a direct effect of 0.40 (sd = 0.08) on Ability, and the positive effect was significant in all countries. The smallest effects (.31 or lower) were observed for Finland, Spain, Hong Kong SAR, and Croatia, while the largest effects (.51 or higher) were observed for Romania, Morocco, Azerbaijan, and the Slovak Republic.

The average effect of the Activity variable on NumLitAb was close to 0, but there was variation across countries (sd = 0.07). For five countries there was a significant negative effect, implying that a high level of Activity was related to higher numeracy skills than literacy skills at school start. Interestingly, these five countries were all are East European countries: Romania, the Russian Federation, Hungary, the Slovak Republic, and the Czech Republic. Three countries, Morocco, Singapore, and Ireland, had a significant positive relationship.

The average direct effect of Activity was close to zero for all three achievement measures, but there was variability across countries (sd between 0.06 and 0.07). The correlations between the βs for the three relations were .92 to .93. For mathematics there were significant negative direct effects for 18 countries, with the largest effects being observed for Morocco, Singapore, Slovenia, the Russian Federation, and Norway. Significant positive direct effects were observed for the United Arab Emirates and the two Emirates of Abu Dhabi and Dubai. For science there were significant negative relationships for eight countries, including all of the aforementioned, with significant negative relationships between Activity and mathematics achievement. There were significant positive effects on science achievement in six countries, among which were those with significant positive effects on mathematics achievement. There was a negative direct effect of Activity on reading for five countries, and a positive effect for six countries, the results largely being in agreement with those observed for science.

With respect to the estimated direct effects of NumLitAct, this variable had a strong direct effect on the Ability variable with an average of 0.20 (sd = 0.08). This finding implies that activities which emphasize literacy rather than numeracy are positively related to a high level of skills in performing both literacy and numeracy tasks at the beginning of primary school. While there was variability in the estimated β coefficients, they were significant and positive in all countries. The estimates ranged from a low of .06 in Singapore to a high of .40 in Azerbaijan. Other countries with large estimated direct effects included Austria, Hungary, Germany, Oman, and Slovenia.

The NumLitAct variable also had a rather large direct effect on the NumLitAb variable, the average effect being 0.13 (sd = 0.10). Only in Georgia was the effect significantly negative; rather, it was positive and significant in most countries. These positive relations thus imply that activities which emphasize literacy more than numeracy are related to higher literacy skills than numeracy skills.

The NumLitAct variable had an average direct effect on mathematics achievement that was negative (-0.07, sd = 0.06). The negative effect was significant for 16 countries, while the effect was non-significant for all other participants. The largest negative effects were observed for Finland, Morocco, Hungary, Iran, and Norway. At a general level, it is perhaps reasonable to expect that activities which emphasize literacy rather than numeracy would have a negative direct effect on mathematic achievement.

The NumLitAct variable had a negative direct effect on science achievement in six countries: Iran, Morocco, Hungary, Romania, Croatia, Ireland, and Chinese Taipei. However, NumLitAct had a positive direct effect on reading achievement for three participants (the Canadian province of Quebec, Sweden, and Spain), and a negative direct effect in three participants (Iran, Romania, and Hungary).

In summary, Activity had a substantial relationship with Ability, supporting the idea of the Main Path. There was no general effect of Activity on NumLitAb or on any of the three achievement variables, but there were small direct effects that varied across countries. As expected, NumLitAct had a significant effect on NumLitAb in almost all countries, even though the effect

Exhibit 4.15: Standardized Direct Effects of the Activity Variables on the Other Variables in the Path Model

Country	Activity				
	Ability	NumLitAb	Mathematics	Science	Reading
Australia	0.396 (0.028)	0.026 (0.038)	−0.039 (0.033)	0.015 (0.034)	0.002 (0.034)
Austria	0.387 (0.022)	0.017 (0.034)	−0.082 (0.031)	−0.012 (0.026)	−0.002 (0.029)
Azerbaijan	0.530 (0.025)	−0.052 (0.047)	−0.021 (0.037)	0.015 (0.035)	0.009 (0.035)
Chinese Taipei	0.386 (0.018)	0.039 (0.029)	−0.022 (0.020)	−0.038 (0.020)	−0.033 (0.020)
Croatia	0.309 (0.021)	−0.037 (0.024)	−0.042 (0.020)	0.000 (0.025)	−0.028 (0.019)
Czech Republic	0.377 (0.019)	−0.106 (0.029)	−0.086 (0.023)	−0.081 (0.025)	−0.058 (0.023)
Finland	0.246 (0.026)	−0.034 (0.026)	−0.058 (0.023)	−0.048 (0.029)	−0.056 (0.023)
Georgia	0.490 (0.023)	−0.042 (0.038)	−0.093 (0.033)	−0.044 (0.034)	−0.033 (0.033)
Germany	0.388 (0.023)	0.056 (0.030)	−0.087 (0.026)	−0.038 (0.025)	−0.03 (0.027)
Hong Kong SAR	0.303 (0.022)	0.012 (0.022)	−0.043 (0.022)	−0.049 (0.022)	−0.035 (0.032)
Hungary	0.465 (0.025)	−0.12 (0.044)	−0.006 (0.024)	−0.02 (0.031)	0.004 (0.030)
Iran, Islamic Rep. of	0.504 (0.030)	−0.027 (0.031)	−0.063 (0.026)	−0.02 (0.028)	−0.025 (0.024)
Ireland	0.374 (0.019)	0.067 (0.024)	−0.007 (0.027)	0.032 (0.032)	0.008 (0.028)
Italy	0.382 (0.020)	0.029 (0.030)	−0.016 (0.029)	0.036 (0.025)	0.016 (0.024)
Lithuania	0.369 (0.019)	−0.033 (0.028)	−0.085 (0.024)	−0.101 (0.023)	−0.098 (0.022)
Malta	0.334 (0.022)	0.021 (0.027)	0.051 (0.027)	0.051 (0.025)	0.092 (0.026)
Morocco	0.569 (0.034)	0.162 (0.039)	−0.274 (0.045)	−0.204 (0.041)	−0.174 (0.037)
Northern Ireland	0.397 (0.025)	0.033 (0.044)	−0.041 (0.034)	−0.044 (0.037)	0.008 (0.036)
Norway	0.466 (0.023)	0.009 (0.044)	−0.117 (0.033)	−0.06 (0.035)	−0.063 (0.037)
Oman	0.435 (0.019)	0.047 (0.025)	0.038 (0.022)	0.047 (0.022)	0.042 (0.020)
Poland	0.470 (0.022)	0.014 (0.034)	−0.05 (0.023)	−0.029 (0.025)	0.005 (0.025)
Portugal	0.356 (0.023)	0.007 (0.034)	−0.071 (0.031)	−0.009 (0.036)	−0.073 (0.030)
Qatar	0.352 (0.020)	−0.002 (0.024)	−0.005 (0.029)	0.037 (0.025)	0.009 (0.023)
Romania	0.587 (0.032)	−0.213 (0.045)	−0.088 (0.042)	−0.032 (0.039)	−0.026 (0.031)
Russian Federation	0.467 (0.023)	−0.121 (0.036)	−0.125 (0.029)	−0.105 (0.036)	−0.089 (0.027)
Saudi Arabia	0.425 (0.030)	0.013 (0.036)	0.010 (0.037)	0.004 (0.039)	0.030 (0.030)
Singapore	0.363 (0.016)	0.069 (0.021)	−0.134 (0.017)	−0.104 (0.014)	−0.088 (0.015)
Slovak Republic	0.511 (0.028)	−0.117 (0.035)	−0.104 (0.036)	−0.088 (0.034)	−0.051 (0.031)
Slovenia	0.383 (0.022)	−0.047 (0.029)	−0.131 (0.023)	−0.079 (0.026)	−0.062 (0.023)
Spain	0.288 (0.025)	−0.022 (0.032)	0.008 (0.028)	0.031 (0.028)	0.022 (0.029)
Sweden	0.344 (0.023)	0.049 (0.032)	−0.062 (0.027)	−0.008 (0.028)	−0.005 (0.027)
United Arab Emirates	0.367 (0.013)	0.026 (0.017)	0.056 (0.018)	0.089 (0.018)	0.083 (0.015)
Sixth Grade Countries					
Botswana	0.472 (0.029)	0.029 (0.032)	0.050 (0.030)	0.068 (0.028)	0.066 (0.023)
Honduras	0.419 (0.026)	0.069 (0.039)	−0.041 (0.041)	−0.048 (0.040)	−0.03 (0.039)
Benchmarking Participants					
Quebec, Canada	0.334 (0.024)	0.014 (0.030)	−0.057 (0.027)	−0.022 (0.035)	0.032 (0.028)
Abu Dhabi, UAE	0.375 (0.021)	0.000 (0.029)	0.064 (0.030)	0.105 (0.027)	0.092 (0.024)
Dubai, UAE	0.338 (0.016)	0.025 (0.026)	0.093 (0.027)	0.111 (0.027)	0.115 (0.023)
International Avg.	0.407 (0.023)	0.039 (0.032)	0.033 (0.028)	0.032 (0.029)	0.025 (0.027)
International Std. Dev.	0.081 (0.005)	0.036 (0.008)	0.023 (0.007)	0.025 (0.007)	0.030 (0.006)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.15: Standardized Direct Effects of the Activity Variables on the Other Variables in the Path Model (Continued)

Country	NumLitAct				
	Ability	NumLitAb	Mathematics	Science	Reading
Australia	0.176 (0.039)	0.164 (0.051)	−0.061 (0.046)	0.008 (0.046)	0.032 (0.043)
Austria	0.393 (0.046)	0.314 (0.064)	−0.133 (0.057)	−0.046 (0.049)	0.000 (0.054)
Azerbaijan	0.398 (0.041)	0.157 (0.074)	0.065 (0.057)	0.032 (0.063)	0.009 (0.061)
Chinese Taipei	0.114 (0.024)	0.033 (0.032)	−0.113 (0.031)	−0.060 (0.027)	−0.005 (0.030)
Croatia	0.232 (0.037)	0.135 (0.039)	−0.126 (0.035)	−0.086 (0.041)	0.002 (0.040)
Czech Republic	0.194 (0.039)	0.109 (0.048)	−0.024 (0.038)	0.026 (0.040)	0.074 (0.040)
Finland	0.189 (0.040)	0.260 (0.050)	−0.182 (0.044)	−0.034 (0.053)	0.041 (0.044)
Georgia	0.199 (0.033)	−0.117 (0.049)	−0.084 (0.038)	−0.032 (0.038)	−0.002 (0.040)
Germany	0.320 (0.045)	0.352 (0.058)	−0.139 (0.059)	−0.027 (0.055)	0.007 (0.054)
Hong Kong SAR	0.147 (0.029)	0.081 (0.028)	−0.083 (0.032)	−0.025 (0.028)	−0.005 (0.026)
Hungary	0.332 (0.036)	0.276 (0.046)	−0.179 (0.036)	−0.109 (0.039)	−0.080 (0.037)
Iran, Islamic Rep. of	0.203 (0.033)	0.174 (0.044)	−0.176 (0.039)	−0.178 (0.037)	−0.166 (0.035)
Ireland	0.173 (0.032)	0.022 (0.043)	−0.061 (0.035)	−0.070 (0.034)	−0.033 (0.033)
Italy	0.228 (0.035)	0.151 (0.045)	−0.062 (0.039)	0.007 (0.043)	0.063 (0.038)
Lithuania	0.159 (0.042)	0.201 (0.041)	−0.080 (0.037)	−0.012 (0.041)	0.014 (0.040)
Malta	0.155 (0.031)	−0.042 (0.035)	−0.018 (0.031)	−0.034 (0.027)	−0.022 (0.026)
Morocco	0.274 (0.037)	0.243 (0.114)	−0.180 (0.060)	−0.137 (0.057)	−0.118 (0.067)
Northern Ireland	0.153 (0.035)	0.117 (0.052)	−0.045 (0.047)	−0.022 (0.052)	0.002 (0.042)
Norway	0.237 (0.036)	0.170 (0.051)	−0.158 (0.052)	0.022 (0.046)	0.037 (0.047)
Oman	0.285 (0.029)	0.091 (0.035)	−0.008 (0.034)	−0.020 (0.034)	−0.031 (0.032)
Poland	0.260 (0.030)	0.220 (0.039)	−0.045 (0.034)	0.054 (0.040)	0.043 (0.034)
Portugal	0.139 (0.046)	0.088 (0.043)	−0.084 (0.037)	−0.041 (0.035)	−0.007 (0.038)
Qatar	0.158 (0.037)	0.049 (0.040)	−0.089 (0.029)	−0.035 (0.032)	−0.004 (0.032)
Romania	0.112 (0.030)	0.124 (0.035)	−0.103 (0.039)	−0.109 (0.040)	−0.087 (0.028)
Russian Federation	0.232 (0.031)	0.045 (0.047)	−0.013 (0.037)	−0.013 (0.043)	0.031 (0.036)
Saudi Arabia	0.201 (0.043)	0.096 (0.055)	0.023 (0.035)	0.012 (0.037)	0.004 (0.033)
Singapore	0.062 (0.019)	0.045 (0.027)	−0.083 (0.019)	−0.039 (0.019)	−0.017 (0.019)
Slovak Republic	0.208 (0.027)	0.240 (0.035)	−0.065 (0.036)	0.008 (0.039)	−0.015 (0.034)
Slovenia	0.281 (0.033)	0.171 (0.052)	−0.038 (0.037)	0.057 (0.039)	0.068 (0.035)
Spain	0.109 (0.040)	0.076 (0.043)	−0.015 (0.047)	0.028 (0.041)	0.069 (0.033)
Sweden	0.236 (0.051)	0.134 (0.062)	−0.075 (0.042)	0.063 (0.046)	0.133 (0.045)
United Arab Emirates	0.115 (0.019)	0.095 (0.023)	−0.001 (0.018)	0.014 (0.021)	0.036 (0.020)
Sixth Grade Countries					
Botswana	0.120 (0.042)	0.115 (0.045)	0.013 (0.034)	−0.005 (0.033)	−0.036 (0.029)
Honduras	0.135 (0.043)	−0.080 (0.050)	−0.018 (0.044)	−0.060 (0.043)	−0.038 (0.039)
Benchmarking Participants					
Quebec, Canada	0.188 (0.040)	0.094 (0.046)	−0.064 (0.044)	0.068 (0.042)	0.139 (0.043)
Abu Dhabi, UAE	0.139 (0.030)	0.113 (0.036)	−0.018 (0.030)	−0.002 (0.031)	0.020 (0.031)
Dubai, UAE	0.103 (0.028)	0.112 (0.033)	−0.025 (0.032)	0.012 (0.034)	0.039 (0.031)
International Avg.	0.209 (0.035)	0.148 (0.047)	0.044 (0.039)	0.028 (0.040)	0.037 (0.038)
International Std. Dev.	0.080 (0.007)	0.085 (0.016)	0.030 (0.010)	0.020 (0.010)	0.035 (0.011)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

was relatively small. NumLitAct also had a significant direct effect on Ability in every country, and this relationship was not expected. This implies that, in homes where there is greater emphasis on literacy activities than on numeracy activities, both numeracy skills and literacy skills at school start are higher. It also was unexpected to find that NumLitAct had a significant negative effect on mathematics achievement in about half of the countries. There may be several explanations for these unexpected relationships, which will be discussed later.

EFFECTS OF THE ABILITY VARIABLES Exhibit 4.16 presents standardized direct effects of the Ability variables on the three achievement variables.

As shown in Exhibit 4.16, the average of the direct effects of Ability on mathematics achievement was 0.25 (sd = 0.10). For both science and reading the direct effects of Ability were 0.21 (sd = 0.08). The direct effect was significant in every country except Azerbaijan.

The average effect of NumLitAb on mathematics achievement was close to zero, but there was variability across countries (sd = 0.07). Significant negative direct effects on mathematics achievement were observed in 14 countries. Such negative effects are to be expected, given that negative scores on NumLitAb express stronger numeracy skills than literacy skills. Significant positive effects were found for seven countries, with the largest effects found for the Emirate of Abu Dhabi, Morocco, Qatar, the United Arab Emirates, the Emirate of Dubai, and Oman.

The average effect of NumLitAb on science achievement was close to zero, though again there was variation across countries (sd = 0.07). There were significant negative direct effects for twelve countries, while there were significant positive direct effects for eight countries.

The average direct effect of NumLitAb on reading achievement was close to zero, similar to mathematics and science, but ten countries had significant negative effects while eleven countries had significant positive effects. The negative effects were rather weak.

In summary, the expected positive direct effects of Ability on the three fourth grade student achievement measures were observed in all countries, except for one. For the NumLitAb variable, there were no general effects on achievement. However, both positive and negative significant effects within different countries were observed.

Exhibit 4.16: Standardized Direct Effects of the Ability Variables on Achievement, Grade 4

Country	Ability			NumLitAb		
	Mathematics	Science	Reading	Mathematics	Science	Reading
Australia	0.320 (0.029)	0.262 (0.029)	0.231 (0.027)	−0.080 (0.027)	−0.071 (0.027)	−0.070 (0.026)
Austria	0.289 (0.039)	0.123 (0.030)	0.116 (0.036)	−0.095 (0.027)	−0.081 (0.029)	−0.044 (0.029)
Azerbaijan	0.024 (0.040)	0.028 (0.042)	0.019 (0.047)	−0.128 (0.028)	−0.102 (0.027)	−0.034 (0.027)
Chinese Taipei	0.301 (0.021)	0.275 (0.022)	0.262 (0.020)	0.012 (0.021)	−0.004 (0.022)	0.019 (0.021)
Croatia	0.379 (0.021)	0.243 (0.025)	0.262 (0.020)	−0.063 (0.024)	−0.009 (0.023)	0.011 (0.023)
Czech Republic	0.254 (0.025)	0.172 (0.026)	0.183 (0.024)	−0.129 (0.023)	−0.106 (0.026)	−0.075 (0.025)
Finland	0.471 (0.021)	0.286 (0.021)	0.315 (0.023)	−0.035 (0.027)	−0.044 (0.026)	0.025 (0.028)
Georgia	0.211 (0.029)	0.198 (0.028)	0.209 (0.025)	−0.090 (0.027)	−0.086 (0.030)	−0.055 (0.023)
Germany	0.290 (0.035)	0.150 (0.036)	0.163 (0.030)	−0.086 (0.032)	−0.092 (0.031)	−0.073 (0.029)
Hong Kong SAR	0.379 (0.023)	0.395 (0.020)	0.359 (0.020)	0.033 (0.026)	0.066 (0.027)	0.105 (0.028)
Hungary	0.215 (0.028)	0.157 (0.026)	0.178 (0.027)	−0.089 (0.022)	−0.068 (0.021)	−0.044 (0.021)
Iran, Islamic Rep. of	0.198 (0.024)	0.175 (0.027)	0.179 (0.026)	−0.102 (0.024)	−0.086 (0.025)	−0.085 (0.023)
Ireland	0.199 (0.032)	0.141 (0.027)	0.163 (0.027)	−0.041 (0.023)	−0.055 (0.032)	−0.025 (0.024)
Italy	0.205 (0.025)	0.091 (0.031)	0.105 (0.025)	−0.044 (0.023)	−0.023 (0.026)	−0.004 (0.025)
Lithuania	0.422 (0.028)	0.390 (0.030)	0.379 (0.024)	0.005 (0.019)	0.003 (0.021)	0.048 (0.024)
Malta	0.194 (0.021)	0.165 (0.021)	0.191 (0.019)	0.003 (0.025)	0.060 (0.020)	0.084 (0.021)
Morocco	0.268 (0.057)	0.244 (0.053)	0.313 (0.042)	0.097 (0.035)	0.127 (0.032)	0.063 (0.037)
Northern Ireland	0.223 (0.033)	0.192 (0.036)	0.193 (0.036)	−0.067 (0.032)	−0.049 (0.036)	−0.072 (0.033)
Norway	0.390 (0.030)	0.302 (0.032)	0.286 (0.034)	−0.063 (0.032)	−0.131 (0.026)	−0.030 (0.027)
Oman	0.216 (0.024)	0.234 (0.026)	0.219 (0.026)	0.052 (0.016)	0.051 (0.019)	0.095 (0.017)
Poland	0.326 (0.020)	0.241 (0.023)	0.247 (0.020)	−0.049 (0.019)	−0.033 (0.021)	0.009 (0.018)
Portugal	0.158 (0.034)	0.124 (0.029)	0.205 (0.022)	−0.089 (0.033)	−0.072 (0.034)	−0.068 (0.027)
Qatar	0.196 (0.029)	0.225 (0.029)	0.211 (0.027)	0.085 (0.024)	0.110 (0.024)	0.094 (0.026)
Romania	0.238 (0.041)	0.219 (0.034)	0.212 (0.030)	−0.079 (0.026)	−0.110 (0.024)	−0.084 (0.024)
Russian Federation	0.295 (0.028)	0.278 (0.028)	0.284 (0.029)	−0.025 (0.026)	−0.030 (0.027)	0.008 (0.022)
Saudi Arabia	0.149 (0.038)	0.143 (0.040)	0.179 (0.037)	0.010 (0.028)	−0.028 (0.028)	0.008 (0.023)
Singapore	0.364 (0.020)	0.341 (0.018)	0.325 (0.019)	−0.027 (0.018)	0.009 (0.018)	0.034 (0.016)
Slovak Republic	0.164 (0.033)	0.133 (0.034)	0.162 (0.029)	−0.043 (0.030)	−0.045 (0.035)	−0.039 (0.026)
Slovenia	0.340 (0.020)	0.201 (0.025)	0.243 (0.020)	−0.017 (0.025)	0.011 (0.024)	0.011 (0.024)
Spain	0.291 (0.023)	0.258 (0.027)	0.253 (0.024)	0.040 (0.020)	0.052 (0.031)	0.097 (0.020)
Sweden	0.383 (0.022)	0.205 (0.027)	0.235 (0.021)	0.012 (0.034)	0.037 (0.026)	0.053 (0.027)
United Arab Emirates	0.110 (0.014)	0.119 (0.015)	0.099 (0.014)	0.083 (0.015)	0.096 (0.015)	0.111 (0.015)
Sixth Grade Countries						
Botswana	0.190 (0.031)	0.216 (0.026)	0.202 (0.025)	−0.005 (0.026)	−0.026 (0.023)	−0.006 (0.021)
Honduras	0.168 (0.040)	0.185 (0.036)	0.206 (0.036)	−0.079 (0.038)	−0.102 (0.035)	−0.070 (0.029)
Benchmarking Participants						
Quebec, Canada	0.240 (0.026)	0.202 (0.023)	0.201 (0.023)	−0.048 (0.028)	−0.010 (0.027)	−0.020 (0.025)
Abu Dhabi, UAE	0.162 (0.028)	0.172 (0.027)	0.150 (0.027)	0.103 (0.023)	0.110 (0.021)	0.117 (0.023)
Dubai, UAE	0.086 (0.017)	0.085 (0.020)	0.068 (0.018)	0.081 (0.021)	0.108 (0.022)	0.111 (0.023)
International Avg.	0.264 (0.028)	0.210 (0.029)	0.218 (0.027)	0.039 (0.025)	0.057 (0.026)	0.051 (0.024)
International Std. Dev.	0.098 (0.009)	0.083 (0.007)	0.077 (0.007)	0.035 (0.005)	0.041 (0.005)	0.039 (0.005)

( ) Standard errors appear in parentheses.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Discussion of Overall Results from the Country-by-Country Analysis

This analysis of country differences in direct effects in the path model demonstrates both similarities and differences. We can first conclude that, for all countries, the links were supported in the hypothesized Main Path from Books to Activity, to Ability, and finally to achievement at the fourth grade. Given that there also was a strong direct effect of Parental Education on Books, this Main Path mediates a part of the total effect of Parental Education on achievement. However, there was no general effect of Gender on Books, even though there was a weak tendency for the parents to report more books in the home for girls; therefore, the Main Path does not mediate much of the Gender differences in achievement.

