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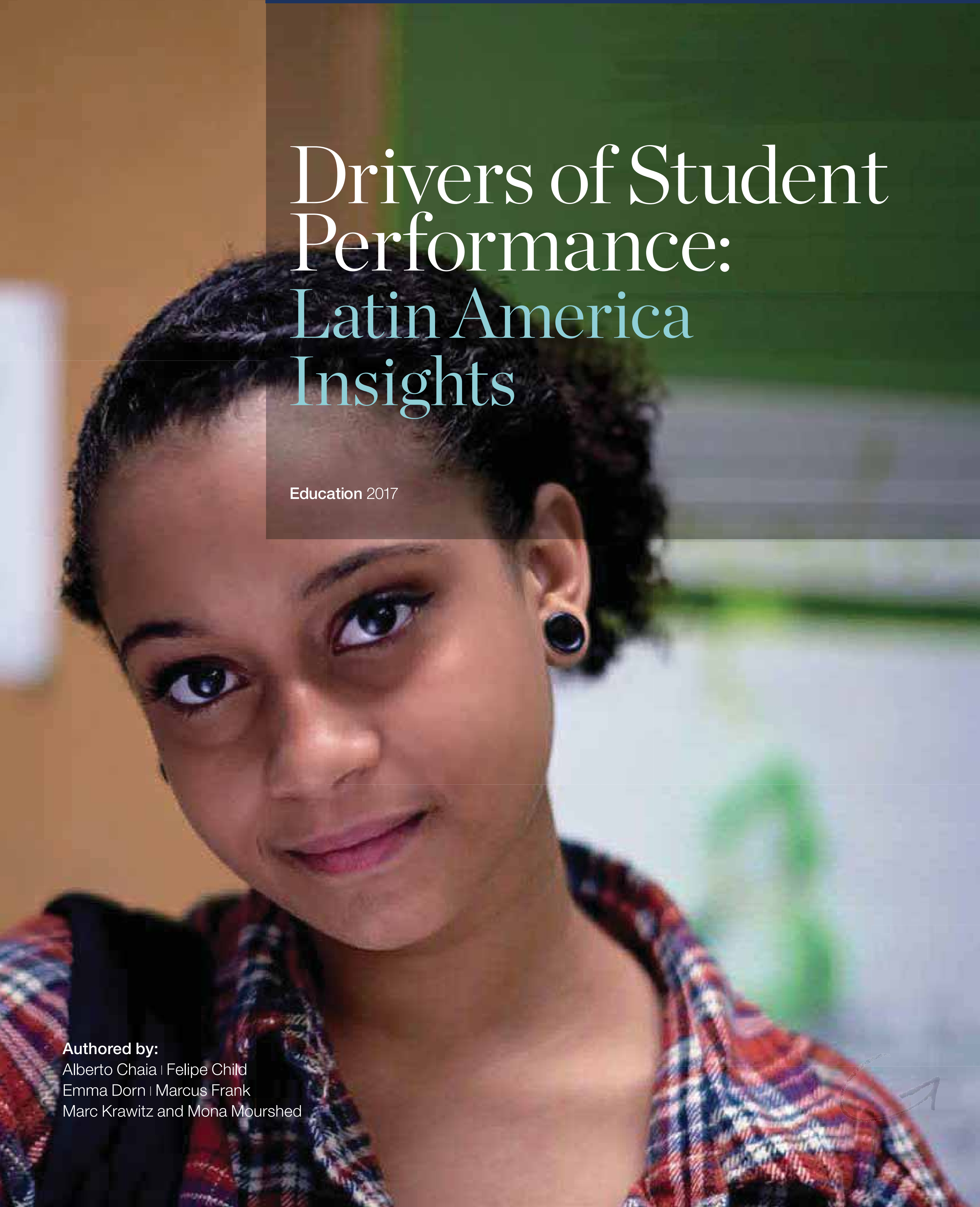
Drivers of Student Performance:
Latin America Insights

Education 2017

Authored by:
Alberto Chaia | Felipe Child
Emma Dorn | Marcus Frank
Marc Krawitz and Mona Mourshed



acknowledgements

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foreword

The PISA data base is open to the world – a powerful resource for everyone who wants to understand education and help improve it, from policy-makers and researchers to school leaders, teachers and parents. Over recent years, McKinsey have done just this, drawing on PISA to identify the policies and practices that make a real difference. Their work began with ground-breaking reports on The World's Best School Systems And How To Build Them. And these new regional analyses of student-level performance represent another significant milestone.

The reports suggest that students' attitudes and motivation are critical drivers of achievement. So too are their experience in the classroom, of both teaching strategies and digital technology, as well as the time they spend in education. McKinsey's perceptive insights will encourage schools around the world to discover new ways to nurture and inspire their students.

What sets these reports apart is their regional focus. I often hear countries say that learning from the world's outstanding systems is vital, but that just as powerful is the chance to learn from their own neighbours, with similar cultural backgrounds and with shared problems and opportunities.

In every country, the search is on for ways to take education to the next level, to prepare young people for a dramatic and challenging century. This is complex work. What is the right mix of policies, implementation strategies and enabling conditions – in each country and region? How should they be prioritised, sequenced and linked? If we are really to secure achievement, well being and equity, on a global basis, then these will be the issues that educators need to work on. The new reports from McKinsey offer us a fresh and welcome perspective.

Andreas Schleicher
Director for the Directorate of Education and Skills | OECD

executive summary

A well-educated citizenry is an economic and social necessity. But there is little consensus about what it takes to deliver a quality education.

In two previous reports, one on the world's best-performing school systems (2007) and the other on the most improved ones (2010), we examined what great school systems look like, and how they can sustain significant improvements from any starting point. In this report, we switch our focus from systems to student-level performance, by applying advanced analytics and machine learning to the results of the Organisation for Economic Co-operation and Development's (OECD) Program for International Student Assessment (PISA). Beginning in 2000 and every three years since, the OECD has tested 15-year-olds around the world on math, reading, and science. It also surveys students, principals, teachers, and parents on their social, economic, and attitudinal attributes.

Using this rich data set, we have created five regional reports that consider what drives student performance. In Latin America, ten countries participated in the 2015 PISA: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Mexico, Peru, Trinidad and Tobago, and Uruguay. On the whole, Latin America's PISA scores have improved, but the region still lags not only the OECD average but also other countries at a similar economic level.

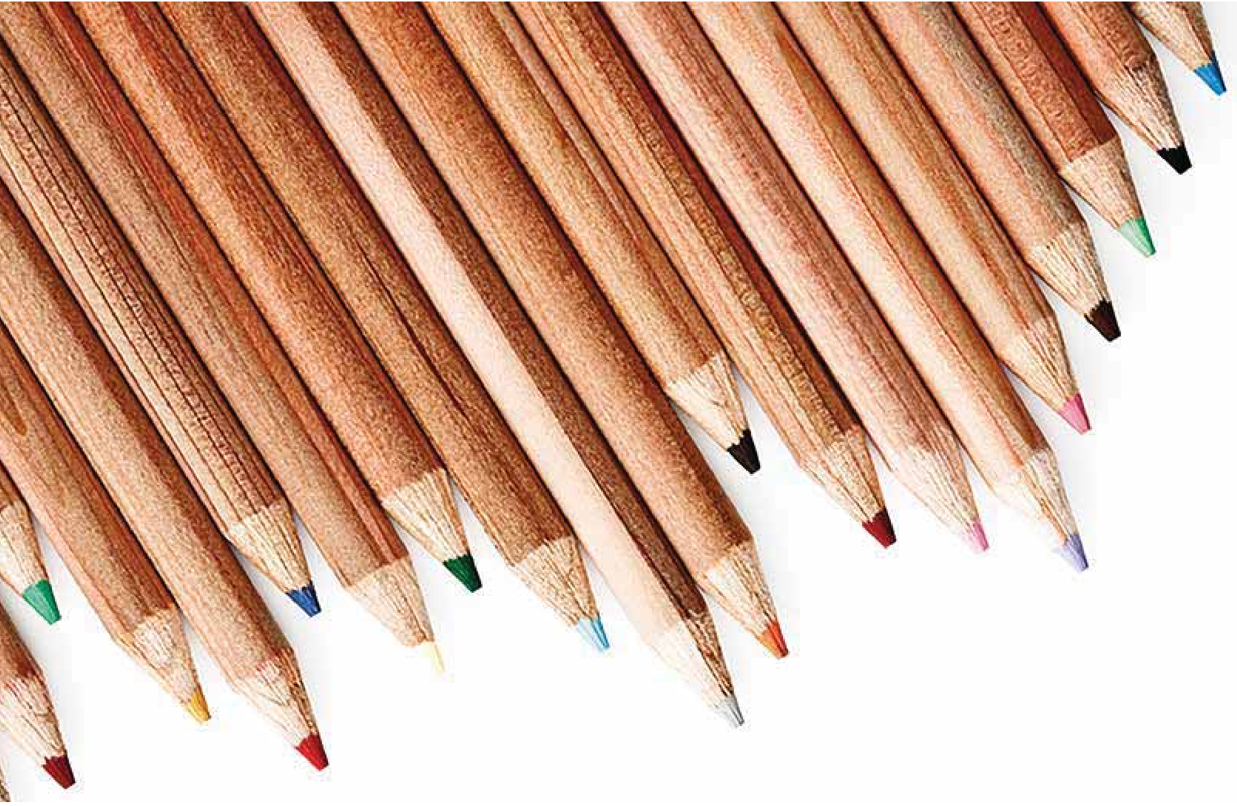
This research is not intended as a roadmap to system improvement; that was the theme of our 2010 report, which set out the interventions school systems need to undertake to move from poor to fair to good to great to excellent performance. Instead, this report examines five specific factors that we found to be particularly important to student outcomes: mindsets, teaching practices, information technology, hours of instruction, and early-childhood education.

The report's findings include the following five highlights:

Student mindsets have almost double the effect of socioeconomic background on outcomes:

It is hardly news that students' attitudes and beliefs—what we term their "mindsets" — influence their academic performance. The magnitude of this effect, and which mindsets matter most, is still under debate; and it is here that we focused our research. While there is likely a linkage between socioeconomics and student mindsets, we measured the effect of mindsets that is not explained by socioeconomics alone. By analyzing the PISA data, we found that mindset factors have almost double the predictive power (30 percent) compared to home environment and demographics (16 percent) on student PISA scores in Latin America. This relationship also holds true in all other regions, which reinforces the importance of this finding.