Unexpectedly, NumLitAct had a direct effect on Ability in all countries. This effect implies that, in homes that place greater emphasis on literacy activities than numeracy activities, the child will develop a greater general Ability to do both numeracy and literacy tasks by the beginning of primary school. One possible explanation of this finding is that literacy activities have a broader range of influence, so that they positively impact both literacy and numeracy skills. A partially different interpretation is that numeracy skills at the beginning of primary school tend to involve both reading and writing, because expression of numeracy skills often is accomplished via literacy skills.

Another possible interpretation is that this relationship is due to the fact that the Ability variable has a bias towards literacy skills. From the presentation of the measurement model in the Common model, it will be remembered that the two indicators of literacy skills had higher loadings on the latent Ability variable than had the two indicators of numeracy skills. This suggests that the Ability variable could be biased in the literacy direction, which would cause the positive relationship with the NumLitAct variable. However, even though this line of argument may be valid, it must be asked why the literacy tasks have such a strong relationship to the Ability variable. One interpretation of this would be that the literacy skills indicators are better indicators of a general Ability to perform school-related tasks than are the numeracy skills indicators. The fact that the latent Ability variable had relatively high relations with all of the fourth grade student achievement measures supports this line of reasoning. Thus, if the latent Ability variable is to have the desirable property of predicting school achievement, it may need to have an emphasis on literacy skills rather than on numeracy skills.

It also is interesting to note that, in nearly all countries, the parents reported a stronger emphasis on literacy activities than on numeracy activities when the child was a girl than when the child was a boy. This suggests that the direct effect of NumLitAct on Ability is an important mediator of gender differences in achievement. For some countries there also were either positive or negative effects of Parental Education on NumLitAct, which implies that this link may mediate a part of the total effect of Parental Education on achievement as well. For the majority of countries, there also was a positive effect of Books on NumLitAct.

Except for the Main Path and the NumLitAct–Ability link, these analyses did not identify other possible mediating paths that hold across countries. However, considerable variability across countries was observed in almost each and every relationship within the model. To more clearly see and interpret these relationships, it seems necessary to investigate the full set of relationships for each country. Thus, the next section reports results from country-by-country analyses based on the path diagrams.

Country Results

This section presents more detailed information about the pattern of results for each participating country. For each country, one path diagram displays effects of Parental Education on achievement, and another path diagram shows effects of Gender on achievement.

For each country, a saturated model was fitted, which included all relationships from a particular variable to all variables to the right of it in the path diagram. However, the path diagrams presented here only report relationships that are significant at the .05 level.

Exhibit 4.17 presents results from the statistical goodness-of-fit test and from the indices RMSEA, CFI and SRMR. As may be seen the model fits the data from all countries excellently.

In the following section, results are presented individually for each country and benchmarking entity (except for Ireland, where data is missing on some variables) in the form of one path diagram for effects of Parental Education and another path diagram for effects of Gender. Brief interpretive comments relative to each path diagram are included.

Exhibit 4.17: Tests and Indices of Model Fit

Country	Chi–2	df	CFI	RMSEA	SRMR	N
Australia	286.45	50	0.990	0.028	0.021	5943
Austria	884.30	50	0.971	0.060	0.041	4587
Azerbaijan	144.81	50	0.994	0.020	0.017	4871
Chinese Taipei	154.90	50	0.997	0.022	0.011	4265
Croatia	359.65	50	0.990	0.037	0.018	4545
Czech Republic	247.59	50	0.990	0.030	0.021	4433
Finland	263.98	50	0.990	0.031	0.019	4541
Georgia	167.52	50	0.996	0.022	0.013	4774
Germany	749.95	50	0.976	0.060	0.042	3928
Hong Kong SAR	129.41	50	0.997	0.020	0.010	3802
Hungary	437.59	50	0.988	0.039	0.028	5149
Iran, Islamic Rep. of	261.64	50	0.995	0.027	0.015	5734
Ireland	278.87	50	0.987	0.032	0.024	4383
Italy	160.54	50	0.996	0.023	0.014	4125
Lithuania	189.57	50	0.995	0.025	0.015	4584
Malta	338.41	50	0.991	0.041	0.022	3492
Morocco	166.95	50	0.995	0.018	0.014	7614
Northern Ireland	201.95	50	0.990	0.030	0.022	3467
Norway	319.07	50	0.984	0.042	0.024	3054
Oman	281.29	50	0.994	0.021	0.013	10237
Poland	351.74	50	0.991	0.035	0.019	4962
Portugal	236.96	50	0.991	0.031	0.014	3991
Qatar	171.90	50	0.994	0.024	0.014	4104
Romania	123.81	50	0.998	0.018	0.008	4643
Russian Federation	205.16	50	0.991	0.026	0.014	4450
Saudi Arabia	149.22	50	0.994	0.021	0.013	4470
Singapore	249.72	50	0.997	0.025	0.012	6208
Slovak Republic	256.38	50	0.994	0.027	0.016	5561
Slovenia	432.05	50	0.986	0.042	0.027	4433
Spain	183.76	50	0.994	0.026	0.013	4105
Sweden	457.37	50	0.981	0.043	0.024	4482
United Arab Emirates	473.34	50	0.995	0.024	0.013	14377
Sixth Grade Countries						
Botswana	139.52	50	0.998	0.021	0.016	4165
Honduras	136.57	50	0.995	0.021	0.023	3830
Benchmarking Participants						
Quebec, Canada	270.68	50	0.989	0.033	0.019	4142
Abu Dhabi, UAE	177.27	50	0.996	0.025	0.014	4100
Dubai, UAE	280.46	50	0.996	0.028	0.015	5922

Reported values are means over analyses of five plausible values.

SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Summary of Country Results

The path diagrams for the TIMSS and PIRLS 2011 assessment participants indicate both similarities and differences across countries. The similarities manifest themselves in several different ways. For nearly all countries, the effects of Parental Education on achievement were mediated via Parental Education, Books, Activities, and Abilities, or what we have termed the Main Path. In addition, for most countries, there also were substantial effects of Books on achievement. Furthermore, for most of the countries, we observed a pattern where a stronger emphasis on literacy than on numeracy activities was associated with a higher level of Ability, which in turn had positive effects on achievement in all domains.

The differences also manifested themselves in several ways. One major source of differences was the strength of the estimated direct effects, and therefore also the size of the indirect effects. Such differences may be reflections of real differences in strength of relationships between variables; however, they also may be due to issues of measurement, such as floor and ceiling effects. Another source of differences was that the estimated coefficients sometimes had different signs in different countries, such as the relationship between Parental Education and the NumLitAct variable. Differences in sign of relationship seem more likely to reflect substantive differences than problems of measurement.

The similarities and differences combine in such a way as to make the pattern of relationships appear markedly different from one country to another, in spite of the fact that it also is possible to recognize the three basic patterns of mediating relationships between Parental Education and achievement, described above.

For Gender, both the total effects and the mediating mechanisms were quite different across the achievement domains. Even though there were effects for mathematics and science, these tended to vary from country to country. For reading, though, the general pattern was one of an achievement advantage for girls, and in many countries it was possible to explain this in terms of a stronger emphasis on literacy activities than on numeracy activities for girls.

Discussion of the Empirical Findings

First, it may be noted that the estimates of the standardized regression coefficients that we obtained with the Common model for pooled data are very close to the means of the standardized parameter estimates for the individual countries. The Common model clearly brings out how the effect of Parental

Education on achievement follows the Main Path, i.e., that it is mediated via Books, Activities, and Abilities. The Common model also showed how Books mediates Parental Education through its direct effects on the three achievement measures. Furthermore, the Common model identified the effect of a stronger emphasis on literacy activities than numeracy abilities on Ability, which in its turn had effects on the three domains of achievement. However, according to the Common model, this mechanism did not mediate the effect of Parental Education on achievement, except for a trivially small effect via Books. This was because of heterogeneity in the relationship between Parental Education and NumLitAb across the countries.

However, for Gender, the Common model identified a stronger emphasis on literacy activities than on numeracy activities for girls as the first part of a mechanism that accounts for gender differences in reading achievement. The second part of this mechanism is that the emphasis on literacy activities influences the ability to perform both literacy and numeracy tasks at the age children begin primary school. In the Common model there were no other mediating relations between Gender and achievement.

Given that this study did not predict the effect on Ability of a stronger emphasis on literacy than numeracy activities, it may be asked whether this is a dependable phenomenon and how it should be interpreted. The fact that this pattern of relationships has been identified in practically every country indicates a high degree of empirical consistency. When the measurement model for the Common model for pooled data was estimated, it was observed that the literacy skills measures had higher loadings on the Ability factor than had the numeracy skills measures. This could be taken as an indication that Ability is biased in favor of literacy, which could explain the positive relationship with NumLitAct. However, another interpretation of this finding is that literacy skills are more generally applicable than are numeracy skills. For example, numeracy tasks are often presented in written form and require written responses.

Previous research reviewed in the Introduction supports the view that numeracy activities and tasks tend to be subordinate to literacy activities and tasks. Thus, there are few, if any, interventions which focus more exclusively on development of numeracy, and it has been hypothesized that numeracy skills develop as a function of training in language and problem-solving skills at young age (Doig, McCrae, & Rowe, 2003). Interestingly enough, Anders et al. (2012) found that numeracy skills were more highly related to the quality of the home learning environment with respect to literacy than with respect to numeracy. These authors also observed that numeracy activities tend to be less frequent than literacy activities, which both makes it difficult to measure numeracy activities reliably, and to identify their effects on development of skills. Even though further research is needed to clarify the nature of literacy and numeracy skills, it does seem that both theory and previous empirical research support the idea that literacy activities can influence the development of both literacy and numeracy skills.

Effects of Parental Education

For practically all countries, support was obtained for the Main Path, or the sequence Parental Education, Books, Activity, Ability, and fourth grade student achievement in mathematics, science, and reading. The high degree of generality of this mechanism across countries is an interesting phenomenon, which has been observed many times before, and for which at least intuitive explanations have been offered. We will not pursue theoretical discussions here, but it can be noted that even though all links in the Main Path are significant they do vary in strength across countries. This variation can be due to issues of measurement, such as floor and ceiling effects in certain countries, and it also can have substantive grounds. It is an important task for further research to investigate different sources of variation across countries more closely.

In addition to the indirect effect via the Main Path, the Books variable also had strong direct effects on all three achievement variables, though with large variation across countries. To account for these direct effects we need other hypothesized mechanisms and further mediating variables. In previous research many such hypotheses have been investigated, and the results show, among other things, that parental expectations and the parents' function as role models are important mediating mechanisms to account for the effects of Parental Education on achievement. It is reasonable to expect that the number of books in the home can play an important part in such mediating mechanisms.

We also have identified another path between Parental Education and achievement, which was unexpected, but which is present in the majority of the countries. The core of this path is the relationship between NumLitAct and Ability, which implies that in homes where there is stronger emphasis on literacy activities than numeracy activities there is a positive effect on the ability to perform both numeracy and literacy tasks at the beginning of primary school. In some countries, there was a direct effect (positive or a negative) of Parental Education on NumLitAct, while in other countries, there was an indirect effect via Books. There also were countries in which both the direct and the indirect effect could be observed, and some countries in which there was neither a direct, nor an indirect effect of Parental Education on NumLitAct.

A positive effect of Parental Education on NumLitAct was observed for seven countries, while a negative effect was observed for four countries. Thus, in the former group of countries, parents with a higher level of education placed more emphasis on literacy activities than on numeracy activities, while in the latter group these parents placed more emphasis on numeracy activities than on literacy activities. However, within both groups of countries, the direct effect of NumLitAct on Ability was positive and approximately the same size (0.23 vs. 0.18). This indicates that the mechanism of influence of the two types of activities on ability is invariant across these two categories of countries.

All three participating Nordic countries (Finland, Norway, and Sweden) showed a positive effect of Parental Education on NumLitAct, along with the Czech Republic, Morocco, Saudi Arabia, and Slovenia. In the Nordic countries there is a long tradition of literacy and reading aloud for the children is a common practice, particularly among parents with a higher level of education.

One hypothesis to account for the different directions of the effect of Parental Education on NumLitAct may be that, in certain countries, higher education places more emphasis on fields such as technology and science, while in other countries there is more emphasis on letters and arts. The four countries with a negative effect of Parental Education on NumLitAct (implying greater emphasis on numeracy than on literacy activities) were Chinese Taipei, Honduras, Iran, and Oman; for at least some of these, higher education may be more oriented towards technology and science.

The direct effect of Books on NumLitAct was significant and positive for around 20 countries. Thus, availability of books was a mediator for activities oriented towards literacy.

It also is interesting to observe that, in many cases, there was not only a positive indirect effect of NumLitAct on the three achievement variables via Ability, but there were also direct effects of NumLitAct on the achievement variables. A negative effect on mathematics achievement was the most frequently observed outcome, but in some cases there were negative effects on mathematics and science, and in other cases a positive effect on reading. The combination of the indirect effects and these direct effects creates an uneven profile of achievement, with a relatively higher level of achievement in reading than in mathematics.

There also were some other frequently recurring patterns of relations in the path model. Thus, the NumLitAb variable, which indicates whether literacy skills at school start are rated higher than numeracy skills or vice versa, had for many countries a negative influence from Books, and it often also had negative direct effects on achievement. For many countries there also was a direct effect NumLitAct on NumLitAb. However, these effects tended to be weak and sometimes difficult to interpret.

Effects of Gender

As previously discussed, only in reading was a strong total effect for Gender observed, and only in reading was the study able to identify mediating mechanisms that were reasonably consistent across countries. The most powerful path accounting for gender differences in reading achievement was the direct effect of NumLitAct on Ability, which in turn had positive direct effects on achievement. Here, too, a negative direct effect of NumLitAct on mathematics achievement was frequently observed.

For any mediating effect to occur, it is, of course, also necessary that there be a Gender effect on NumLitAct, such that greater emphasis on literacy than on numeracy activities is reported for girls. This effect was positive and significant in all but two countries (Morocco and Saudi Arabia). The participants with the strongest direct effect of gender on NumLitAct were Norway, Lithuania, Sweden, the Canadian province of Quebec, Germany, Finland, and Poland. It is quite interesting to observe such strong differentiation of activities between boys and girls in societies that emphasize gender equality, particularly the three Nordic countries. One tentative explanation for this may be that the parents, following strong literacy traditions, offer book-sharing activities with their children, but that boys are less interested in participating in such activities than girls because of their perceptions of what are appropriate activities for girls and boys.

Another mediating path went through NumLitAb, on which Gender had a positive effect in most countries. This positive effect implies that girls were assessed as being relatively better at doing literacy tasks than at doing numeracy tasks at the beginning of primary school. The NumLitAb variable was positively related to reading in many countries, or to reading and science in other countries, or negatively related to mathematics in yet other countries.

Limitations and Future Research

While this study has identified several interesting mediating mechanisms that at least partly explain the effects of Parental Education and Gender on fourth grade student achievement, it also generated many questions that need to be addressed in future research. Some of these questions are discussed below.

From a statistical point of view, the indirect effects identified in many of the models are quite small, and it may be asked whether they are large enough to warrant any strong conclusions. However, it must be remembered that the information about the mediating variables in the model is based on a limited number of responses to questionnaire items. Further, given the well-known problems of reliability and validity of such information, it is surprising that it has been possible to identify so many consistent and meaningful patterns of relationships among the variables. Yet, because of the problems of measurement, it is likely that the strength of the relationships among the variables is underestimated, which in turn causes the indirect effects to be underestimated.

A modeling approach with latent variables was used to at least partially address the measurement problems. However, for practical reasons a "testlet" approach was adopted, and this approach does not fully utilize the information available in the item responses. It would therefore be useful to put further effort into the development of the measurement model, through using item level data rather than testlet data.

Yet another measurement problem is that the parents provided the information retrospectively; retrospective information tends to be unreliable, and there also is risk for systematic bias caused by selective memory and reinterpretation of earlier events in light of later events and developments. It is difficult to assess to what extent such threats to the validity of the Home Questionnaire data are present in the current data. However, the fact that the assessment is low-stakes implies that no gains are made from misreporting of facts. A more optimal approach for collecting information about the quality of home learning environments for literacy and numeracy was used by Anders et al. (2012), who relied on a combination of self-report questionnaires, interviews, and observations. While such data-collection techniques cannot be used in large-scale international assessments, they may be useful for investigating the measurement characteristics of questionnaire data and for optimizing the design of questionnaire items.

It also should be acknowledged that there is further information in the TIMSS and PIRLS 2011 data that could be used to extend the model. For example, there are data on parental attitudes towards reading and on parental reading practices, both of which may be hypothesized to influence actual use of books. The model also could be extended with more student variables, reflecting, for example, attitudes towards reading, reading practices, and computer use. Thus, there are many possibilities to extend the current study in different directions.

Conclusion

The aims of this study were twofold: to investigate the extent to which parental education and gender influence fourth grade student achievement in reading, mathematics, and science in different countries; and to investigate the mechanisms through which parental education and gender influence achievement in these three core subjects via books in the home, literacy and numeracy activities, and the child's ability to carry out literacy and numeracy tasks when starting school. Through applying path modeling techniques to data from the TIMSS and PIRLS 2011 assessments and Home Questionnaires, it had been possible to identify some important mechanisms through which Parental Education and Gender influence achievement in mathematics, science, and reading at the fourth grade.

For nearly all countries, the effects of Parental Education on achievement were mediated via Parental Education, Books, Activities, and Abilities, or what we have termed the Main Path. According to this mechanism, parental education influences the number of books available in the home. In turn, the number of books is related to the frequency of home activities oriented towards both literacy and numeracy, and these activities influence the general level of literacy and numeracy skills that the child has developed upon beginning primary school. The literacy and numeracy skills that the child brings to school influence achievement at the fourth grade. In addition, for most countries, there also were substantial direct effects of number of books in the home on achievement.

Another mechanism is that a stronger emphasis on literacy than on numeracy activities influences the general level of literacy and numeracy skills children have developed by the time they begin primary school, and this in turn influences achievement at the fourth grade. It is more common for girls than for boys to have such an emphasis, which partially explains the higher level of reading achievement for girls. In homes with a larger number of books there is in many countries also a tendency to put more emphasis on literacy than on numeracy activities, which influences the general level of numeracy and literacy skills at school start, which influences achievement.

For reading, though, the general pattern was one of an achievement advantage for girls.

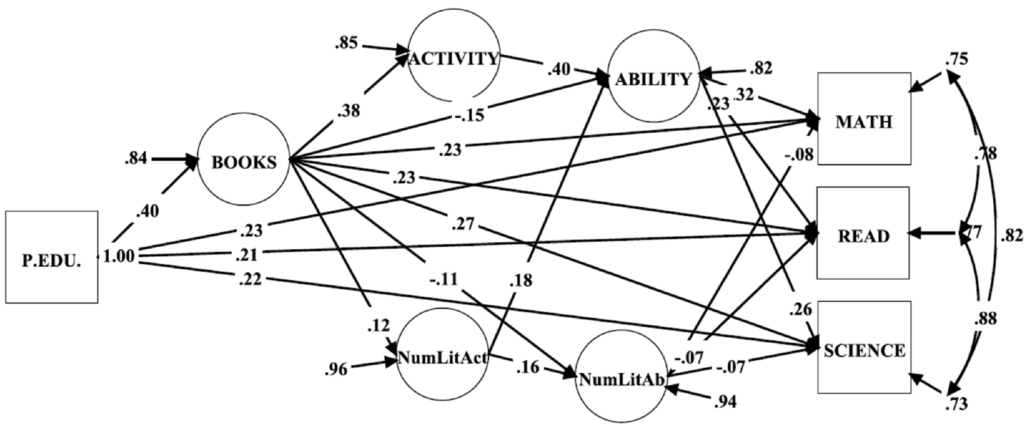
In terms of gender differences, both the total effects and the mediating mechanisms were quite different across the achievement domains. Even though there were effects for mathematics and science, these tended to vary from country to country, and so it is difficult to generalize the effects for mathematics and science across countries. However, for reading, the general pattern was one of an achievement advantage for girls, and in many countries it was possible to explain this in terms of a stronger emphasis on literacy activities than on numeracy activities for girls.

While the abovementioned mechanisms could be identified in almost all of the 37 participating countries and benchmark entities, interesting differences among the countries also could be identified, both with respect to the strength of estimated relationships, and in the patterns of relationships among variables.

The research presented in this chapter can be extended in many different ways in order to obtain better estimates of the relationships in the model, as well as to allow investigations of further variables and hypothesized mechanisms.

Exhibit 4.18: Australia

PARENTAL EDUCATION The total effects were .33, .35, and .33 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .11, .14, and .12. Most of the indirect effect was mediated via Books and via the Main Path. However, the number of books in the home also was related to more literacy than numeracy activity, which in turn influenced Ability positively, and Ability had significant direct effects on achievement in all three domains. There also were weak indirect effects via NumLitAb.



GENDER The total effects were -.03, .00, and .12 for mathematics, science, and reading, respectively. The total indirect effects were all close to 0. Most of the Gender effect on reading was direct. However, Gender was related to an overrepresentation of literacy activity, which had a positive effect on achievement in all three domains via Ability. Gender also was related to a relatively higher assessment of literacy skills than numeracy skills, which was negatively related to achievement in all three domains.