Some mindsets are more important than others. For example, we compared motivation calibration (being able to identify what motivation looks like in day-to-day life, including "working on tasks until everything is perfect" and "doing more than what is expected") to self-identified motivation ("wanting to be the best," and "wanting to get top grades"). In the 2015 PISA assessment, motivation calibration has more than twice the impact of self-identified ambition. Students who had good motivation calibration scored 14 percent (or 55 PISA points) higher on the science test than poorly calibrated ones. The relationship is particularly strong for students in poorly performing schools, where having a well-calibrated motivation mindset is equivalent to vaulting into a higher socioeconomic status. In these schools, students in the lowest socioeconomic quartile who are well-calibrated



perform better than those in the highest socioeconomic quartile who are poorly calibrated. In contrast, students with high self-identified motivation score just six percent higher than those without.

Other general mindsets that are predictive of student outcomes include having a strong sense of belonging at school and having low test anxiety. We also found that students with a strong growth mindset (those who believe they can succeed if they work hard) outperform students with a fixed mindset (those who believe that their capabilities are static) by 12 percent. Having a growth mindset was particularly predictive for students in poorly performing schools, for those in lower-income quartiles, and for boys.

The prevalence of beneficial mindsets varies between boys and girls. While girls are more likely to have strong motivation calibration and instrumental motivation, they are also more likely to have high levels of test anxiety.

To be clear, mindsets alone cannot overcome economic and social barriers, and researchers still debate the extent to which school-system-level interventions can shift student mindsets. Our research does, however, suggest that they matter a great deal, particularly for those living in the most challenging circumstances. The research on this subject is both nascent and predominantly U.S.-based. Considering its importance, local experimentation in Latin America and elsewhere should be a priority.

Students who receive a blend of inquiry-based and teacher-directed instruction have the best outcomes:

High-performing and fast-improving school systems require high-quality instruction. It's that simple. And that difficult. We evaluated two types of science instruction to understand how different teaching styles affect student outcomes. The first type is "teacher-directed instruction" where the teacher explains and demonstrates scientific ideas, discusses questions, and leads classroom discussions. The second is "inquiry-based teaching," where students play a more active role, creating their own questions and engaging in experiments. Our research found that student outcomes are highest with a combination of teacher-directed instruction in most or almost all classes, with inquiry-based teaching in some classes. If all students experienced this blend, average PISA scores in Latin America would rise 19 PISA points, equivalent to over half a school year of learning.

Given the strong support for inquiry-based pedagogy, this seems counterintuitive. We offer two hypotheses for these results. First, students cannot progress to inquiry-based methods without a strong foundation of knowledge, gained through teacher-directed instruction. Second, inquiry-based teaching is inherently more challenging to deliver, and teachers who attempt it without sufficient training and support will struggle. Better teacher training, high-quality lesson plans, and school-based instructional leadership can help. It's also important to note that some kinds of inquiry-

In poorly performing schools having a well-calibrated motivation mindset is equivalent to vaulting from the lowest to the highest socioeconomic quartile.

based teaching are better than others. For example, explaining how a science concept can be applied to a real-world situation appears to boost outcomes, whereas having students design their own experiments does the opposite.

While technology can support student learning outside of school, its record inside school is mixed. The best results come when technology is placed in the hands of teachers:

Screens are not the problem when it comes to student outcomes—but neither are they the answer. Our research examined the impact of first exposure to information and communications technologies (ICT), and the impact of ICT for 15 year olds - at home and also during school. Students with their first digital exposure before the age of 6 score 45 PISA points higher than those exposed at age 13 or later (controlling for socioeconomic status, school type, and location). Higher socioeconomic status students are more likely to start using devices at an early age, which has worrying implications for the equity gap.

At home, two to four hours of Internet use per day for 15-year-olds is associated with the highest science performance, 46 PISA points higher than for students with no after-school Internet use (again, after controlling for socioeconomic status, school type, and location). Notably, more than half the benefit of after-school use is captured with just 31 to 60 minutes of Internet use a day. There appears to be declining impact (and possibly negative behavioral implications) when students spend four hours or more a day before a screen.

The impact of ICT use on students during the school day is much more mixed: from minus-40 to plus-46 PISA points, depending on the type of hardware. Most important, we found that deploying ICT to teachers, rather than students, works best. For example, adding one data projector per classroom leads to a marked increase on students' PISA science performance, over 30 times as much as adding one student computer to the same classroom. Some student-based classroom technologies, such as tablets and e-book readers, actually appear to hurt Latin American student performance. These results describe the impact of education technology as currently implemented, not its eventual potential. They evaluate only hardware, not software, and do not account for rapid evolution. Even so, Latin American leaders should not assume the impact of ICT will always be positive or even neutral. Systems should ensure that ICT programs are fully integrated with curriculum and instruction, and are supported by teacher professional development and coaching.

Increasing the school day improves outcomes - up to seven hours per day. Significant gains can also be made from using existing time better:

School facilities are stressed in many parts of Latin America, with buildings often hosting two shifts of students daily. One consequence is that many students simply don't spend that much time in school. Although the regional average is five hours per day, 15 percent of students are in school 4.5 hours a day or less. A number of countries, including Brazil and Colombia, are therefore seeking to end school sharing and extend the school day.

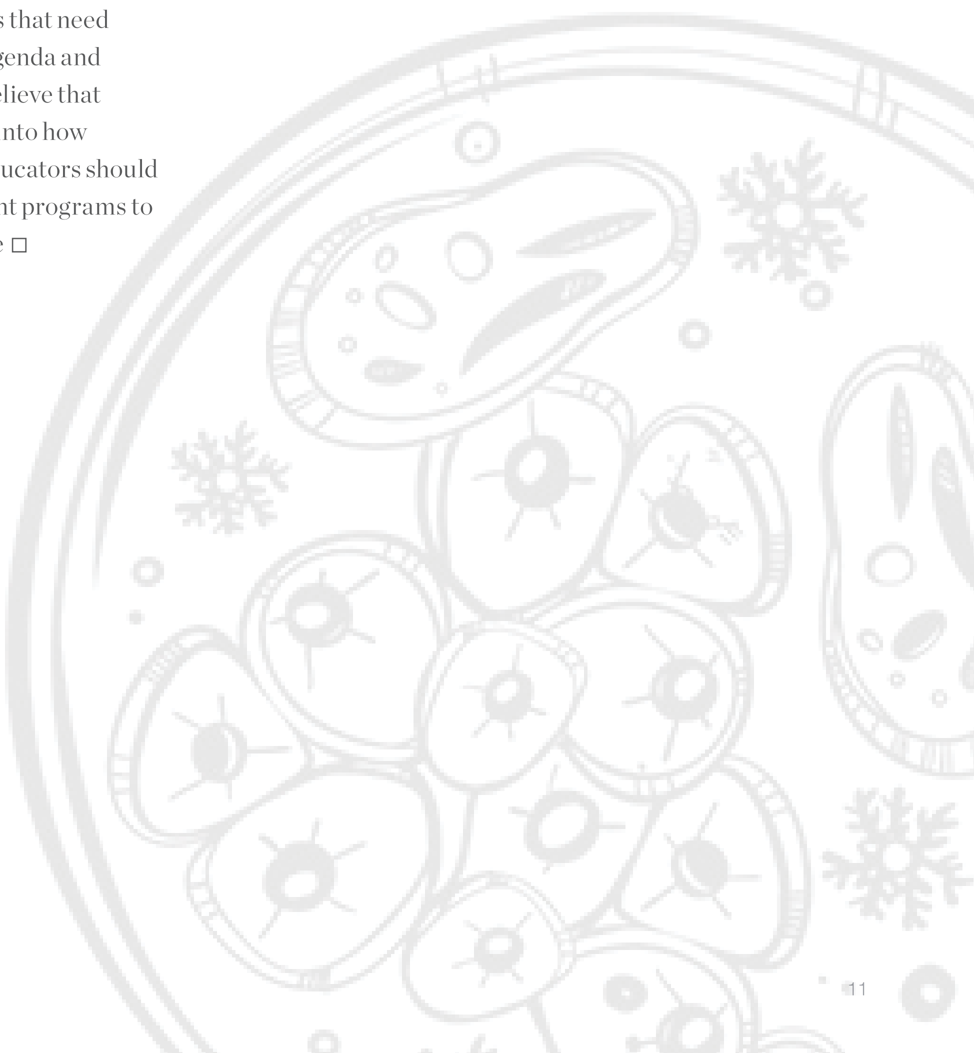
It makes intuitive sense that spending more time in school should improve performance, and the PISA results bear that assumption out. Across Latin America, PISA science outcomes increase by 3.7 percent (or 14 PISA points) for every 30 minutes of additional daily classroom instruction, up to seven hours per day. If all students performed at the level of those currently receiving 6.5 to 7 hours of instruction per day, this would boost average science achievement by about 35 PISA points across the region. But extending the school day is costly, requiring more infrastructure and teachers. Another option to increase hours of instruction is lengthening the school year; however, recent research in Mexico showed diminishing marginal returns to additional days in school at present quality levels. Indeed, Latin American countries are among the least productive of all the countries that take PISA in terms of PISA points per hour-in-school, partly because only 65 percent of classroom time is actually used for learning in several countries; versus an OECD benchmark of 85 percent. Ultimately, systems will need to both increase the number of hours in school and the quality of each hour. In the short term, they can make important strides in improving student learning for every existing hour in school by ensuring they are minimizing non-instructional time, and by raising teacher quality through coaching and professional development.

Early childhood education had a positive academic impact on today's 15 year olds, however low income students received less benefit than high income ones:

Many studies have shown that quality early-childhood education (ECE) improves social and academic outcomes, although there are some concerns about fade-out in later years. Our findings, like other research, validate the overall positive impact of ECE at age 15, but show that there is a trade-off between increasing access and ensuring quality.

On the whole, students with some ECE perform eight percent better on the PISA science test a decade later, but there are troubling differences among students from different backgrounds. High socioeconomic status children get over double the benefit of lower socioeconomic status children, and they benefit at every age, with the highest scores when starting at age two. Lower socioeconomic status children have the highest scores when starting at age four. This highlights the importance of investing in good quality ECE especially for lower income children.

As we share these five findings, we are mindful of their limits. One cannot find definitive answers from a single source, no matter how broad or well designed. The direction of causality, sample sizes, missing variables, and nonlinear relationships are other issues. There are still many questions that need to be resolved through a thoughtful research agenda and longitudinal experimentation. That said, we believe that these five findings provide important insights into how students succeed—and that Latin American educators should incorporate them into their school improvement programs to deliver the progress that their students deserve □



introduction

Effective education is essential to forge economic productivity, address inequality, and prepare children for constructive citizenship. No wonder, then, that there is broad interest in understanding how to build school systems that serve everyone well, regardless of background, and how to improve systems that are not making the grade.