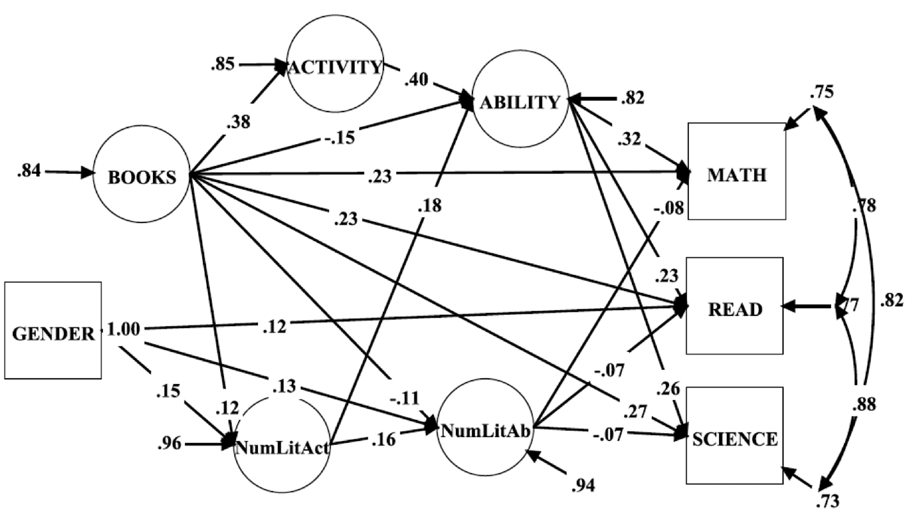
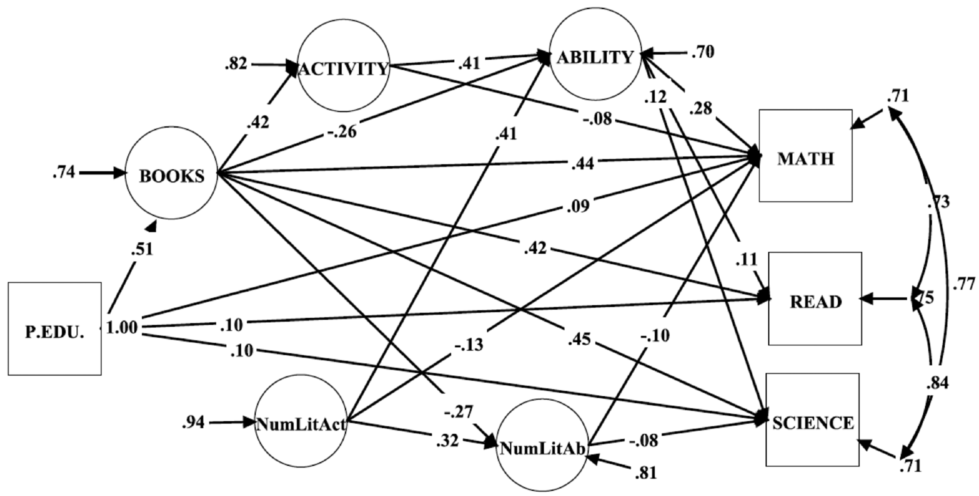


Exhibit 4.19: Austria

PARENTAL EDUCATION The total effects were .31, .33, and .32 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .22, .23, and .22. Thus, a substantial proportion of the total effect was indirect. Most of the indirect effects were mediated via Books and via the Main Path. However, the number of books in the home also was associated with higher assessed numeracy skills than literacy skills, which in turn was associated with achievement in mathematics and science.



GENDER The total effects of Gender were -.07, -.09, and .06 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were -.02, -.01, and .01. There was more literacy than numeracy activity for girls, which affected achievement positively via Ability, and mathematics achievement negatively through a direct effect. There also were higher ratings of literacy than numeracy skills for girls, which was associated with a lower level of performance in mathematics and science.

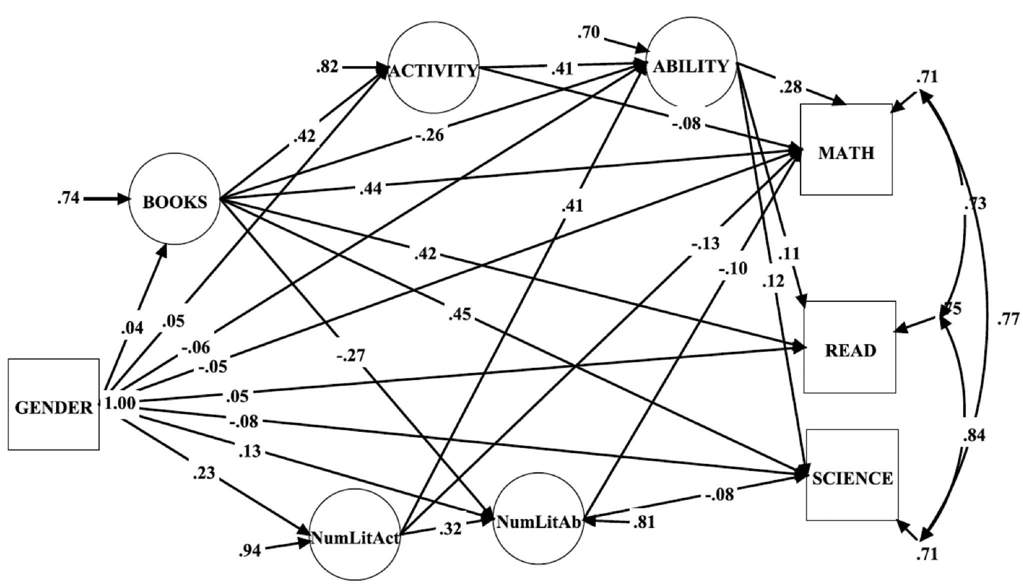
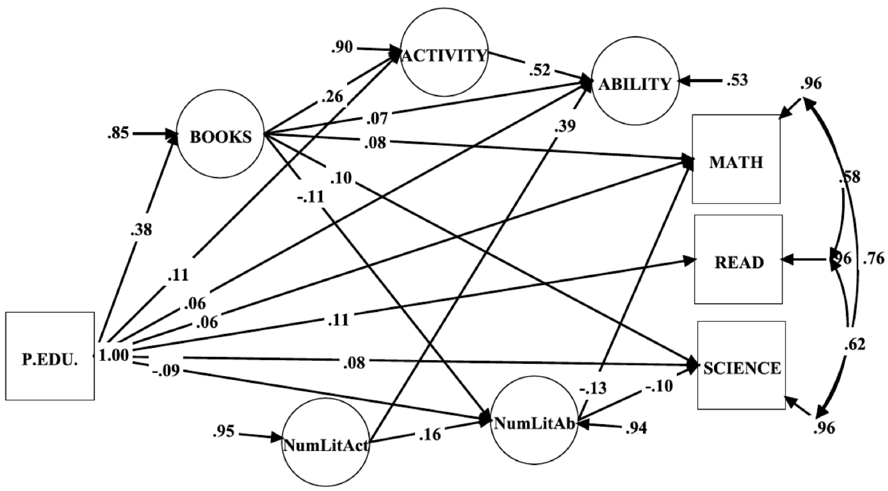


Exhibit 4.20: Azerbaijan

PARENTAL EDUCATION The total effects were .11, .14, and .15 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .05, .06, and .03. Thus, the total effects were among the lowest observed. However, for mathematics and science a rather large proportion of the total effect was mediated. These indirect effects were mediated via Books and via Books and NumLitAb. The Books variable predicted a higher ability to do numerical tasks than literacy tasks and the NumLitAb variable was negatively related to mathematics and science achievement, implying positive effects of having higher ability to do numerical tasks.



GENDER The total effects were .04, .03, and .10 for mathematics, science, and reading, respectively. The total indirect effects were all close to 0. However, there were significant negative indirect effects of Gender on mathematics and science. This was because Gender predicted more literacy than numeracy activity, which in turn was positively related to the NumLitAb variable, which was negatively related to mathematics and science achievement.

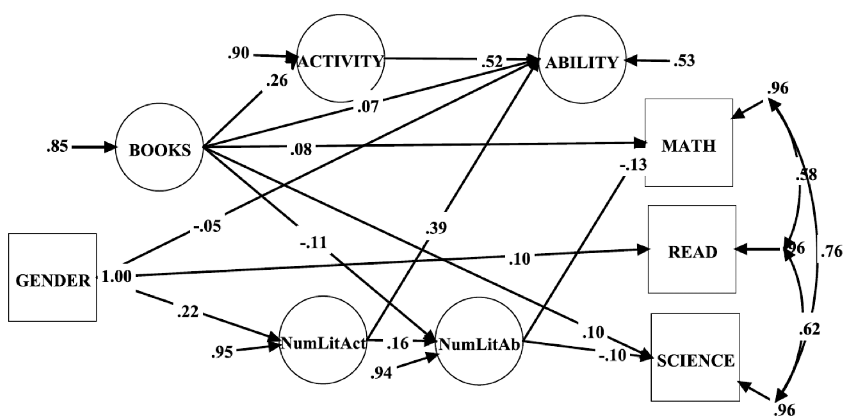
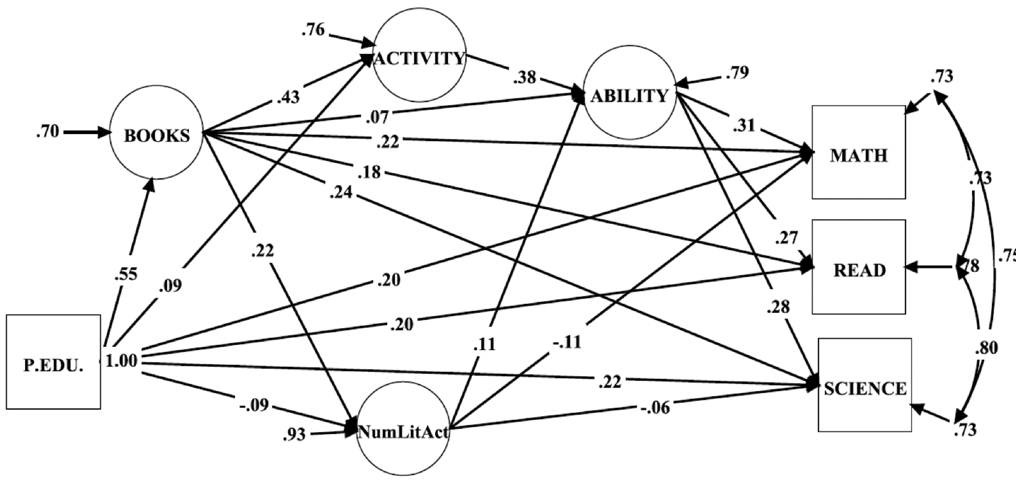
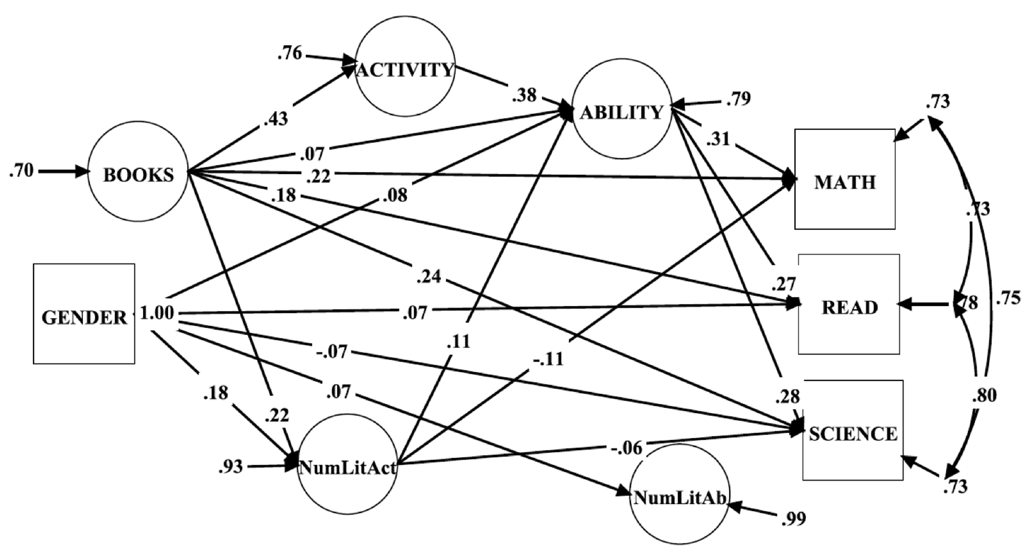


Exhibit 4.21: Chinese Taipei

PARENTAL EDUCATION The total effects of Parental Education were .37, .39, and .34 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .17, .17, and .13. The indirect effects were mediated via the Main Path and via Books. However, there also was a direct effect of Parental Education on Activity. Parental Education also was associated with more numeracy than literacy activity, which influenced mathematics and science achievement positively.



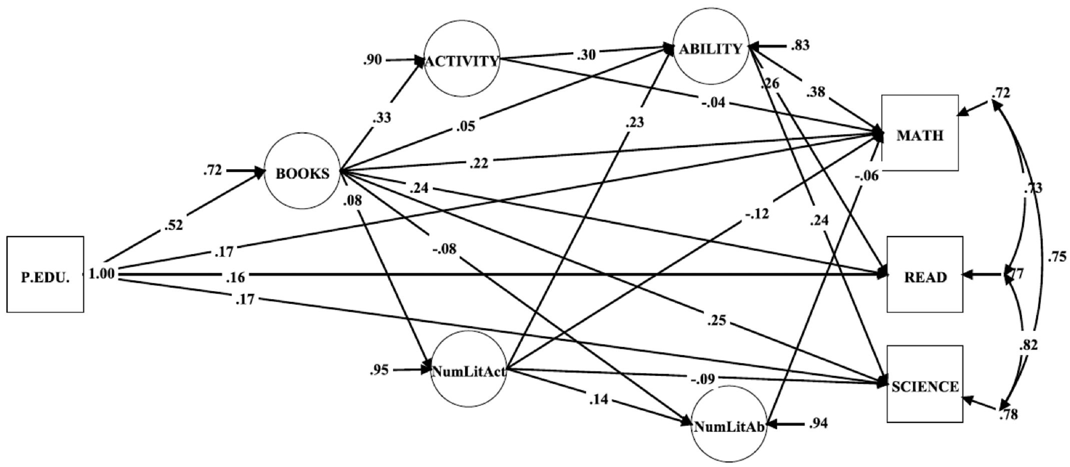
GENDER The total effects of Gender were .01, -.05, and .10 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .02, .02, and .03. Thus, girls outperformed boys in reading, while boys had higher achievement in science. There was a positive indirect effect via Ability on achievement for girls in all domains. For girls, there was more of an emphasis on literacy activities than on numeracy activities. This had a positive effect on achievement in all three domains via Ability, and negative direct effects on mathematics and science achievement for girls.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.22: Croatia

PARENTAL EDUCATION The total effects of Parental Education were .31, .32, and .31 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .14, .15, and .14. The indirect effects were mediated via the Main Path and via Books. The number of books in the home also was related to an overrepresentation of literacy activity, which influenced achievement via Ability, and there also was a positive effect of Books on mathematics achievement via NumLitAb.



GENDER The total effects of Gender were -.08, -.04, and .12 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .02, and .04. Girls thus outperformed boys in reading, while boys had higher achievement in mathematics and science. For girls there was an overrepresentation of literacy activities, which had a positive indirect effect on achievement in all domains via Ability, but also negative direct effects on mathematics and science achievement. Girls furthermore had higher rated literacy skills than numeracy skills, which was negatively related to mathematics achievement.

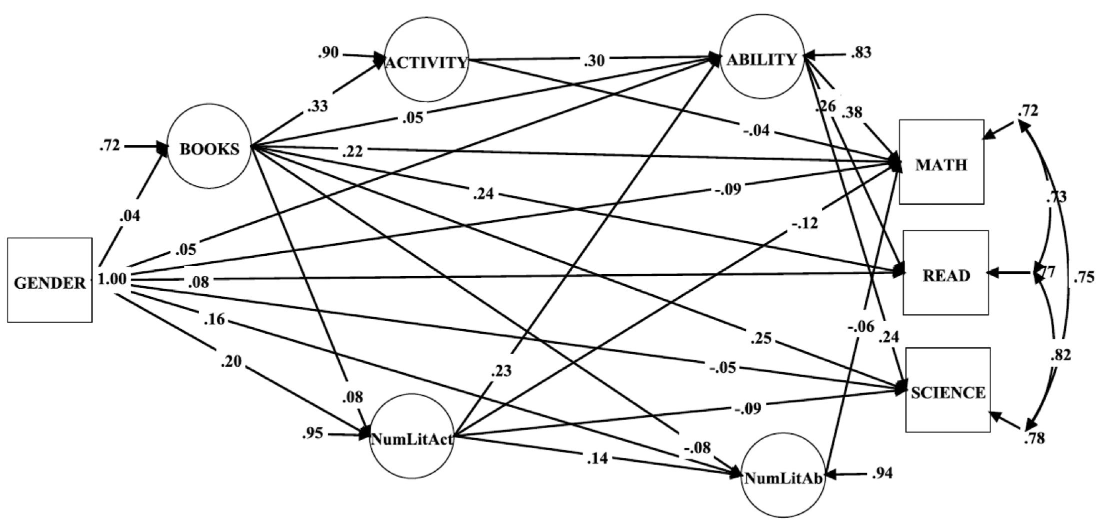
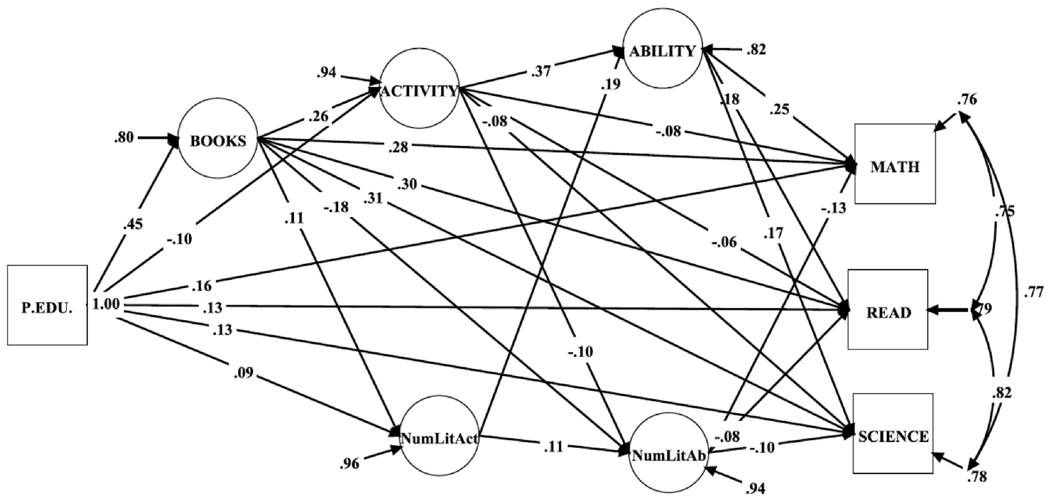
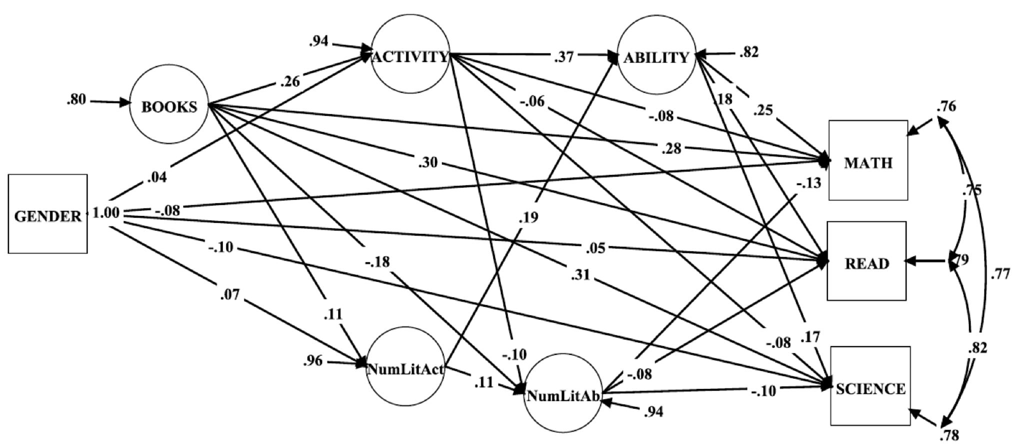


Exhibit 4.23: Czech Republic

PARENTAL EDUCATION The total effects of Parental Education were .31, .29, and .29 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .14, .16, and .16. The indirect effect was to a large extent mediated via the Main Path and via Books. Both Parental Education and Books also were related to a stronger emphasis on literacy activity than on numeracy activity, which had positive effects on achievement in all three domains via Ability. Books and Activity also were related to higher assessed numeracy skills than literacy skills.



GENDER The total effects of Gender were -.08, -.09, and .06 for mathematics, science, and reading, respectively and the corresponding total indirect effects were .01, .01 and .01. Girls thus outperformed boys in reading, while boys had higher achievement in Mathematics and science. The advantage for girls in reading was, to a small extent, mediated via activities that emphasized literacy more than numeracy for girls, and the effect of which was mediated via Ability. The NumLitAb variable also mediated effects from Activity and NumLitAct.

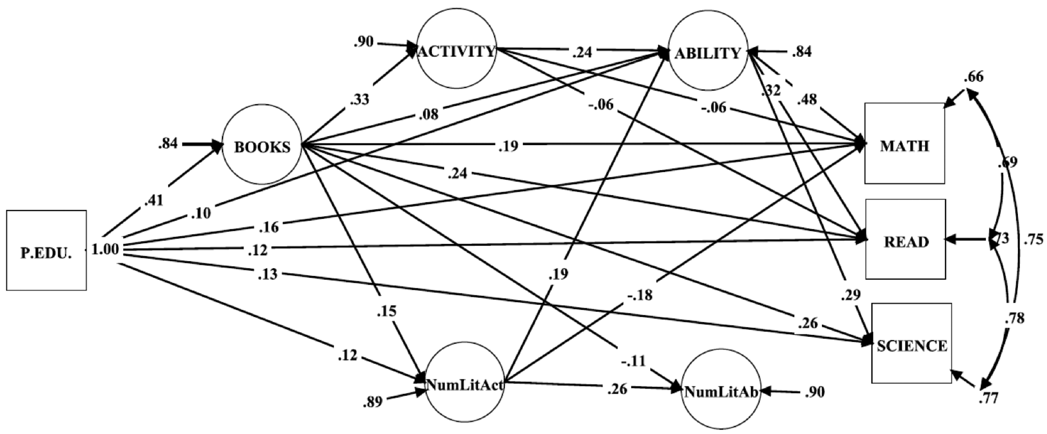


SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Exhibit 4.24: Finland

PARENTAL EDUCATION The total effects of Parental Education were .29, .28, and .28 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .13, .15, and .16. The indirect effect was to a large extent mediated via the Main Path and via Books. Parental Education influenced mathematics achievement negatively via activities that emphasized literacy more than numeracy, while this influenced achievement in all domains positively via Ability.



GENDER The total effects of Gender were -.06, -.01, and .17 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .03, and .06. Girls thus outperformed boys in reading by a wide margin, while boys had higher achievement in mathematics. For girls, literacy activities were more emphasized than numeracy activities, which had a positive indirect effect on achievement in all three domains via Ability. However, this emphasis also had a negative direct effect on mathematics achievement for girls.

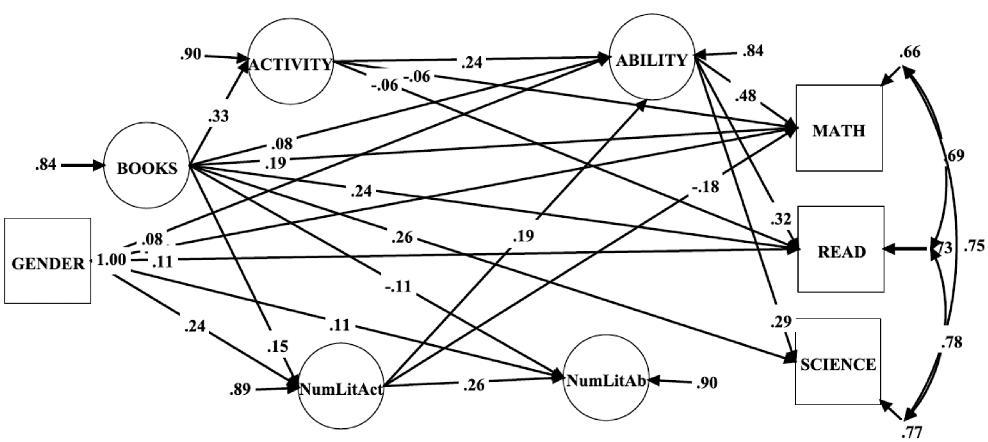
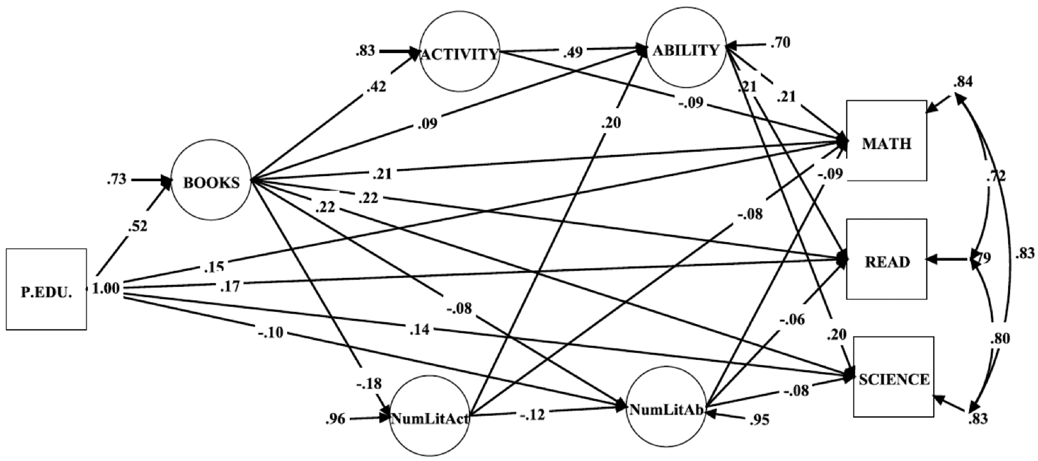


Exhibit 4.25: Georgia

PARENTAL EDUCATION The total effects of Parental Education were .28, .29, and .31 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .13, .14, and .14. The indirect effects were to a very large extent mediated via Books and via the Main Path. The number of books in the home also was associated with a relatively stronger emphasis on numeracy activities than literacy activities, which had a positive effect on mathematics achievement and negative effects on achievement in all three domains via Ability. Similar effects of Books were mediated via NumLitAb.



GENDER The total effects of Gender were .04, .06, and .15 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .00, .01, and .01. Girls thus outperformed boys in all three domains of achievement, and particularly so for reading. For girls, there was a relatively stronger emphasis on literacy activities than numeracy activities, which influenced achievement in all three domains positively, via Ability. This pattern of activities also was negatively related to mathematics achievement. Girls also were assessed higher in literacy skills than in numeracy skills, which was negatively related to achievement.

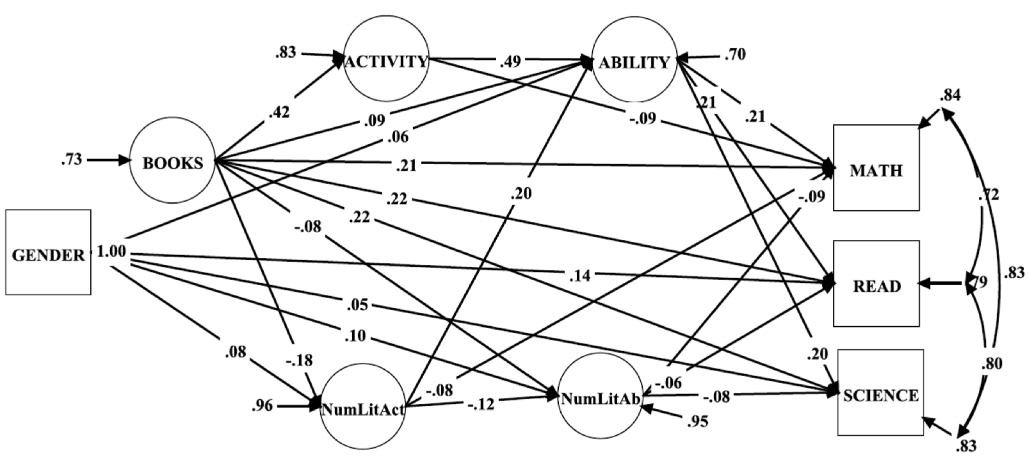
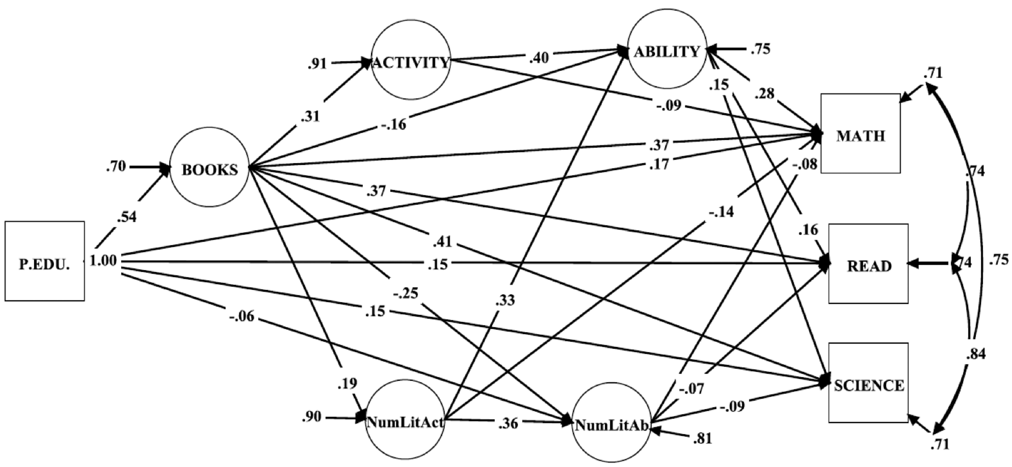


Exhibit 4.26: Germany

PARENTAL EDUCATION The total effects of Parental Education were .36, .38, and .36 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .19, .23, and .21. The total indirect effect was, to a large extent, mediated via Books and via the Main Path. The number of books in the home also was associated with a relatively stronger emphasis on literacy activities than numeracy activities, which indirectly affected achievement positively via Ability. To some extent the effect of Parental Education was mediated via the balance of the assessment of literacy and numeracy skills, as well as more highly educated parents tending to assess numeracy skills higher, both directly and mediated via Books.



GENDER The total effects of Gender were -.07, -.09, and .06 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were -.02, .00, and .01. Girls thus outperformed boys in reading, while boys had higher achievement in mathematics and science. For girls, there was a stronger emphasis on literacy activities than numeracy activities, which had a positive effect on achievement, via Ability. However, this imbalance also was negatively related to mathematics achievement. Girls also were assessed as having stronger literacy skills than numeracy skills, which was negatively related to achievement.

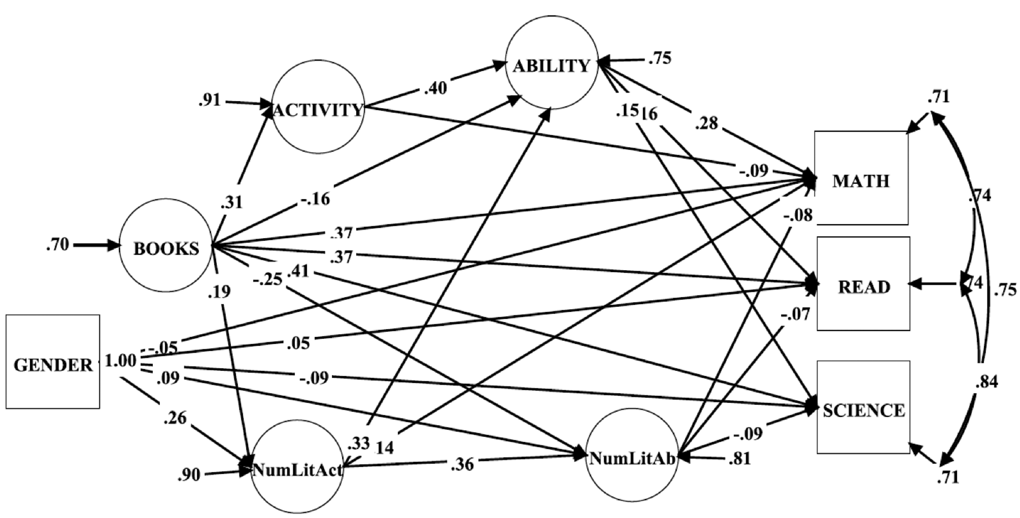
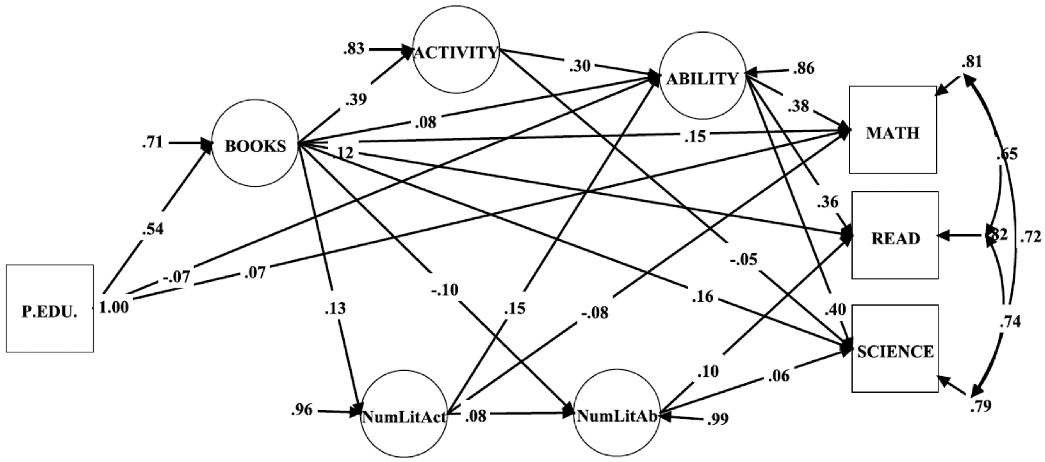
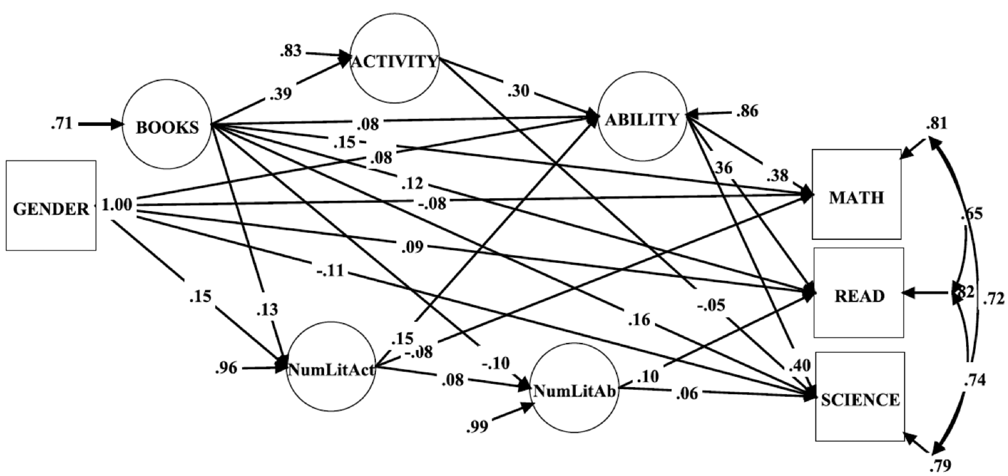


Exhibit 4.27: Hong Kong SAR

PARENTAL EDUCATION The total effects of Parental Education were .16, .15, and .12 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .09, .10, and .08. Thus, there was only a small total effect of Parental Education on the three achievement measures, and particularly so for reading. However, the total indirect effect accounted for a considerable part of the total effect. Indirect effects went via the Main Path and via Books.



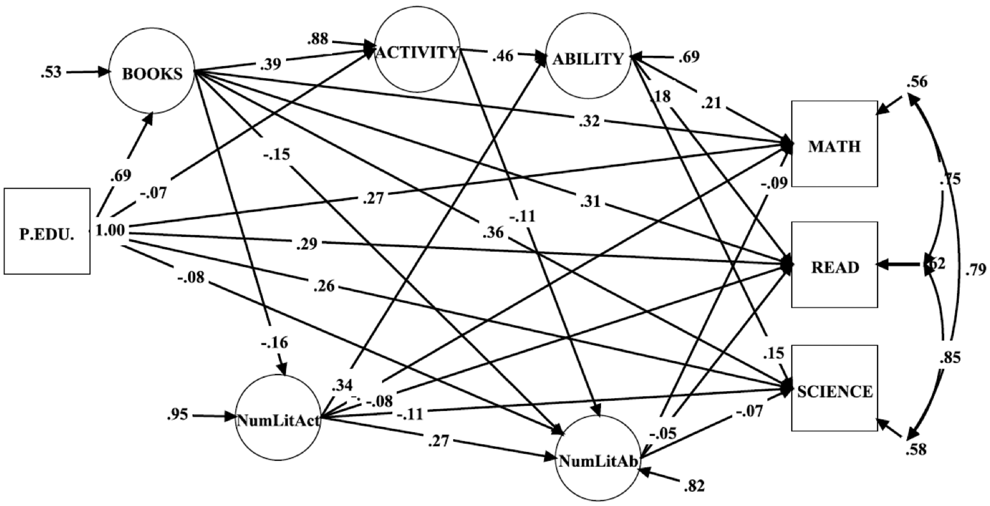
GENDER The total effects of Gender were -.05, -.07, and .13 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .04, and .04. Girls thus outperformed boys in reading, while boys had higher achievement in mathematics and science. For girls, there was a stronger emphasis on literacy activities than numeracy activities, which had a positive indirect on achievement in all domains via Ability. Girls also were assessed somewhat higher on Ability than were boys.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.28: Hungary

PARENTAL EDUCATION The total effects of Parental Education were .55, .55, and .53 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .28, .29, and .24. There was thus a substantial total effect of Parental Education on the three achievement measures, and the total indirect effect accounted for a considerable part of the total effect. Indirect effects went via the Main Path and via Books. Parents with a higher level of education tended to assess numeracy skills higher than literacy skills, which had a positive effect on achievement in all three domains. Similar effects of Parental Education on both NumLitAct and NumLitAb were mediated via Books.



GENDER The total effects of Gender were -.03, -.03, and .10 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were -.02, -.01, and .00. Girls thus outperformed boys in reading, while boys had higher achievement in mathematics and science. For girls, there was more of an emphasis on literacy activities than numeracy activities. This was associated with a positive indirect effect on achievement in all three domains via Ability, at the same time as there were negative effects on achievement, and particularly so in mathematics and science.

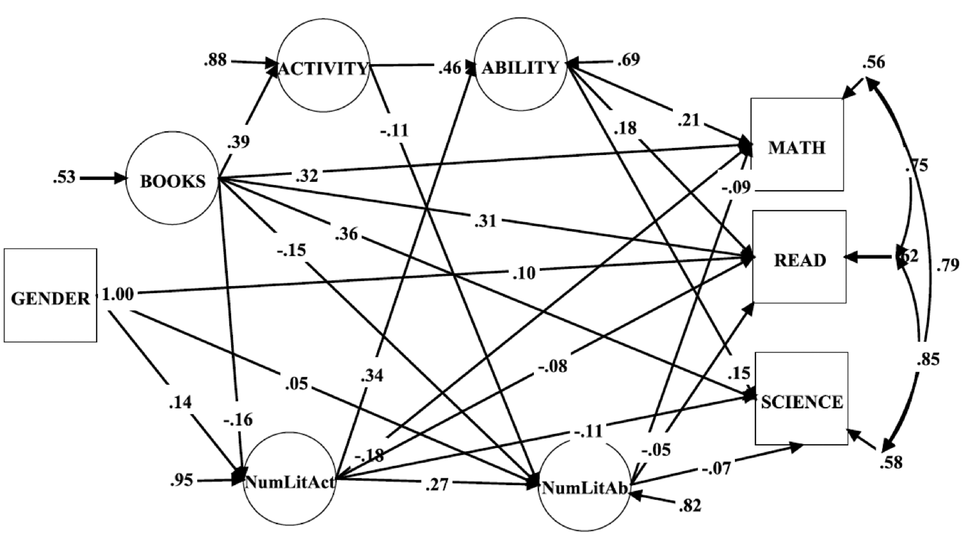
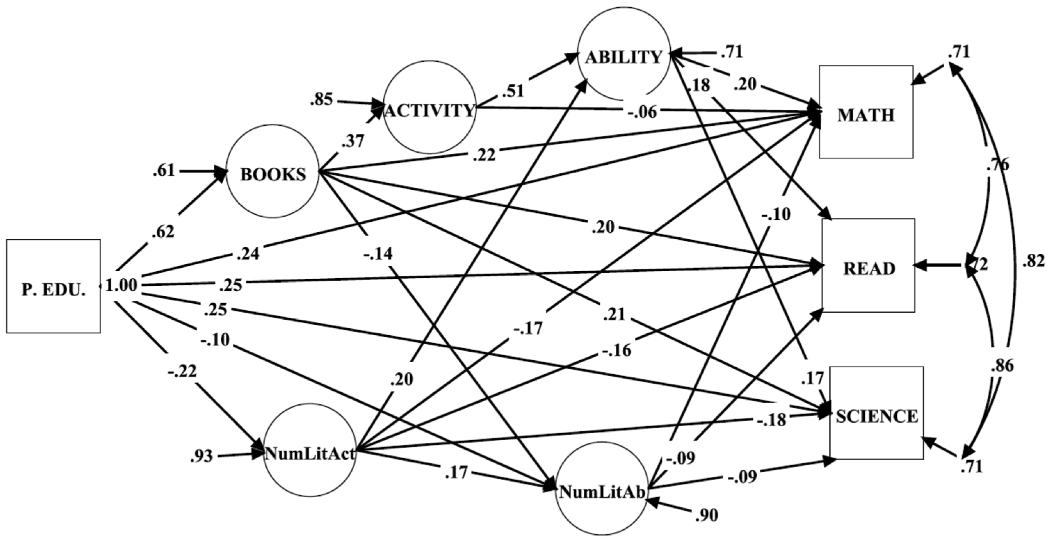
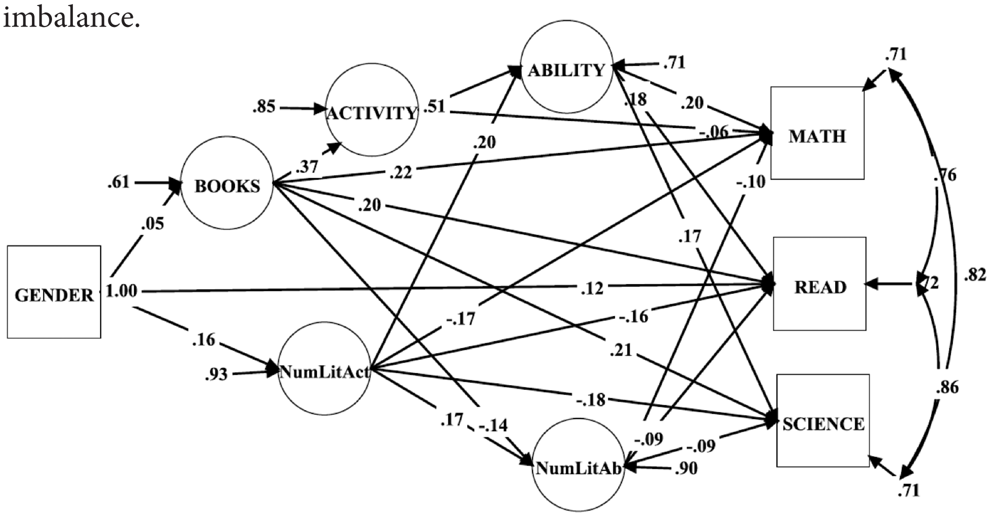


Exhibit 4.29: Iran, Islamic Republic of

PARENTAL EDUCATION The total effects of Parental Education were .44, .45, and .43 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .19, .20, and .18. Indirect effects went particularly via the Main Path and via Books. Parents with a higher level of education tended to place higher emphasis on numeracy activities than on literacy activities, which had a negative effect on achievement in all three domains via Ability. However, there also was a positive direct effect on mathematics achievement. Parental Education and Books also both were associated with assessing numeracy skills higher than literacy skills, which was positively associated with achievement.



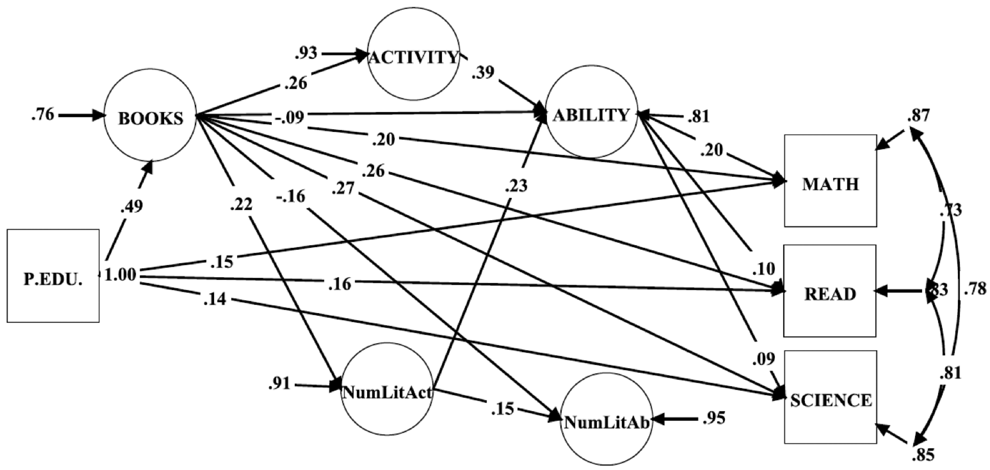
GENDER The total effects of Gender were -.02, -.03, and .11 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were -.01, -.01, and -.01. There was a small positive indirect effect via the Main Path on achievement for girls in all domains. For girls, there was a stronger emphasis on literacy activities than on numeracy activities, and via Ability this had a positive effect on achievement in all domains. However, there also were strong negative direct effects on achievement in all three domains of this imbalance.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.30: Italy

PARENTAL EDUCATION The total effects of Parental Education were .24, .28, and .30 for Mathematics, science, and reading, respectively, and the corresponding total indirect effects were .09, .14, and .14. The indirect effects went via the Main Path, and there was also an effect of Books such that, with more books in the home, there was a stronger emphasis on literacy activities than on numeracy activities. This literacy emphasis had a positive effect on achievement in all three domains, which was mediated via Ability.



GENDER The total effects of Gender were -.06, -.05, and .03 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .00, .01, and .02. For girls, there was more of an emphasis on literacy than on numeracy activities, which had an indirect effect on achievement via Ability.