For the past decade, McKinsey has studied these issues. In 2007, we published *How the world's best-performing school systems come out on top*, which examined why some school systems consistently perform better than others. This report highlighted the importance of getting the right people to become teachers, developing their skills, and ensuring that the system is able to offer the best possible instruction to every child. In 2010, *How the world's most improved school systems keep getting better* explored what it takes to achieve significant and sustained performance improvement. This report defined poor, fair, good, great and excellent systems (see the analytical appendix for more detail) and outlined what school systems need to do to progress from one performance level to the next[1] (Exhibit 1).

These two reports focused on interventions at the system level. In this report, we undertake a quantitative analysis at the student level. To do so, we applied advanced analytics and machine learning to develop insights from the world's deepest and broadest education data set, the Program for International Student Assessment (PISA), run by the Organisation for Economic Co-operation and Development (OECD).

Begun in 2000 and repeated every three years since, PISA examines 15-year-olds on applied mathematics, reading, and science. The most recent assessment, in 2015, covered nearly 540,000 students in 72 countries. PISA test-takers also answer a rich set of attitudinal questions; students, teachers, parents, and principals completed surveys that provided

EXHIBIT 01: OUR 2010 REPORT OUTLINED WHAT INTERVENTIONS ARE REQUIRED AT EACH STAGE OF THE SCHOOL SYSTEM IMPROVEMENT JOURNEY

IMPROVEMENT JOURNEY	POOR TO FAIR	FAIR TO GOOD	GOOD TO GREAT	GREAT TO EXCELLENT
THEME	*Achieving the basics of literacy and numeracy*	*Getting the foundations in place*	*Shaping the professional*	*Improving through peers and innovation*
INTERVENTION CLUSTER	• **Providing motivation and scaffolding for low skill teachers** – Scripted teaching materials – External coaches – Instructional time on task – School visits by center – Incentives for high performance • **Getting all schools to a minimum quality level** – Outcome targets – Additional support for low performing schools – School infrastructure improvement – Provision of textbooks • **Getting students in seats** – Expand school seats – Fulfil students' basic needs to raise attendance	• **Data and accountability foundation** – Transparency to schools and/or public on school performance – School inspections and inspections institutions • **Financial and organizational foundation** – Optimization of school and teacher volumes – Decentralizing financial and administrative rights – Increasing funding – Funding allocation model – Organizational redesign • **Pedagogical foundation** – School model/ streaming – Language of instruction	• **Raising calibre of entering teachers and principals** – Recruiting programs – Pre-service training – Certification requirements • **Raising calibre of existing teachers and principals** – In-service training programs – Coaches – Career tracks – Teacher and community forums • **School-based decision-making** – Self-evaluation – Independent and specialized schools	• **Cultivating peer-led learning for teachers and principals** – Collaborative practice – Decentralizing pedagogical rights to schools & teachers – Rotation and secondment programs • **Creating additional support mechanisms for professionals** – Release profession-als from admin burden by providing additional administrative staff • **System-sponsored experimentation/ innovation across schools** – Providing additional funding for innovation – Sharing innovation from front-line to all schools
COMMON ACROSS ALL JOURNEYS	Six interventions: [1] Revising curriculum and standards; [2] Reviewing reward and remunerations structure; [3] Building technical skills; [4] Assessing student performance; [5] Utilizing student learning data, and [6] Establishing policy documents and education laws			

EXHIBIT 02: PISA IS A RICH SET OF ASSESSMENT AND SURVEY DATA[3]

OECD PISA test performance + survey data

72 countries[1]	18,000 schools	140,000 parents	110,000 teachers	540,000 students
3 subjects	~270 school variables	~150 parent variables	~250 teacher variables	~770 student variables
• Math • Science • Reading	E.g., • Size • Resources • Governance and autonomy • Extra-curriculars	E.g., • Education • Income • Employment • Attitudes to school and education	E.g., • Experience • Certification • Professional development • Teaching strategies • Assessment strategies	E.g., • Attitude to study and learning • Growth mindset • Problem solving approach • Repeated grade • Economic and social status

Linked over time through mapping of variables across 2003–2006–2009–2012–2015
1 Report analysis excludes Albania: includes Kazakhstan, Malaysia, Argentina

information on home environment, economic status, student mindsets and behaviors, school resources and leadership, teaching practices, teacher background, and professional development (Exhibit 2). The 2015 PISA focused on scientific performance, with half of the student assessment related to science, and the other half split between reading and math[2]. The survey questions therefore largely addressed science teaching and learning.

Standardized tests have their shortcomings. They cannot measure important soft skills or non-academic outcomes, and they are subject to teaching-to-the-test and gaming the system. Even so, we believe that PISA provides powerful insights on global student performance, especially because it aims to test the understanding and application of ideas, rather than facts derived from rote memorization.

In this report, we examine educational performance in Latin America, specifically in terms of the ten countries in the region that took PISA in 2015: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Mexico, Peru, Trinidad and Tobago, and Uruguay.[4] While we concentrate on the 2015 PISA results, we also consider previous ones, using a range of traditional and advanced analytical techniques.