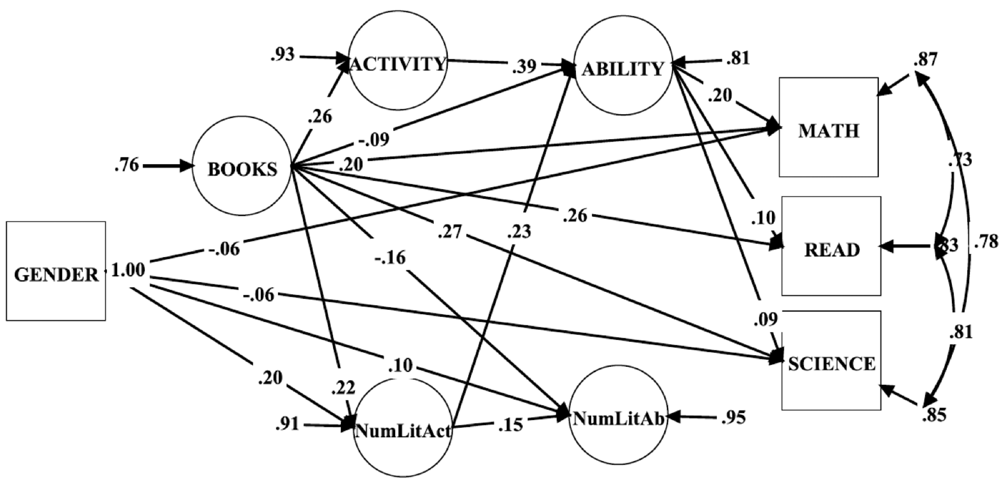
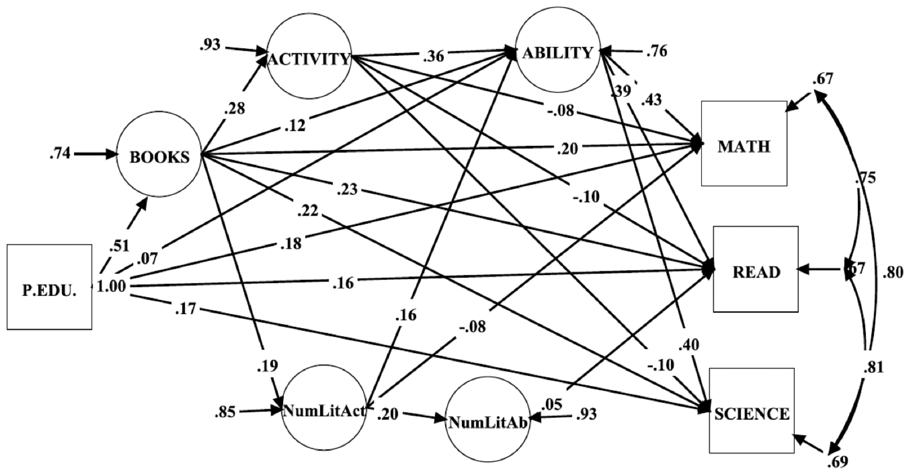
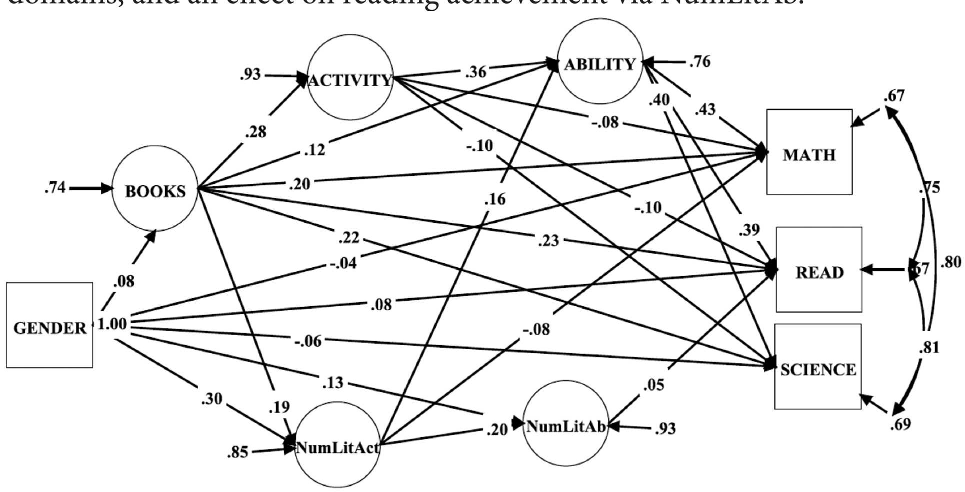


Exhibit 4.31: Lithuania

PARENTAL EDUCATION The total effects of Parental Education were .36, .35, and .35 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .17, .18, and .19. Indirect effects went via the Main Path and via Books. The number of books in the home also was related to a stronger emphasis on literacy activities than on numeracy activities, which had an indirect effect on achievement via Ability. There also was an indirect effect of Parental Education on achievement via Ability.



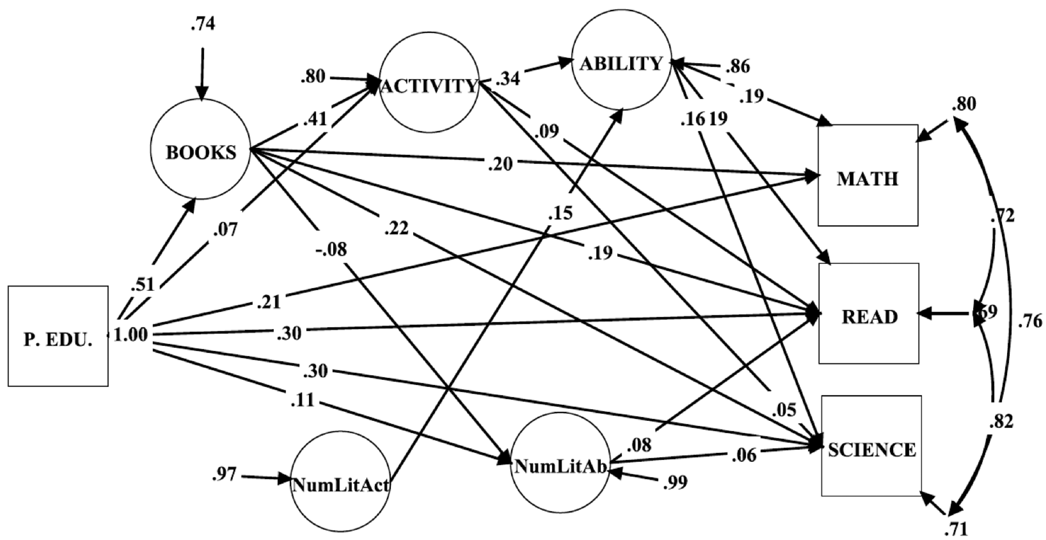
GENDER The total effects of Gender were -.01, -.01, and .15 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .04, .06, and .07. Girls thus had a considerably higher level of achievement than boys in reading. This pattern of gender differences was partially mediated via a stronger emphasis on literacy activities than on numeracy activities, which had an indirect effect on achievement via Ability. In addition to the direct effect of Gender, there was an indirect effect on NumLitAct via Books in the same direction. There also was an effect of Gender via the Main Path on achievement in all domains, and an effect on reading achievement via NumLitAb.



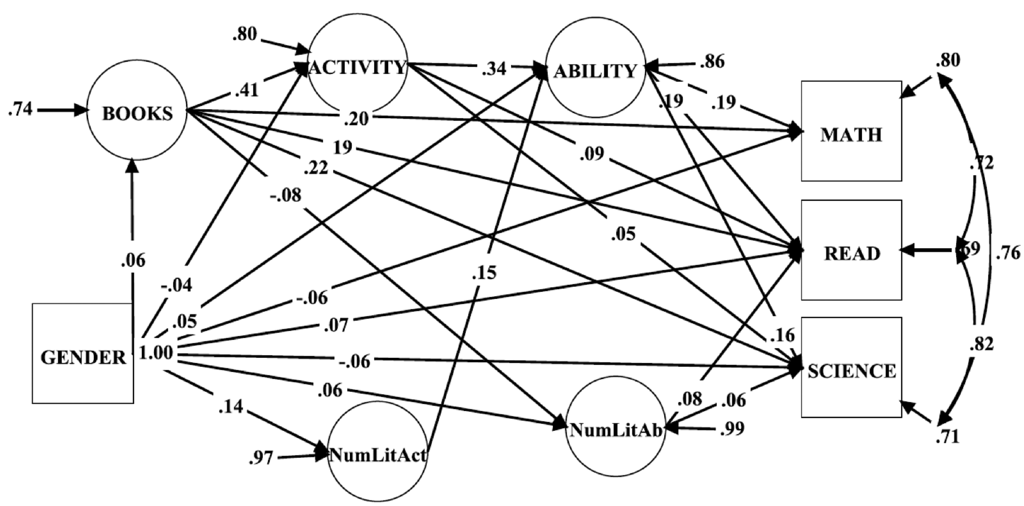
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.32: Malta

PARENTAL EDUCATION The total effects of Parental Education were .34, .45, and .44 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .13, .15, and .15. There was thus a very strong total effect of Parental Education on reading and science achievement and a strong effect on mathematics achievement. The total indirect effect accounted for about one-third of the total effect. Indirect effects went particularly via the Main Path and via Books. There also was an effect of Books, such that the variable was related to a higher level of assessed numeracy skills than literacy skills, which in turn had positive effects on science and reading achievement.



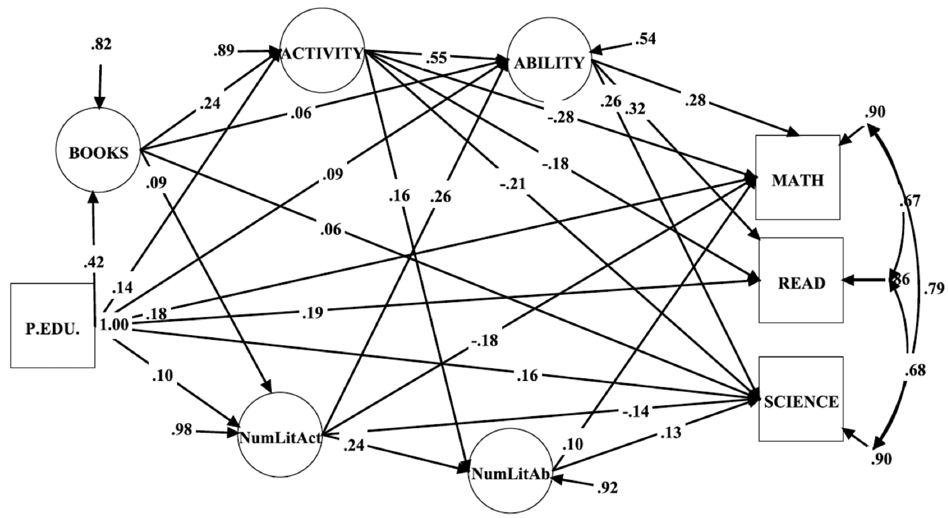
GENDER The total effects of Gender were -.04, -.04, and .10 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .02, .02, and .02. The indirect effects were partially mediated via the Main Path and via Books. For girls, there also was a stronger emphasis on literacy activities than on numeracy activities, which had a positive effect on achievement, which was mediated via Ability.



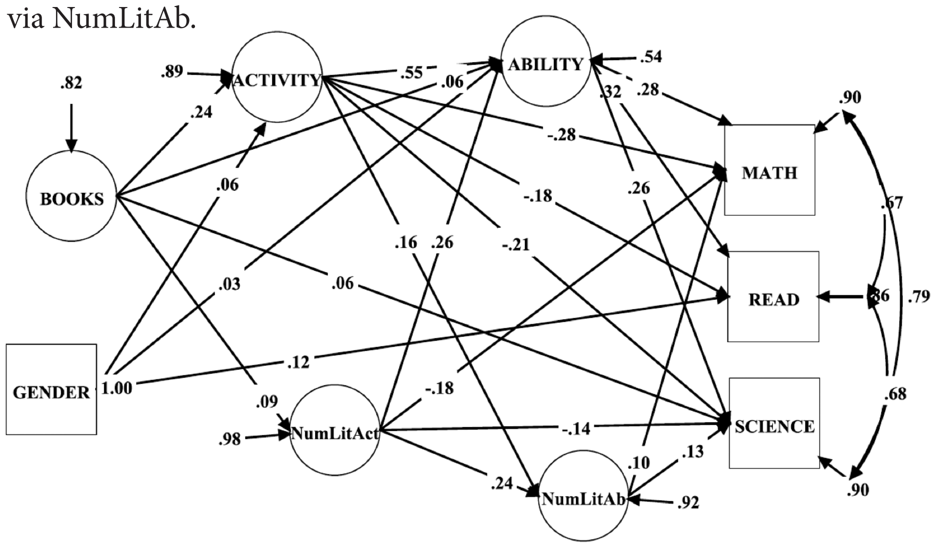
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.33: Morocco

PARENTAL EDUCATION The total effects of Parental Education were .19, .19, and .24 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .00, .03, and .05. The indirect effects went in particular via the Main Path and also via Ability, on which there were effects of Parental Education and Books. Higher levels of Parental Education and Books also were associated with a stronger emphasis on literacy activities than on numeracy activities, which influenced achievement positively in all domains via Ability, but which also had negative direct effects on mathematics and science achievement. A higher level of Activity was associated with a higher assessment of literacy skills than numeracy skills, which had positive effects on mathematics and science achievement.



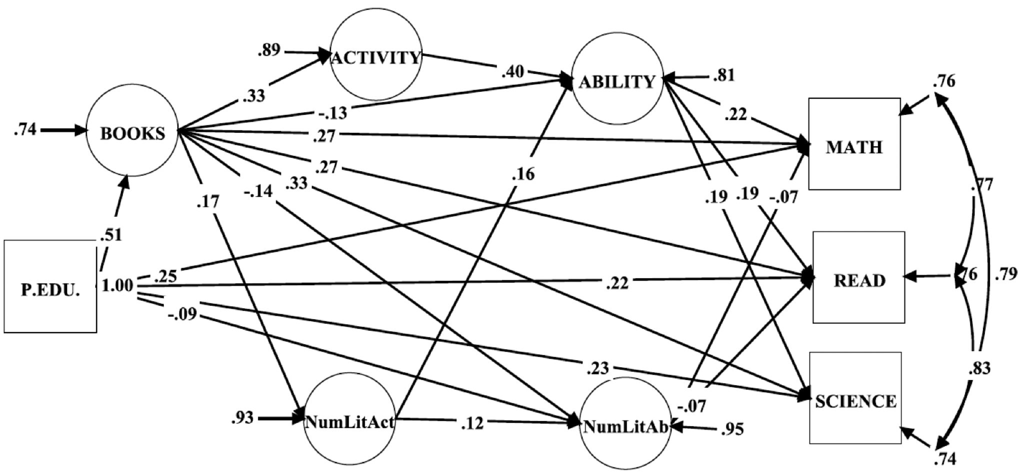
GENDER The total effects of Gender were .03, .04, and .13 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .01, and .01. Girls thus had a higher level of achievement than boys in reading, and to a smaller extent in mathematics and science. A somewhat higher level of Activity was reported for girls than for boys, which influenced achievement positively via Ability. Activity had negative direct effects on achievement in all three domains, and positive indirect effects on mathematics and science via NumLitAb.



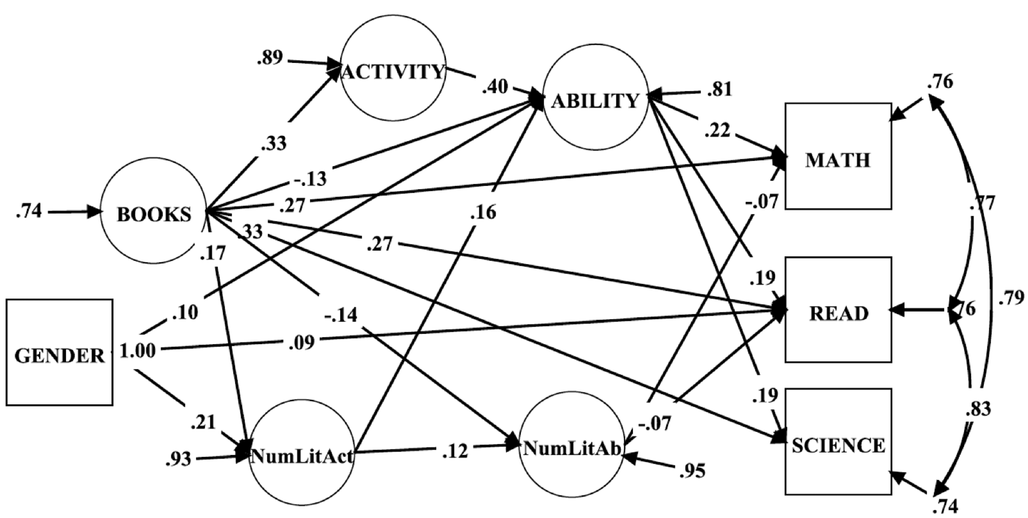
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.34: Northern Ireland

PARENTAL EDUCATION The total effects of Parental Education were .38, .39, and .36 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .13, .16, and .14. The indirect effects of Parental Education were mediated via the Main Path and via Books. In families with a larger number of books, greater emphasis was placed on literacy activities than on numeracy activities, which had a positive indirect effect on achievement via Ability. In such families, numeracy skills also were assessed higher than literacy skills, which was associated with a higher level of achievement in mathematics and reading.



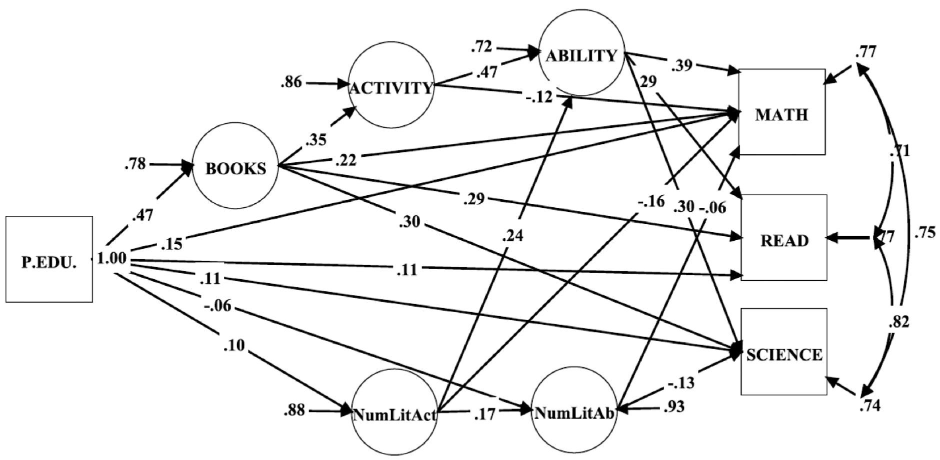
GENDER The total effects of Gender were .02, .02, and .13 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .04, and .04. Girls thus outperformed boys in reading. The effect of Gender was partially mediated via Ability. Furthermore, for girls, there was more emphasis on literacy activities than on numeracy activities, which had positive indirect effects on achievement via Ability.



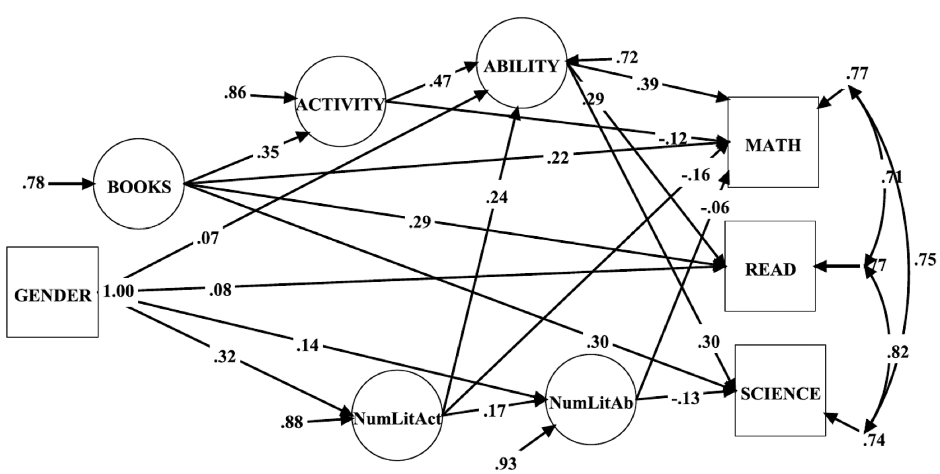
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.35: Norway

PARENTAL EDUCATION The total effects of Parental Education were .25, .28, and .26 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .10, .17, and .16. Compared to other countries there was thus a relatively weak total effect of Parental Education on reading, mathematics, and science achievement, and a rather large part of the total effect was indirect. The indirect effects were due to the Main Path and to mediation via Books. Higher Parental Education also was associated with a stronger emphasis on literacy activities than on numeracy activities, which in turn influenced achievement positively via Ability. It also was associated with higher assessed literacy skills than numeracy skills, which had negative direct effects on mathematics and science achievement.



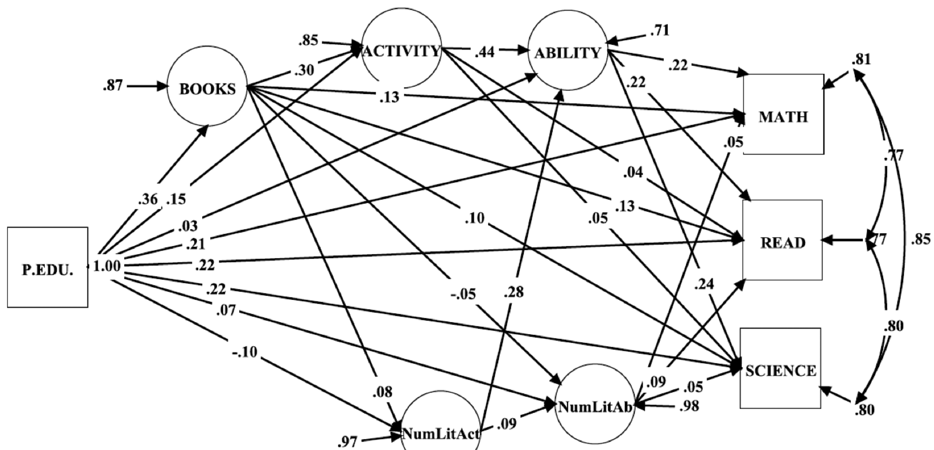
GENDER The total effects of Gender were -.04, -.01, and .13 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .00, .03, and .06. Girls thus had a higher level of achievement than boys in reading, while boys had a somewhat higher level of achievement in mathematics. The indirect effect on reading was partially due to the fact that, for girls, there was a stronger emphasis on literacy activity than on numeracy activity. This affected achievement positively via Ability and it also had a negative direct effect on mathematics achievement. Girls also were assessed as having better literacy skills than numeracy skills, which was negatively related to mathematics and science achievement.



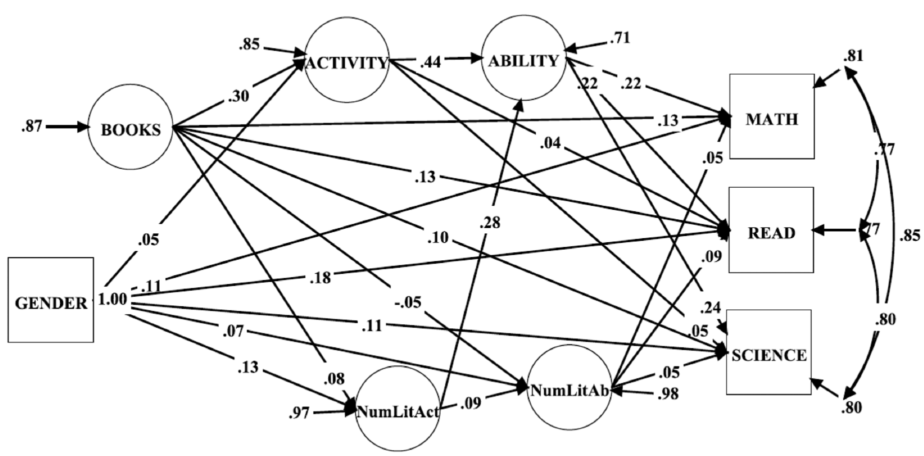
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.36: Oman

PARENTAL EDUCATION The total effects of Parental Education were .30, .31, and .32 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .09, .08, and .09. The indirect effects were mediated via the Main Path and via Books. There also was a direct effect of Parental Education on Activity. For higher levels of Parental Education, there was a relatively stronger emphasis on numeracy than on literacy activities, which indirectly influenced achievement in all domains negatively via Ability. However, there also were positive indirect effects of Parental Education via Books, which was associated with more literacy activity than numeracy activity. Parents with a higher level of education also tended to assess literacy skills higher than numeracy skill, which was positively related to achievement in all three domains.



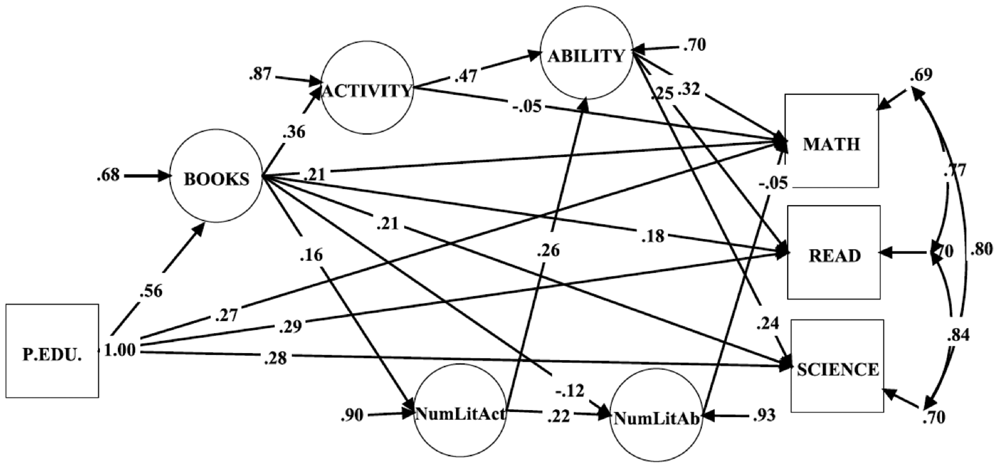
GENDER The total effects of Gender were .13, .14, and .20 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .02, .02, and .03. Girls thus had a considerably higher level of achievement than boys in reading, and they also outperformed boys in mathematics and science. The indirect effects were small for all three outcomes. For girls, there was a relatively stronger emphasis on literacy than numeracy activities, which influenced achievement in all domains via Ability. Girls also were assessed relatively higher in literacy skills than numeracy skills, which influenced achievement in all three domains.



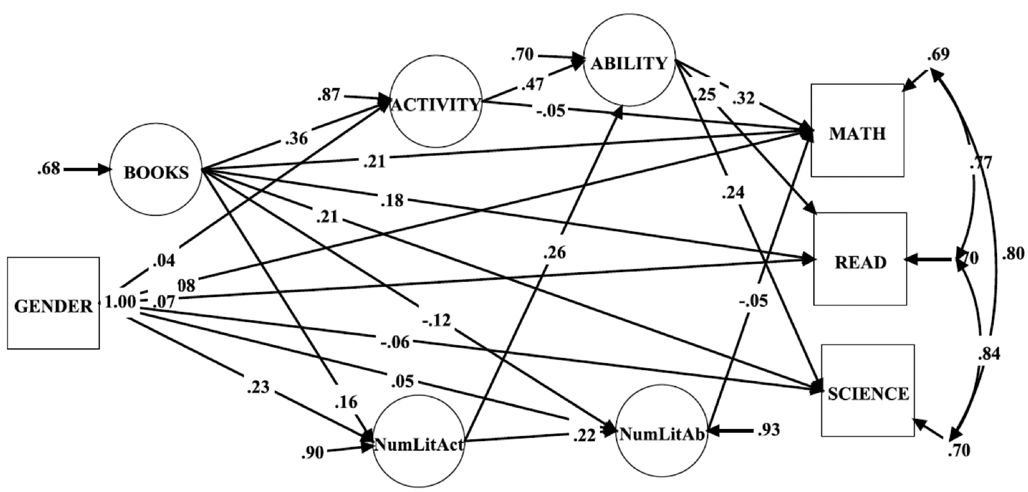
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.37: Poland

PARENTAL EDUCATION The total effects of Parental Education were .43, .44, and .43 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .15, .16, and .14. The indirect effects were mediated via the Main Path and via Books. In homes with many books, there also was a tendency to place relatively more emphasis on literacy than on numeracy activity. This had a positive effect on Ability, which in turn influenced achievement in all three domains.



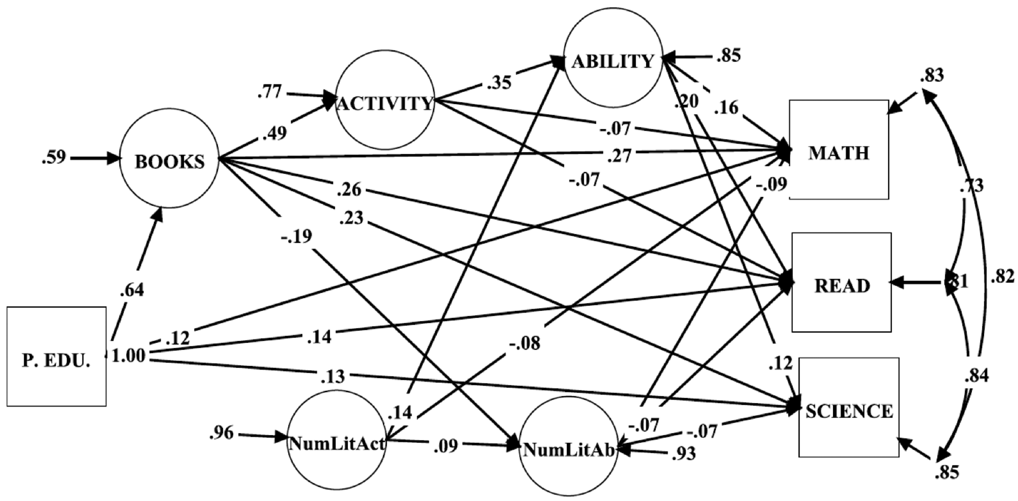
GENDER The total effects of Gender were -.06, -.02, and .11 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .02, .04, and .04. Girls thus had a considerably higher level of achievement than boys in reading, while boys outperformed girls in mathematics and science. The indirect effects occurred mainly because for girls there was relatively more emphasis on literacy than on numeracy activities, which influenced Ability positively, and which in turn had a positive effect on achievement in all three domains.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.38: Portugal

PARENTAL EDUCATION The total effects of Parental Education were .30, .30, and .31 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .18, .17, and .18. The relatively substantial indirect effects went via the Main Path and via Books. There also was a weak effect via Books, because homes with many books tended to assess numeracy skills higher than literacy skills, which in turn had a positive effect on mathematics and science performance.



GENDER The total effects of Gender were -.04, -.03, and .11 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were -.01, .00, and .00. Girls thus had a considerably higher level of achievement than boys in reading, while boys had a higher level of achievement than girls in mathematics and science. There was an indirect effect via the pattern of activities, with more emphasis on literacy than on numeracy activities for girls. This indirectly affected achievement positively via an effect on Ability. There also was a small indirect effect via the pattern of assessed skills, with girls having relatively higher assessed literacy skills than numeracy skills, which had negative effects on achievement in mathematics and reading.

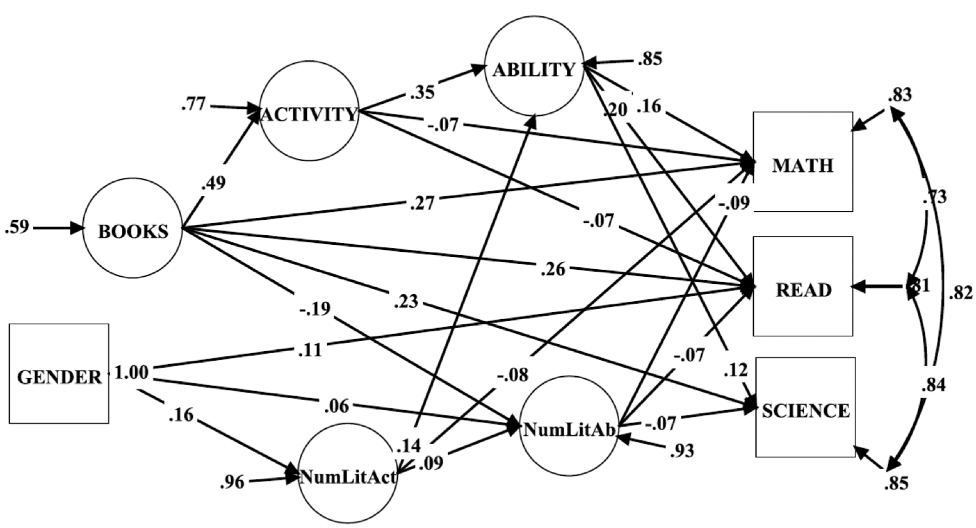
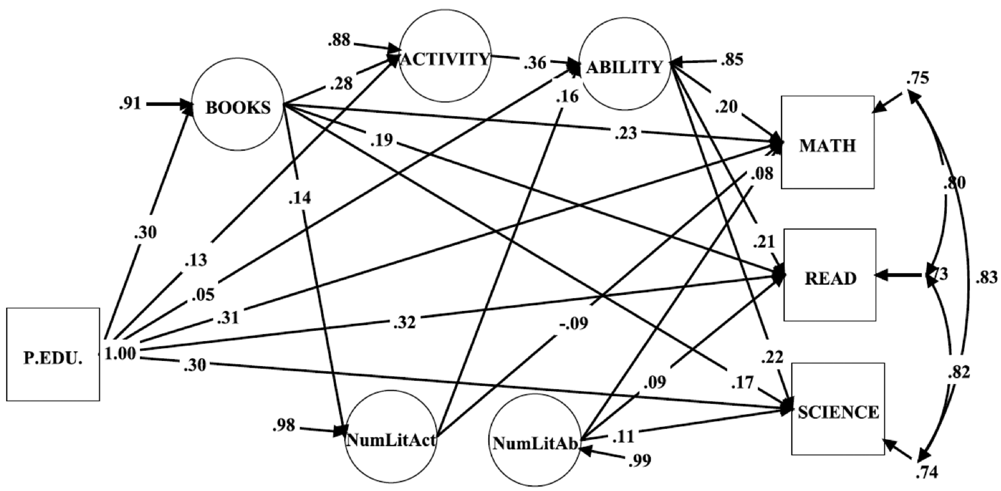
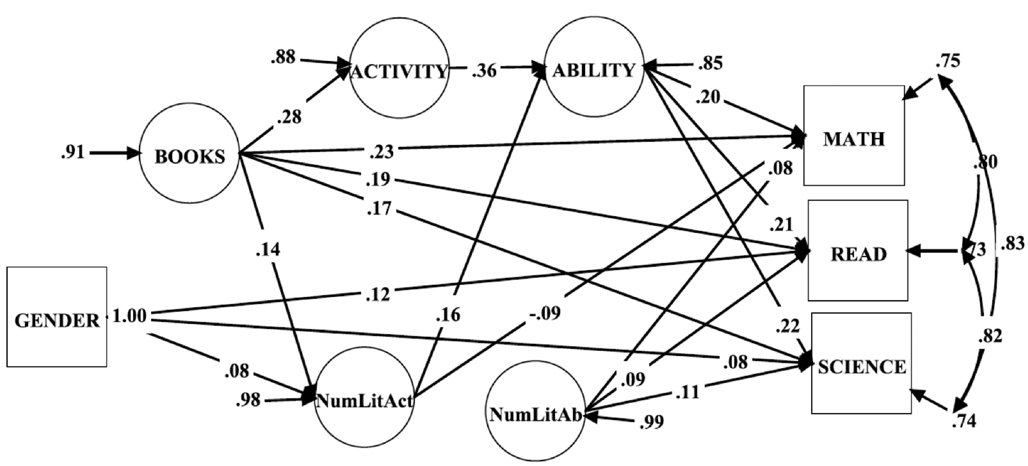


Exhibit 4.39: Qatar

PARENTAL EDUCATION The total effects of Parental Education were .39, .38, and .40 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .09, .08, and .08. The indirect effects were mediated via the Main Path and via Books. In homes with a larger number of books, there was a relatively greater emphasis on literacy than on numeracy activities, which had a positive effect on achievement in all three domains via Ability, along with a negative direct effect on mathematics achievement.



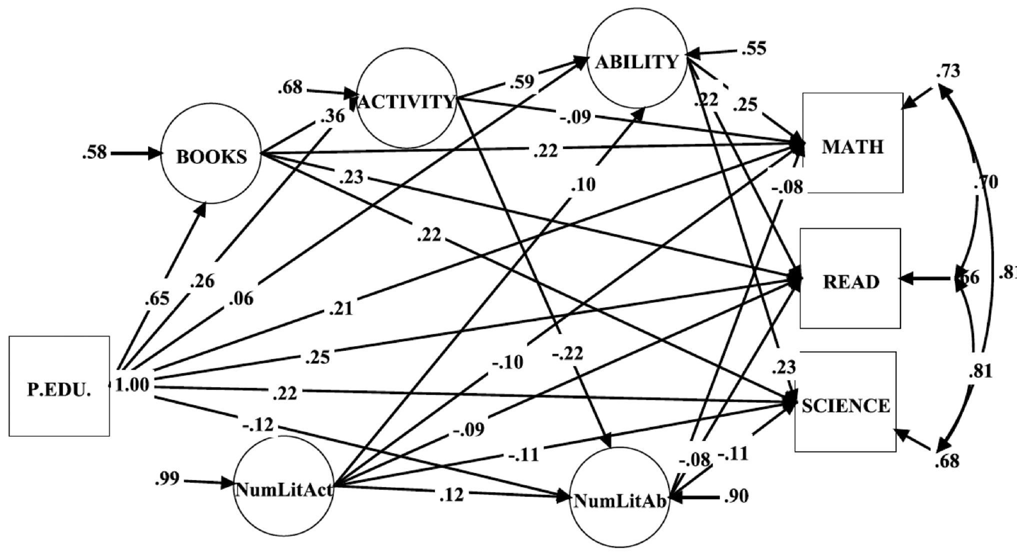
GENDER The total effects of Gender were .06, .11, and .14 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .02, and .02. Girls thus had a considerably higher level of achievement than boys in reading and they also outperformed boys in mathematics and science. There was a small mediating effect via the pattern of activities, with a stronger emphasis on literacy than on numeracy activities for girls. This had a negative direct effect on mathematics achievement, and also a positive effect on Ability, which in turn had positive effects on achievement in all three domains.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.40: Romania

PARENTAL EDUCATION The total effects of Parental Education were .43, .47, and .49 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .22, .24, and .24. Thus, there were large total effects of Parental Education on mathematics, science, and reading achievement, and the total indirect effects also were substantial. The indirect effects were mediated via the Main Path and via Books. There also was a direct effect on Activity of Parental Education. In homes with a high level of activity, numeracy skills were assessed higher than literacy skills, which caused positive indirect effects of Activity on achievement in all three domains.



GENDER The total effects of Gender were -.02, -.01, and .08 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .01, and .02. The small indirect effect was partially mediated via Books and via Ability. For girls, there also was a stronger emphasis on literacy than on numeracy activity, which had a positive indirect effect on achievement via Ability, but also negative direct effects in all three domains.

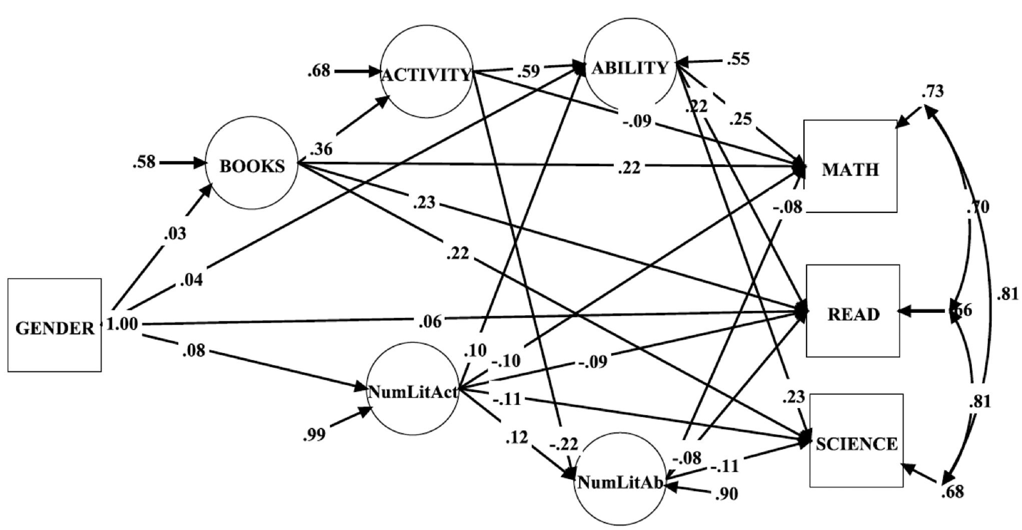
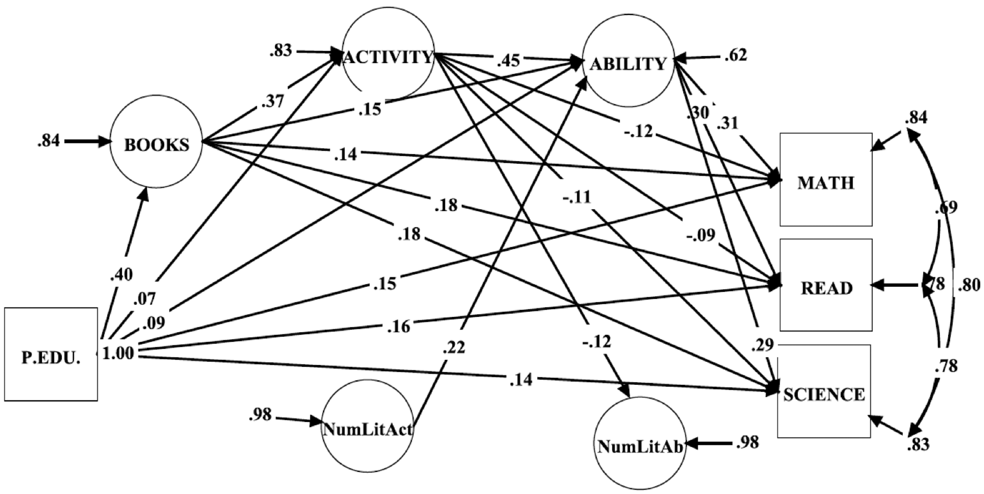
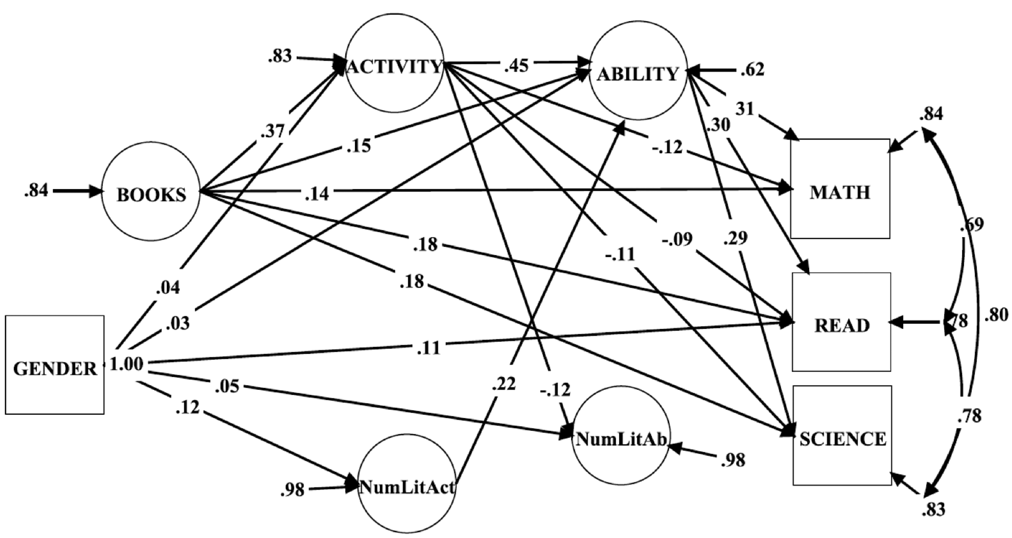


Exhibit 4.41: The Russian Federation

PARENTAL EDUCATION The total effects of Parental Education were .27, .27, and .29 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .11, .13, and .13. The indirect effects were primarily mediated via the Main Path and via Books. There also was an effect of Parental Education on Ability, which had a positive effect on achievement in all three domains.



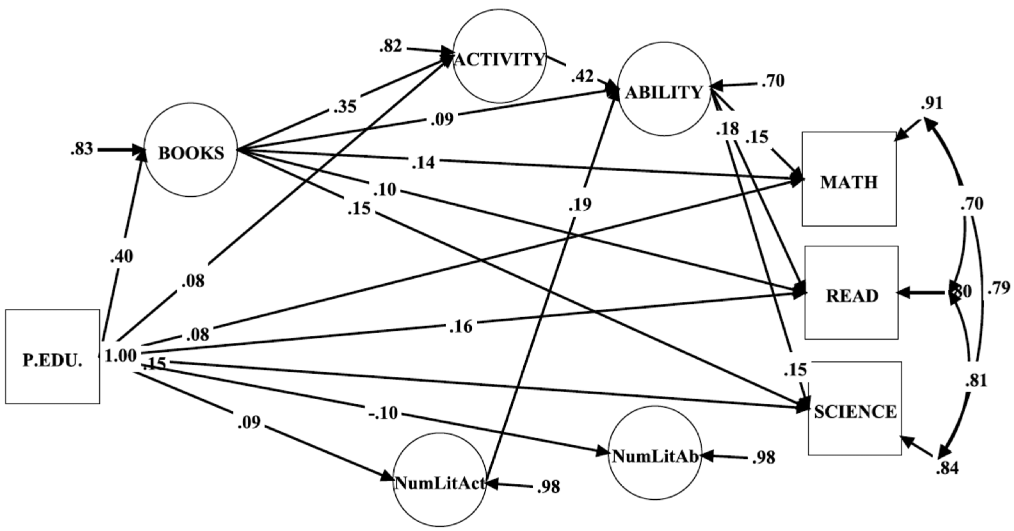
GENDER The total effects of Gender were .01, -.01, and .14 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .02, .02, and .03. Girls thus outperformed boys in reading. A part of the indirect effects was mediated via Activity and Ability. For girls, there also was more emphasis on literacy activities than on numeracy activities, which had a positive impact on achievement via Ability.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.42: Saudi Arabia

PARENTAL EDUCATION The total effects of Parental Education were .18, .25, and .24 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .09, .10, and .09. The indirect effects were primarily mediated via the Main Path and via Books. There also was greater emphasis on literacy activities than numeracy activities in homes with higher Parental Education, which influenced achievement in all three domains via was Ability.