First, we used a supervised machine learning and feature discovery tool that identified variables and groups of variables that were most predictive of student performance. We then applied more traditional descriptive and statistical analyses to factors that were shown to be most important in contributing to students' PISA performance. (For more, see the analytical appendix at the end of the report.)

We looked not only at macro performance, but also at how patterns differed by the system performance levels outlined in our 2010 report, and by students' economic, social, and cultural status (or ESCS; see the analytical appendix for an explanation). Our research resulted in five key findings, regarding mindsets, duration of classroom instruction, teaching practices, information technology, and early-childhood education. These five findings emerged as both highly predictive of student performance and potentially responsive to school system interventions, and therefore should be subject to further exploration.

In what follows, we first examine Latin America's education performance in historical terms and then discuss each of the five findings, before suggesting possible implications for school systems. Our intention is to offer insights that policymakers and practitioners can use to make improvements □

setting the context:

Latin America's educational performance

Educational performance can be measured in terms of overall quality (absolute scores), cost-effectiveness (performance per dollar spent) and equity (differences in performance between boys and girls, and among different economic and ethnic groups).

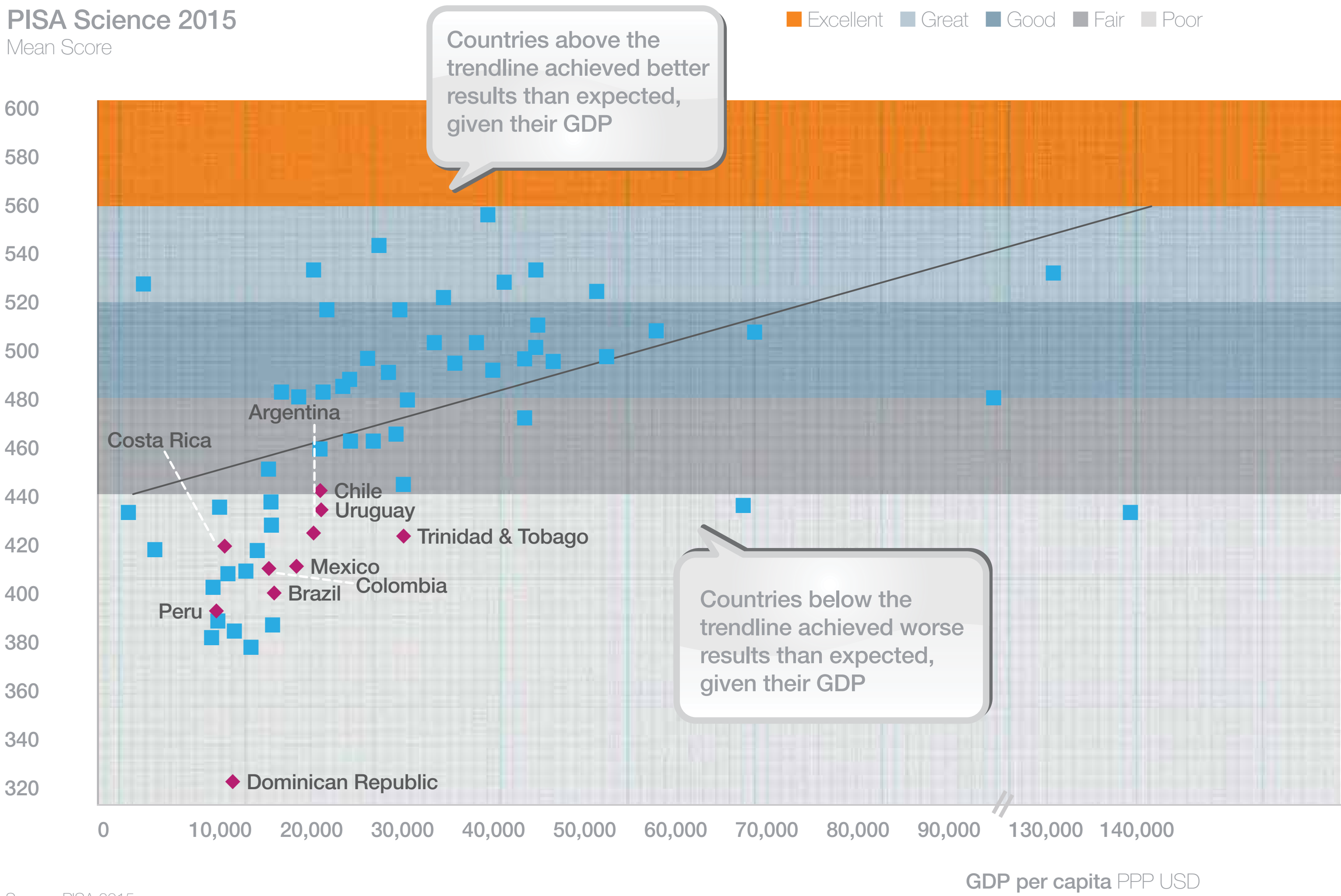
In terms of overall quality, Latin America's PISA scores are well below the OECD average in math, reading, and science (Exhibit 3).