GENDER The total effects of Gender were .06, .20, and .27 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .04, .04, and .04. Girls thus outperformed boys in all three domains, but particularly so in reading and science. For girls, there was a higher level of Activity and higher level of Ability, which was positively related to achievement in all three domains.

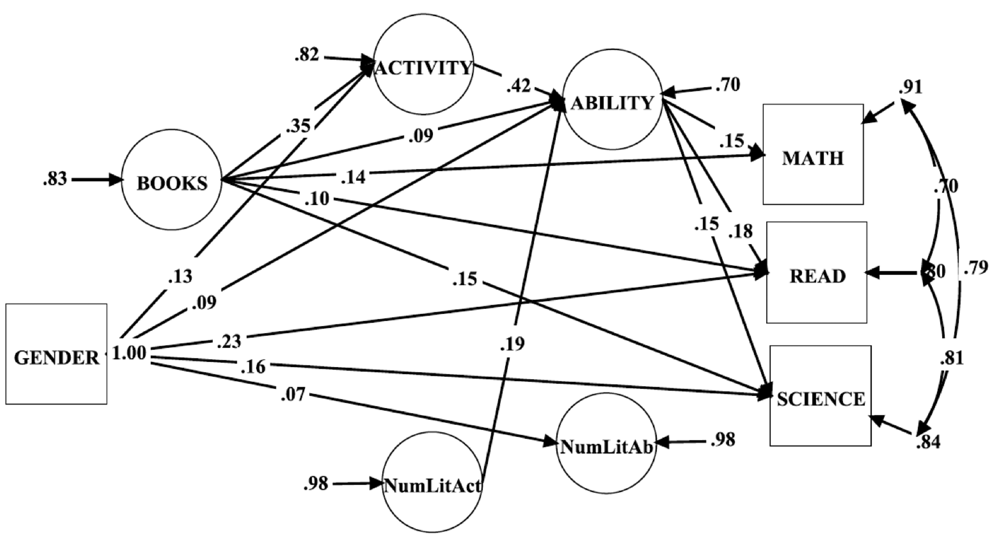
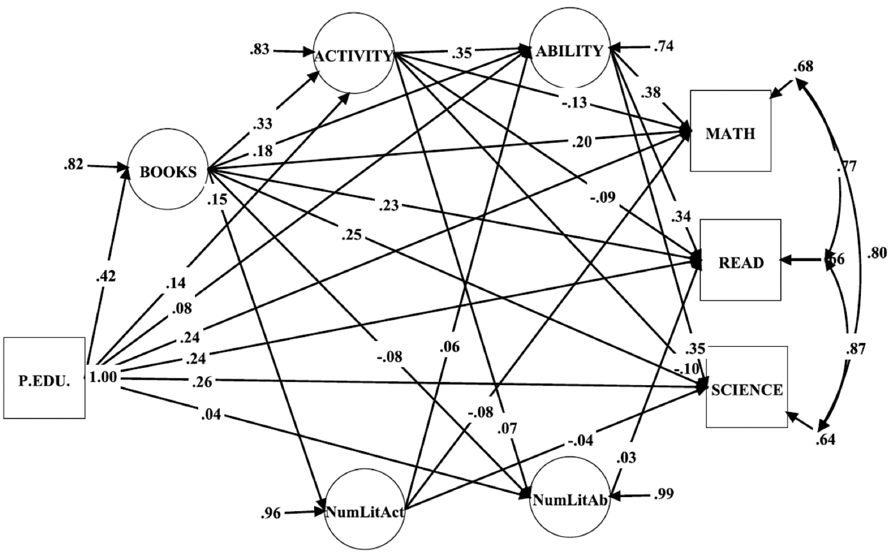


Exhibit 4.43: Singapore

PARENTAL EDUCATION The total effects of Parental Education were .39, .44, and .41 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .15, .17, and .17. The indirect effects were mainly mediated via the Main Path and via Books. There also was an effect of Books on the balance of activities, such that in homes with many books there was greater emphasis on literacy activities than on numeracy activities. This had a weak effect on Ability, which influenced achievement in all three domains positively.



GENDER The total effects of Gender were .02, -.03, and .10 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .04, and .04. Girls thus outperformed boys in reading, while boys had a somewhat higher level of achievement in science. The indirect effects were partially mediated via the Main Path and via Ability. For girls, there also was more of an emphasis on literacy activities than numeracy activities, which had a positive effect on achievement via Ability, and a negative direct effect on mathematics achievement. Girls also had somewhat higher assessed literacy skills than numeracy skills, which had a direct effect on reading achievement.

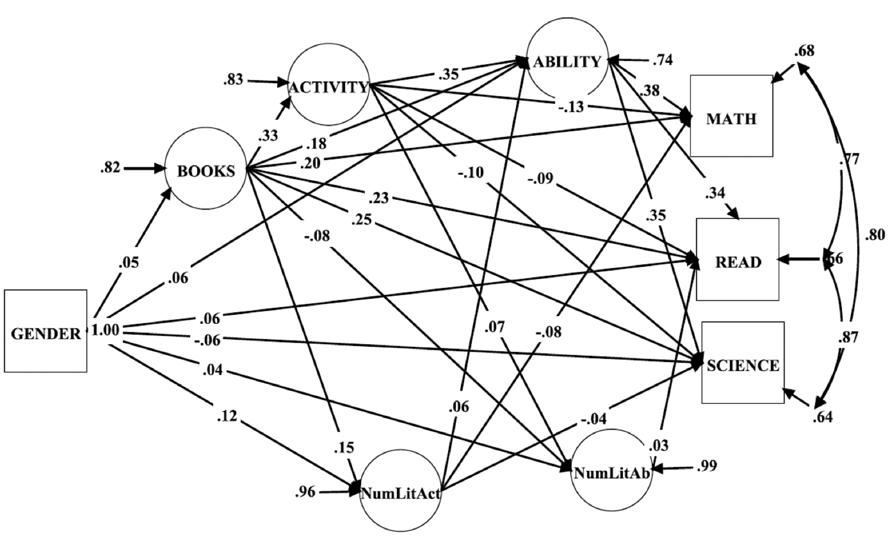
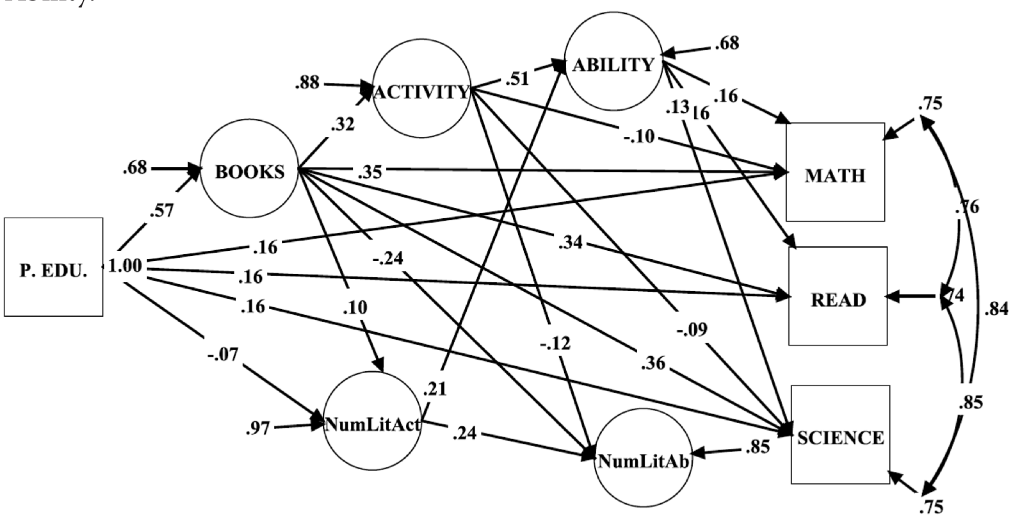


Exhibit 4.44: The Slovak Republic

PARENTAL EDUCATION The total effects of Parental Education were .37, .38, and .38 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .21, .21, and .21. The indirect effects were mediated via the Main Path and via Books. For homes with a high level of parental education, there was more emphasis on numeracy activities than on literacy activities, which had a weak negative effect on achievement via Ability.



GENDER The total effects of Gender were -.05, -.05, and .08 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .00, .01, and .01. The weak indirect effects were mediated the Main Path and via Activity. There also was an indirect effect via Books. For girls, there also was more of an emphasis on literacy activities than numeracy activities. This had a positive effect on achievement, which was mediated via Ability.

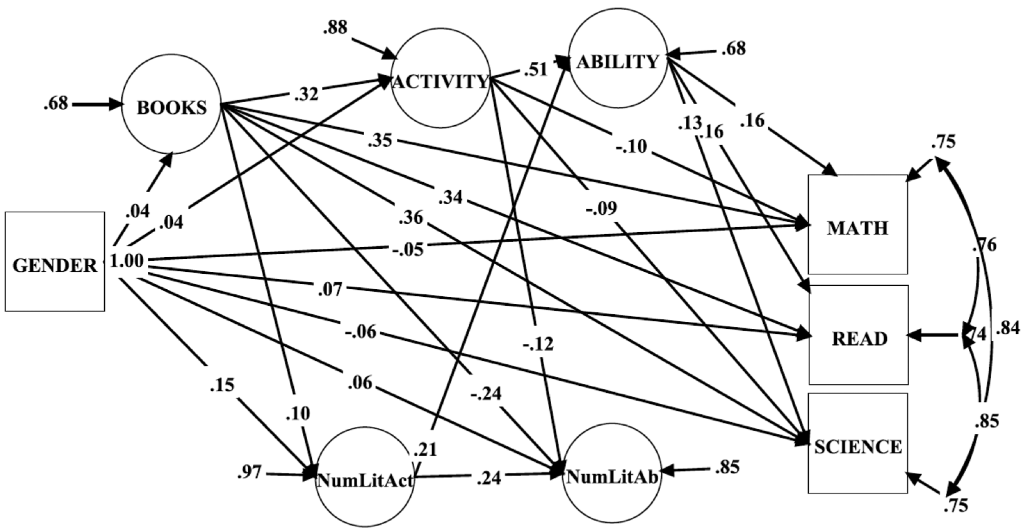
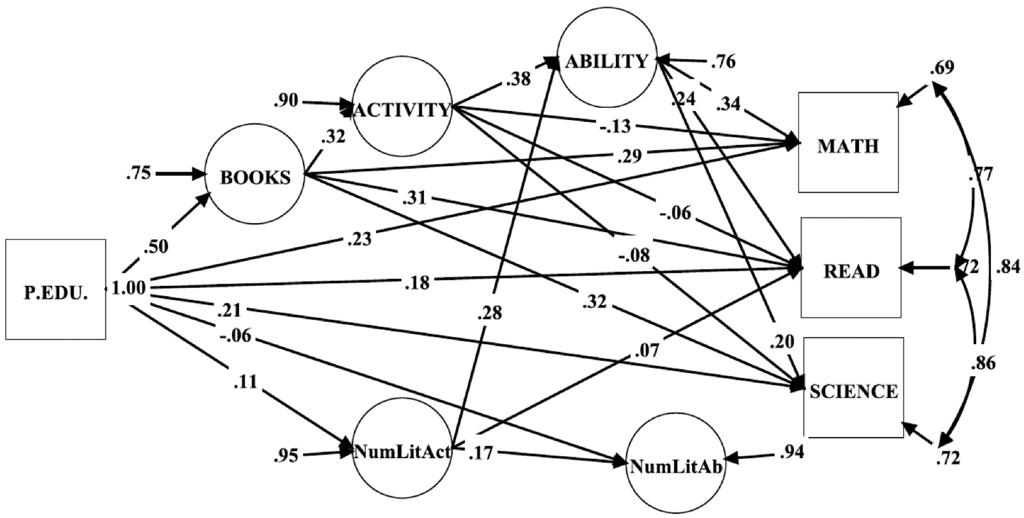


Exhibit 4.45: Slovenia

PARENTAL EDUCATION The total effects of Parental Education were .38, .39, and .35 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .15, .17, and .17. The indirect effects were mediated via the Main Path and via Books. In homes with more highly educated parents, there was more emphasis on literacy activities than on numeracy activities. This had a positive indirect effect on achievement, which was mediated via Ability.



GENDER The total effects of Gender were -.06, -.02, and .12 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .04, .05, and .06. Girls thus outperformed boys in reading, while boys had a higher level of achievement in mathematics. The indirect effects were mediated via the Main Path and via Ability. There also was an indirect effect via Books. For girls, there was more emphasis on literacy activities than numeracy activities, which had a positive indirect effect on achievement in all domains via Ability.

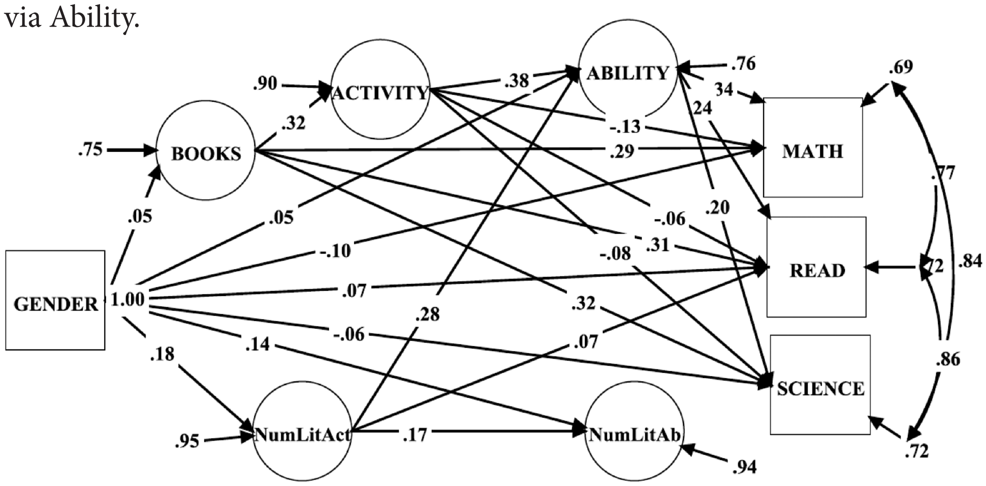
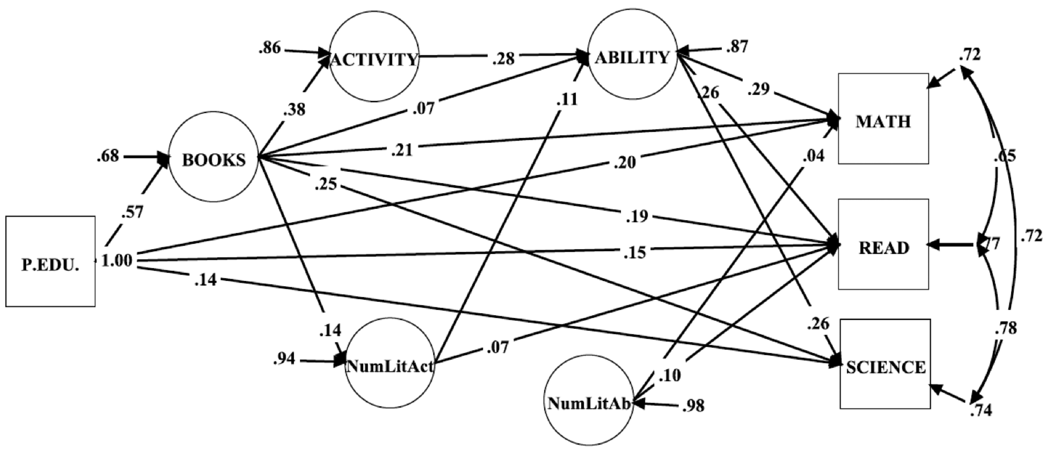
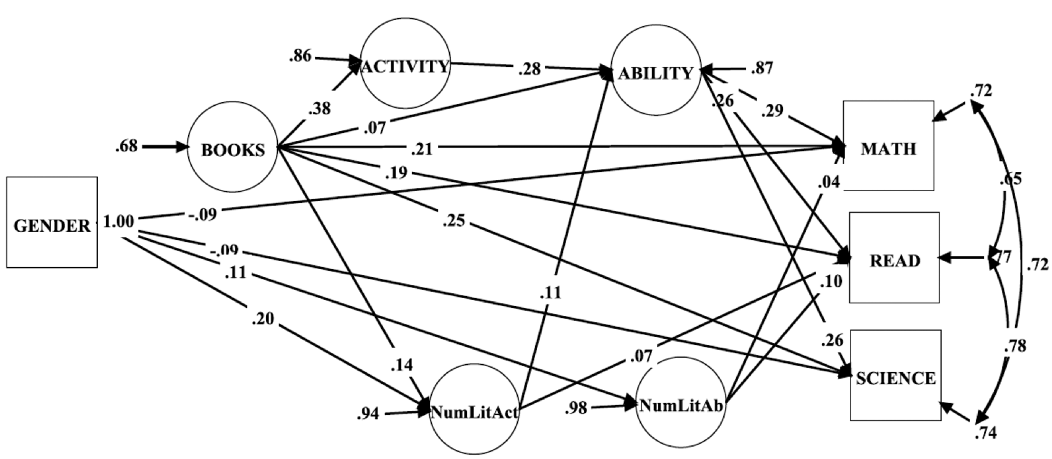


Exhibit 4.46: Spain

PARENTAL EDUCATION The total effects of Parental Education were .37, .33, and .31 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .17, .19, and .16. The indirect effects were mediated via the Main Path and via Books. In homes with a larger number of books, there was greater emphasis on literacy activities than numeracy activities, which had a positive effect on achievement in all domains via Ability.



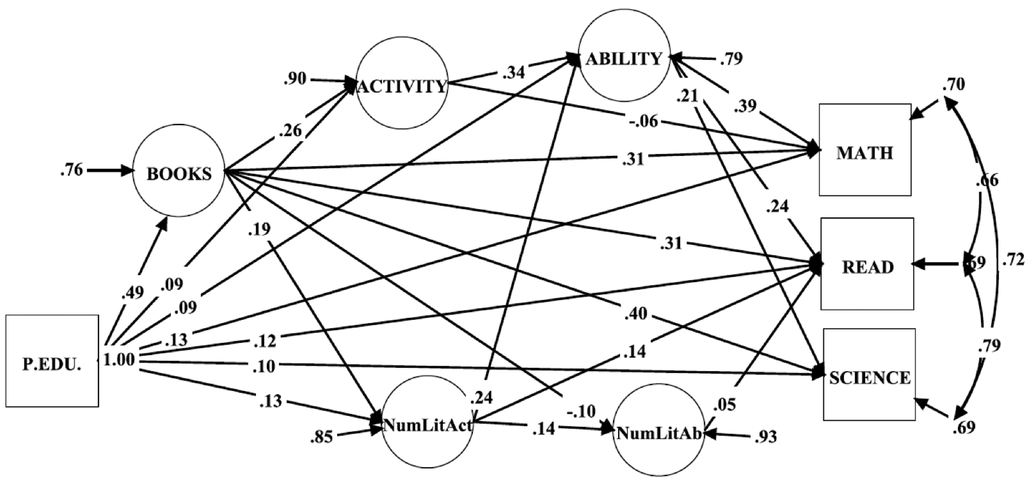
GENDER The total effects of Gender were -.08, -.07, and .03 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .02, and .03. Boys thus outperformed girls in mathematics and science, while girls had a somewhat higher level of achievement in reading. For girls, there was more emphasis on literacy than on numeracy activities, which had a positive indirect effect on achievement in all three domains via Ability, along with a positive direct effect on reading achievement. Girls also were assessed higher on literacy skills than on numeracy skills, which had a positive effect on reading achievement in particular.



SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.47: Sweden

PARENTAL EDUCATION The total effects of Parental Education were .32, .34, and .34 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .20, .25, and .22. The indirect effects were mediated via the Main Path and via Books. Both for homes with more books and more highly educated parents there was more literacy activity than numeracy activity. This had a positive indirect effect on achievement in all three domains, which was mediated via Ability, and there also was a positive direct effect on reading achievement.



GENDER The total effects of Gender were -.05, -.03, and .11 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .05, .08, and .10. Girls thus outperformed boys in reading, while boys had a higher level of achievement in mathematics and science. Weak indirect effects of Gender were mediated via Books and via Ability. For girls, there also was more emphasis on literacy activities than on numeracy activities, which had a positive indirect effect on achievement via Ability, and there was also a positive direct effect on reading achievement. Girls also were more highly assessed on literacy skills than on numeracy skills, which was associated with a higher level of reading achievement.

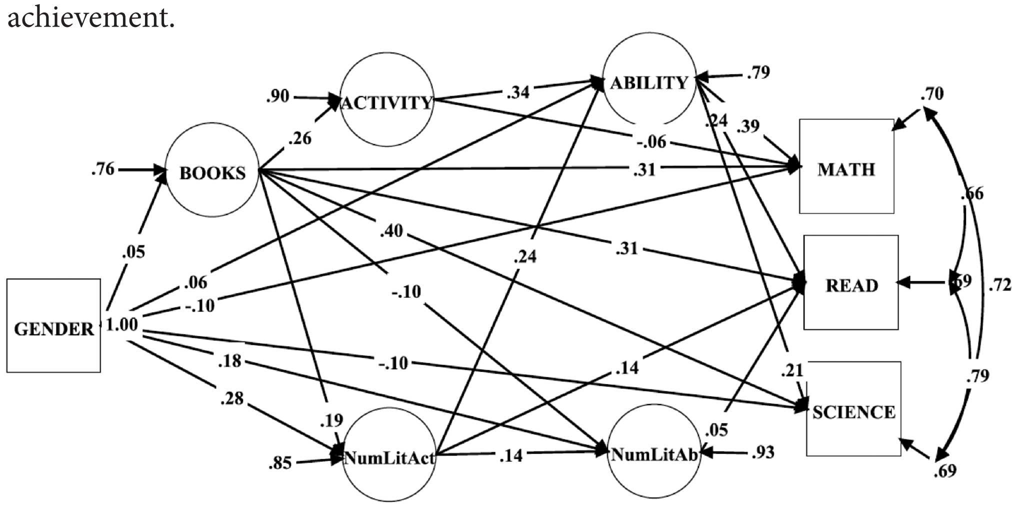
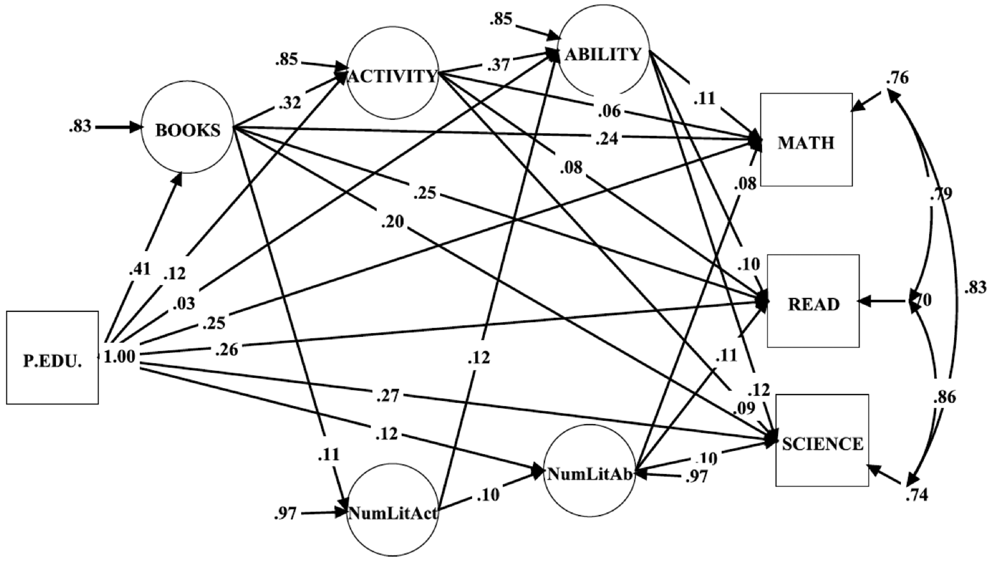
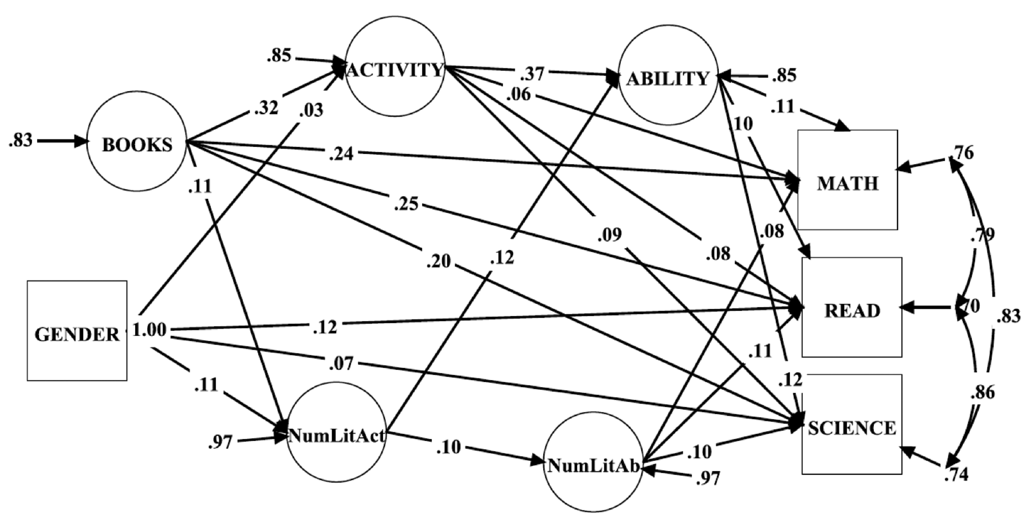


Exhibit 4.48: United Arab Emirates

PARENTAL EDUCATION The total effects of Parental Education were .39, .40, and .42 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .14, .13, and .15. The indirect effects were mediated via the Main Path and via Books. Homes with many books also tended to put more emphasis on literacy activities than numeracy activities, which indirectly had a positive effect on achievement via Ability. Parents with a higher level of education tended to assess literacy skills higher than numeracy skills, which also was positively related to achievement in all three domains.



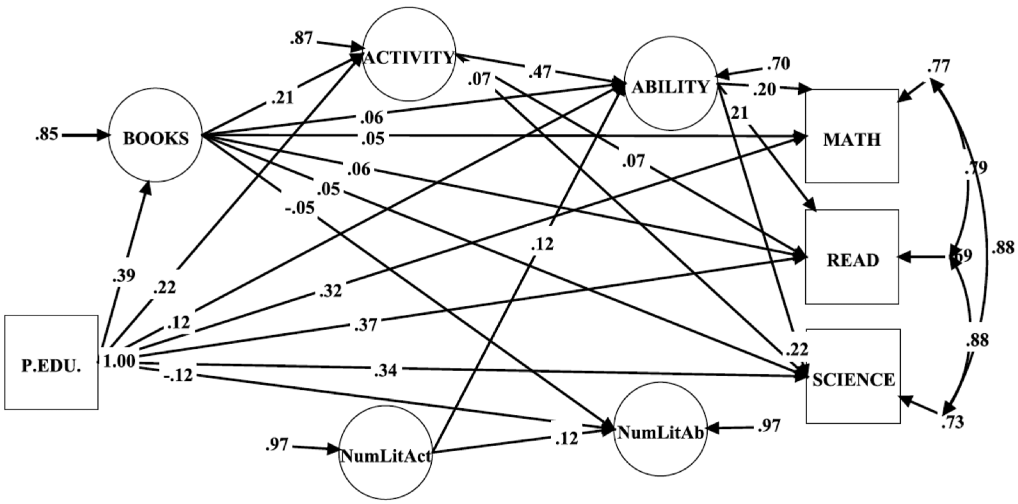
GENDER The total effects of Gender were .04, .09, and .14 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .01, .02, and .02. Girls thus outperformed boys in all three domains, and particularly so in reading and science. For girls, there was more emphasis on literacy activity than numeracy activity which indirectly influenced achievement positively via Ability. For students who had more of literacy than numeracy activities, literacy skills also were assessed higher than numeracy skills, which also had positive effects on achievement in all three domains.



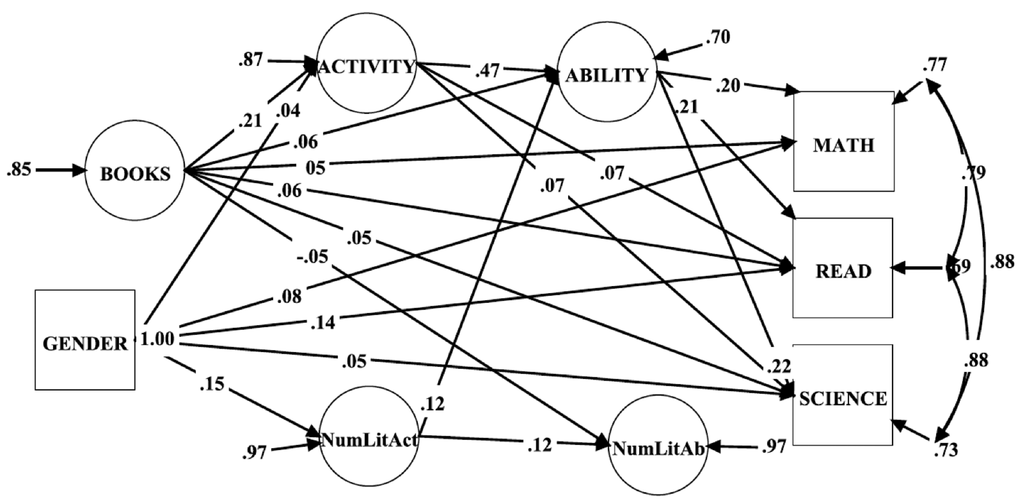
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.49: Botswana *Sixth Grade Country*

PARENTAL EDUCATION The total effects of Parental Education were .41, .45, and .48 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .09, .10, and .10. A part of the indirect effect was mediated via the Main Path, but there also was a relatively strong direct effect of Parental Education on Activity, and also a smaller direct effect of Parental Education on Ability.



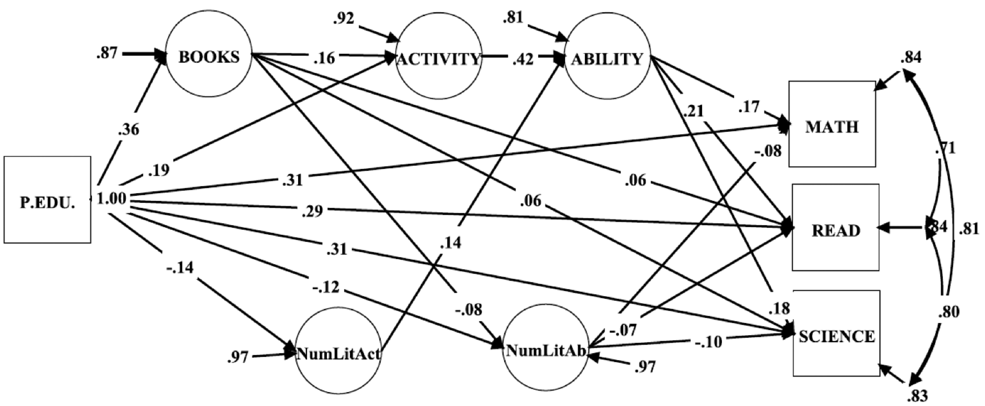
GENDER The total effects of Gender were .10, .06, and .15 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .02, .02, and .01. Thus, girls outperformed boys in all three domains. Most of the effect of Gender was direct. However, for girls there was more emphasis on literacy activity than on numeracy activity, which had a positive effect on achievement in all three domains via Ability.



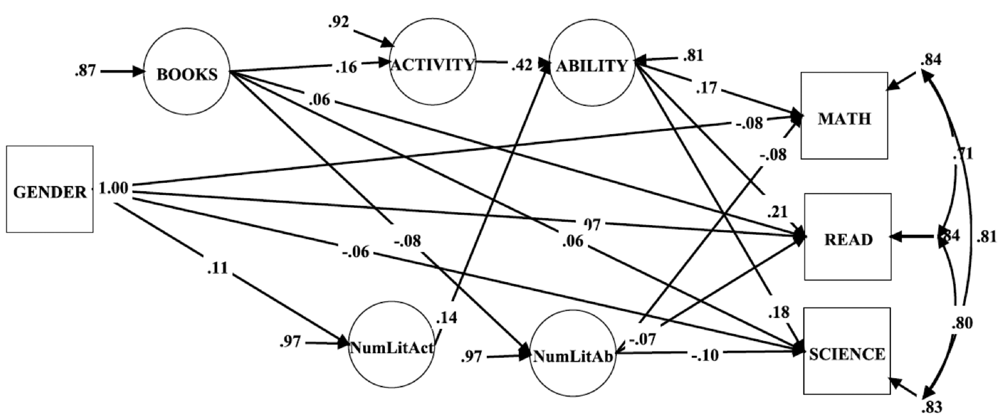
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.50: Honduras *Sixth Grade Country*

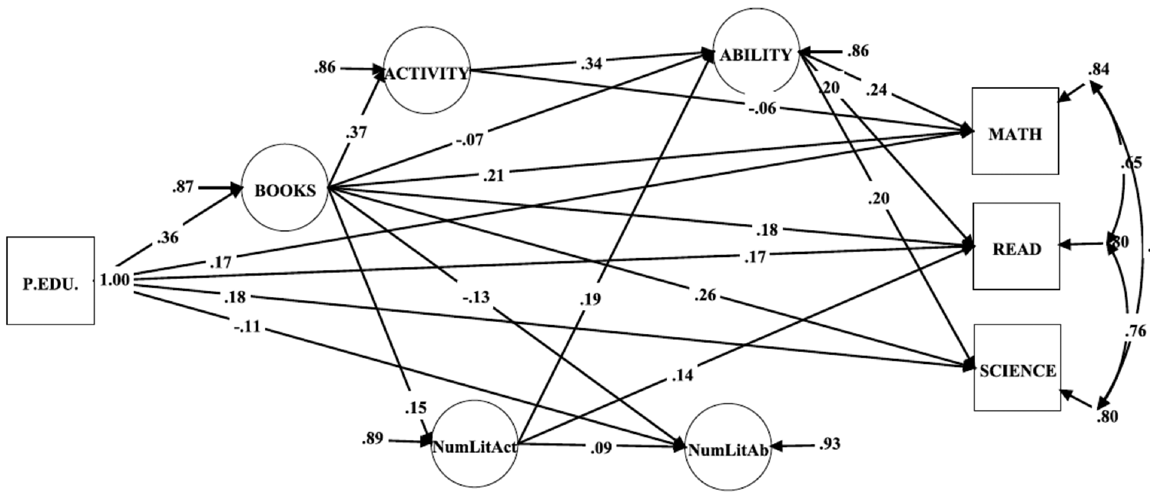
PARENTAL EDUCATION The total effects of Parental Education were .34, .36, and .34 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .05, and .05. The total indirect effect thus accounted for only a small part of the total effect. Small indirect effects went via the Main Path and via Books. To a small extent, the effect of Parental Education was mediated via the balance of the activities and assessment of literacy and numeracy skills, as well as more highly educated parents tending to emphasize numeracy activities more and to assess numeracy skills higher.



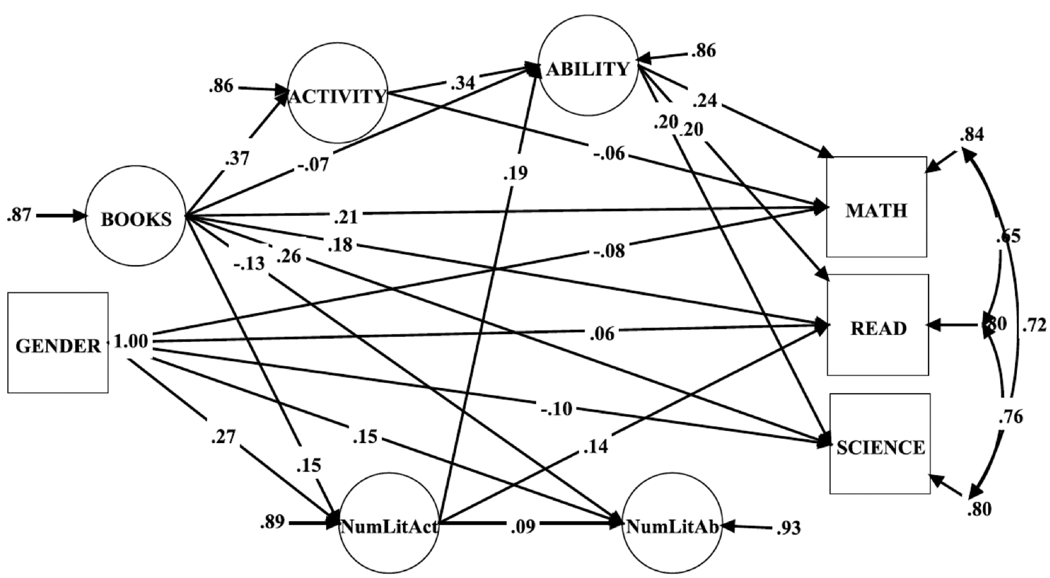
GENDER The total effects of Gender were -.08, -.06, and .07 for mathematics, science, and reading, respectively, and the total indirect effects were all close to 0. Girls thus outperformed boys in reading, while boys had higher achievement in mathematics and science. However, no significant indirect effects were identified. There was, however, a tendency for girls to have more emphasis on literacy activities than on numeracy activities, which influenced achievement in all three domains positively via Ability.



PARENTAL EDUCATION The total effects of Parental Education were .40, .39, and .40 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .13, .12, and .15. The indirect effects were mediated via the Main Path and via Books. In families with a larger number of books, there was greater emphasis on literacy than numeracy activities, which had positive indirect effects on achievement via Ability, and there also was a positive direct effect on reading achievement.



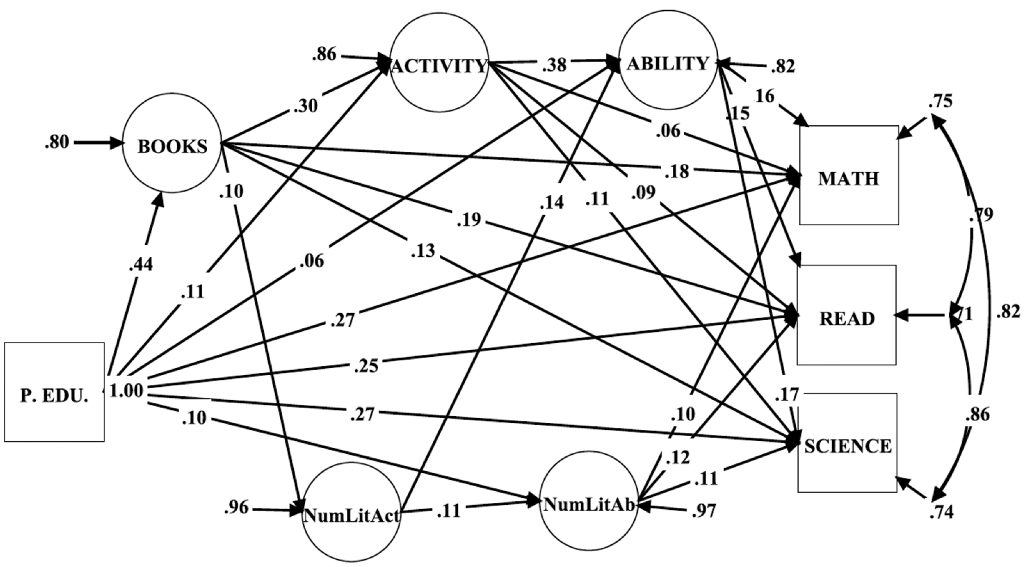
GENDER The total effects of Gender were .08, .14, and .19 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .03, and .03. Girls thus outperformed boys in all three domains, and particularly so in reading and science. For girls, there was more emphasis on literacy activities than on numeracy activities, which had positive indirect effects on all domains of achievement via Ability, and also a positive direct effect on reading achievement.



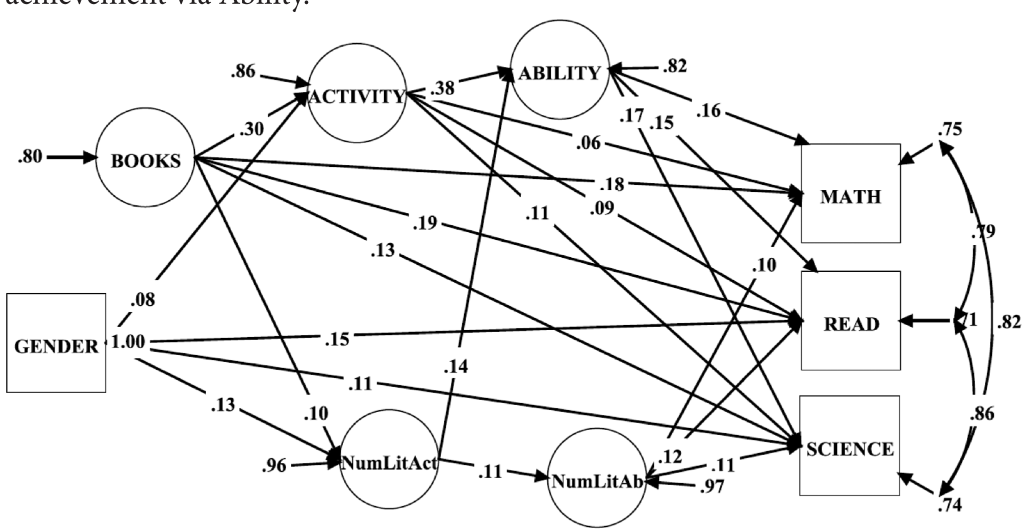
SOURCE: IEA's Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study – TIMSS and PIRLS 2011

Exhibit 4.52: Abu Dhabi, UAE *Benchmarking Participant*

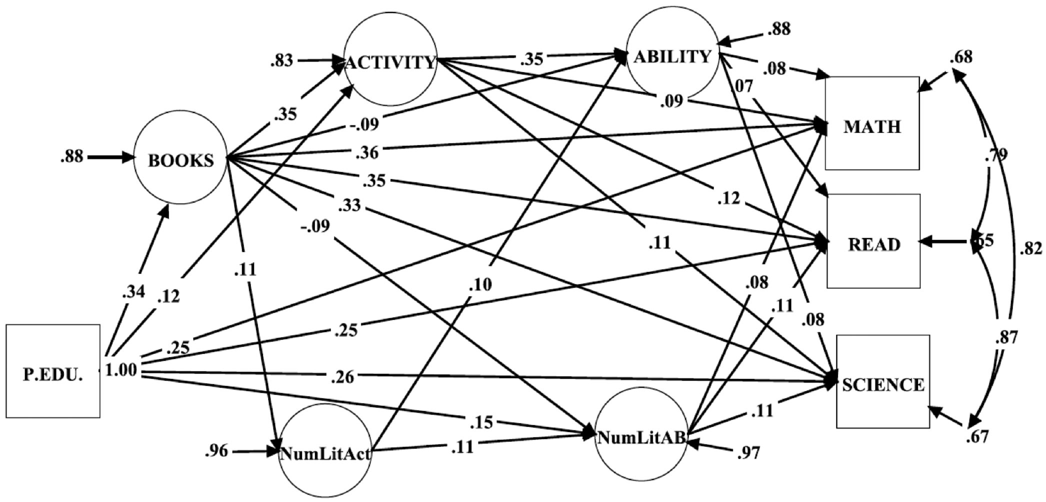
PARENTAL EDUCATION The total effects of Parental Education were .40, .39, and .40 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .13, .12, and .15. The indirect effects were mediated via the Main Path and via Books. In families with a larger number of books, more emphasis was placed on literacy activities than on numeracy activities, which had a positive indirect effect on achievement via Ability. Parents with a higher level of education also assessed literacy skills higher than numeracy skills, which influenced achievement in all three domains.



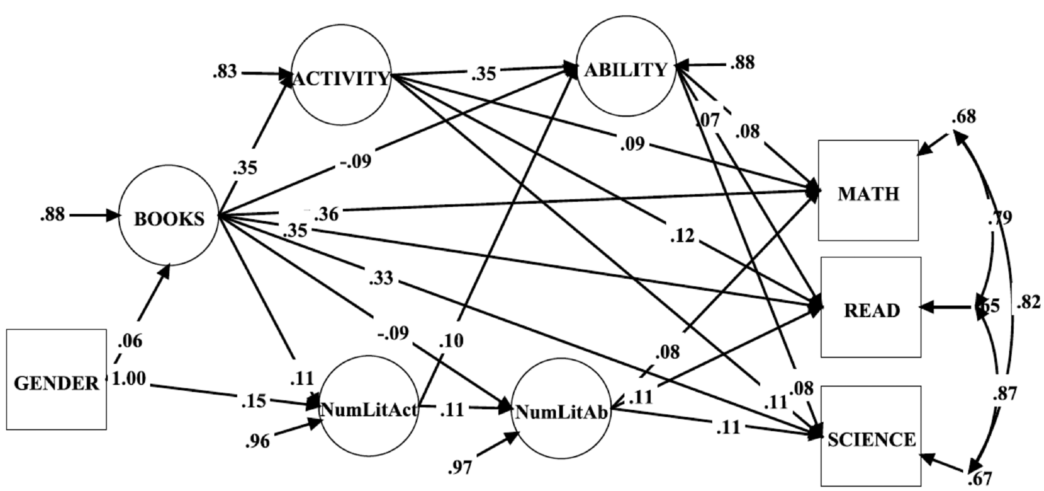
GENDER The total effects of Gender were .08, .14, and .19 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .03, and .03. Girls thus outperformed boys in all three domains, and particularly so in reading. The indirect effects of Gender were mediated via Activity and via Ability. For girls, there was a stronger emphasis on literacy activities than on numeracy activities, which had a positive indirect effect on achievement via Ability.



PARENTAL EDUCATION The total effects of Parental Education were .41, .42, and .42 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .16, .16, and .17. Indirect effects were mediated via the Main Path and via Books. In homes with many books, more emphasis was placed on literacy activities than numeracy activities, which had an indirect effect on achievement in all domains via Ability. Parents with a higher level of education also assessed literacy skills higher than numeracy skills, which was associated with a higher level of achievement in all three domains.



GENDER The total effects of Gender were -.01, .02, and .07 for mathematics, science, and reading, respectively, and the corresponding total indirect effects were .03, .04, and .04. Girls thus outperformed boys in reading. Indirect effects were mediated via the Main Path and via Books. For girls, more emphasis was placed on literacy activities than on numeracy activities; this had an indirect effect on achievement via Ability, and via a higher assessment of literacy skills than numeracy skills.



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