EXHIBIT 03: LATIN AMERICA'S PISA SCORES ARE BELOW THE OECD AVERAGE IN ALL SUBJECTS

Science 2015			**Reading** 2015			**Math** 2015		
Rank	Country	Mean	Rank	Country	Mean	Rank	Country	Mean
1	Singapore	556	1	Singapore	535	1	Singapore	564
2	Japan	538	2	Hong Kong (China)	527	2	Hong Kong (China)	548
3	Estonia	534	3	Canada	527	3	Macao (China)	544
4	Chinese Taipei	532	4	Finland	526	4	Chinese Taipei	542
5	Finland	531	5	Ireland	521	5	Japan	532
	OECD	493		OECD	493		OECD	490
43	Chile	447	41	Chile	459	41	Chile	423
47	Uruguay	435	45	Uruguay	437	45	Uruguay	418
	Argentina	432	51	Costa Rica	427	53	Trinidad & Tobago	417
53	Trinidad & Tobago	425	52	Trinidad & Tobago	427		Argentina	409
56	Costa Rica	420	55	Colombia	425	56	Mexico	408
57	Colombia	416		Argentina	425	59	Costa Rica	400
58	Mexico	416	55	Mexico	423	61	Colombia	390
63	Brazil	401	59	Brazil	407	62	Peru	387
64	Peru	397	63	Peru	398	65	Brazil	377
66	Tunisia	386	66	Dominican Republic	358	66	FYROM	371
67	FYROM	384	67	FYROM	352	67	Tunisia	367
68	Kosova	378	68	Algeria	350	68	Kosova	362
69	Algeria	376	69	Kosovo	347	69	Algeria	360
70	Dominican Republic	332	70	Lebanon	347	70	Dominican Republic	328

1 Data represented across report is Argentina, not Argentina-CABA, despite the fact that Argentina's results may not be comparable to previous years; Argentina accounts for 7% of represented Latin America population
Source: PISA 2015

EXHIBIT 04: LATIN AMERICAN COUNTRIES PERFORM WORSE THAN EXPECTED GIVEN THEIR GDP PER CAPITA



Source: PISA 2015

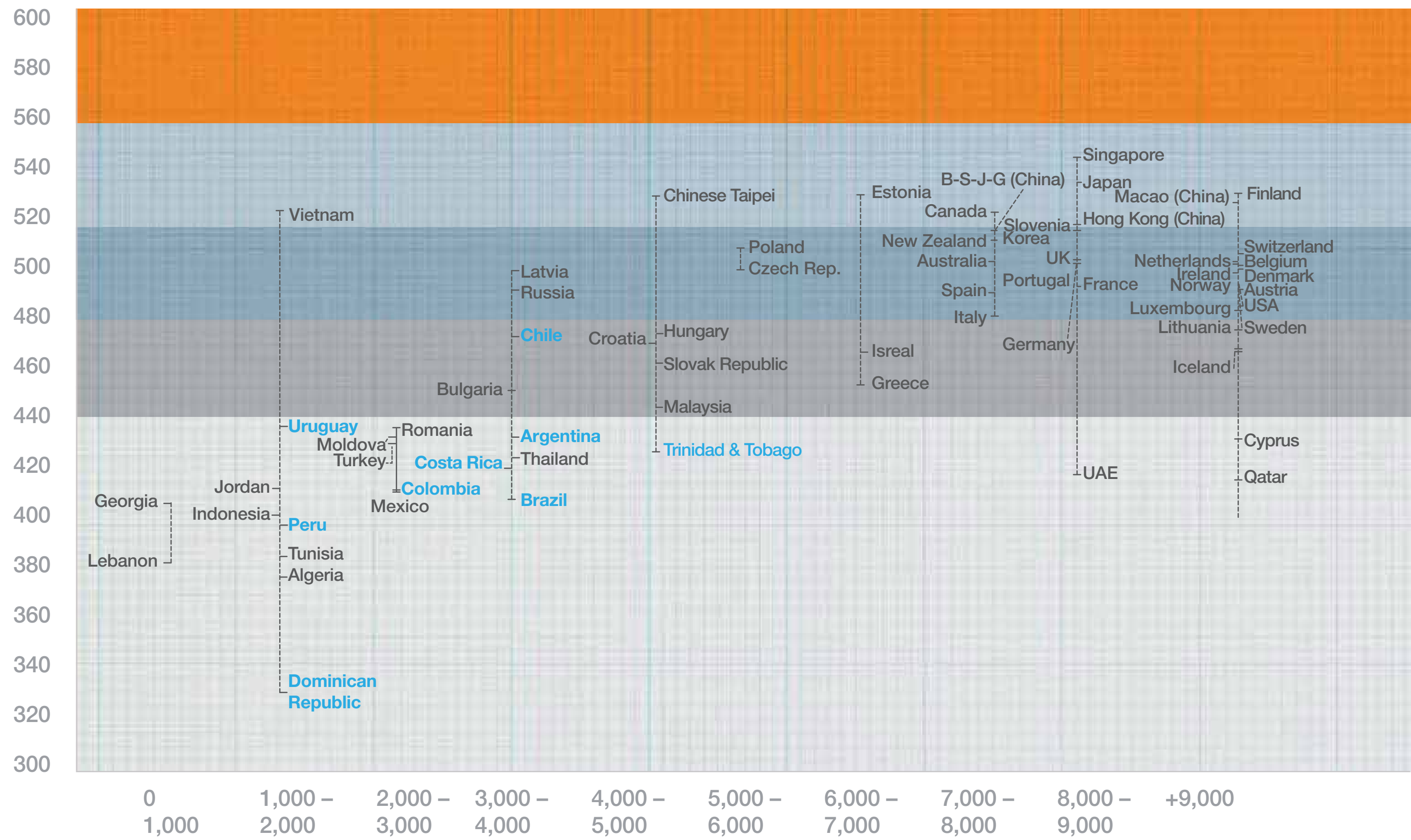
When compared with global peers with similar levels of GDP and education spending, Latin America does not perform well either, suggesting low cost-effectiveness (Exhibit 4 and 5).

Even Latin American countries that perform relatively well are struggling with equity. The percent of score explained by economic, social, and cultural status is more than 15 percent in Chile, Costa Rica, and Uruguay, and more than 20 percent in Argentina and Peru. The global average is 13 percent (Exhibit 6).

EXHIBIT 05: OTHER COUNTRIES AND REGIONS ACHIEVE BETTER RESULTS AT SIMILAR LEVELS OF SPENDING

2015[1] PISA science
Mean Score

Excellent | Great | Good | Fair | Poor



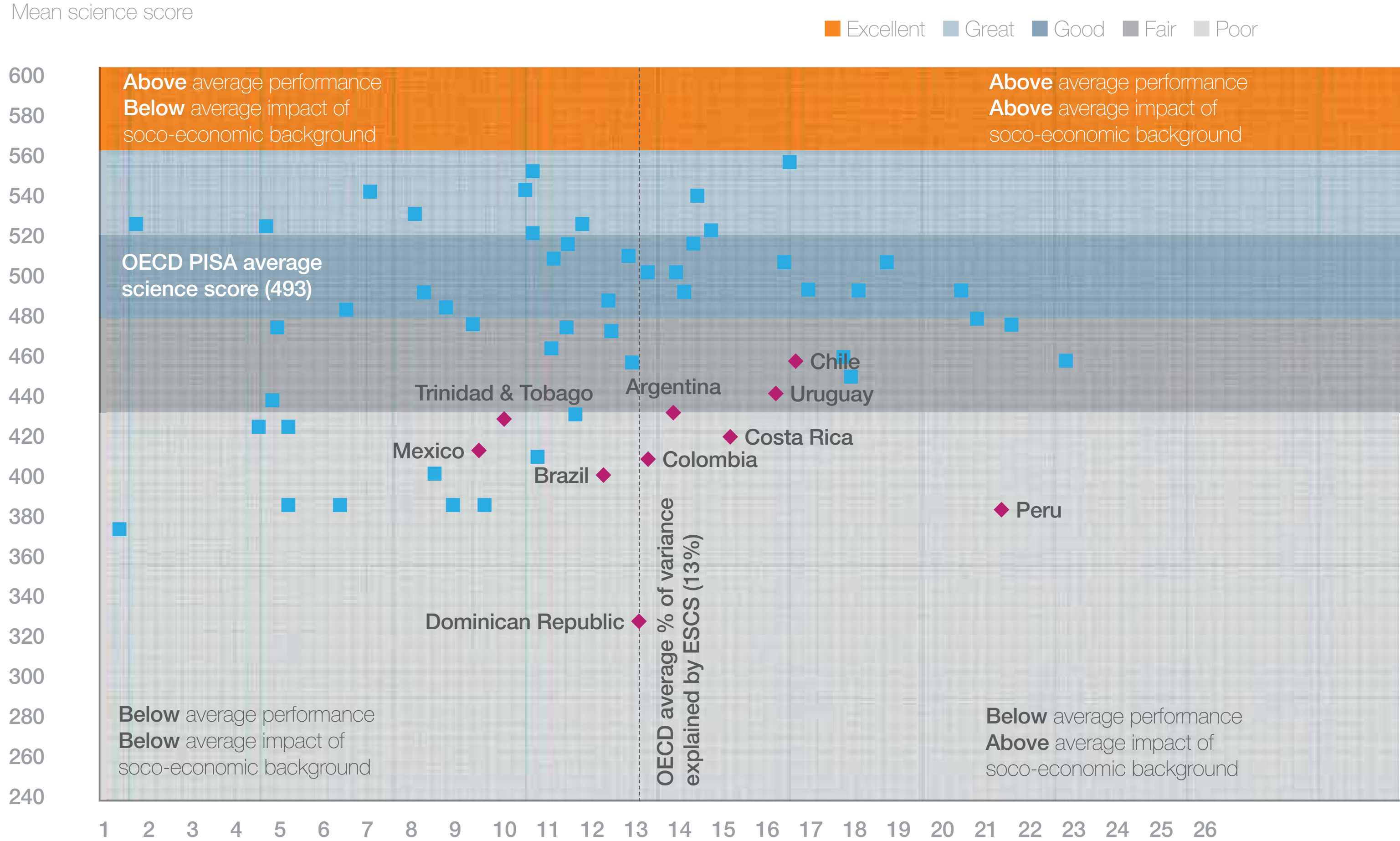
Public spend per student, PPP USD

1 If 2015 was not available, most recent year was used.
Source: Global Insight; IMF; PISA; UNESCO; World Bank EdStats; McKinsey analysis

EXHIBIT 06: THE INFLUENCE OF SOCIO-ECONOMIC BACKGROUND ON PERFORMANCE VARIES SIGNIFICANTLY

Latin America: Impact of socio-economic background on performance

Mean science score



Degree to which socio-economic background determines score

(% of variance explained by PISA's index of economic social and cultural status)

Source: PISA 2015

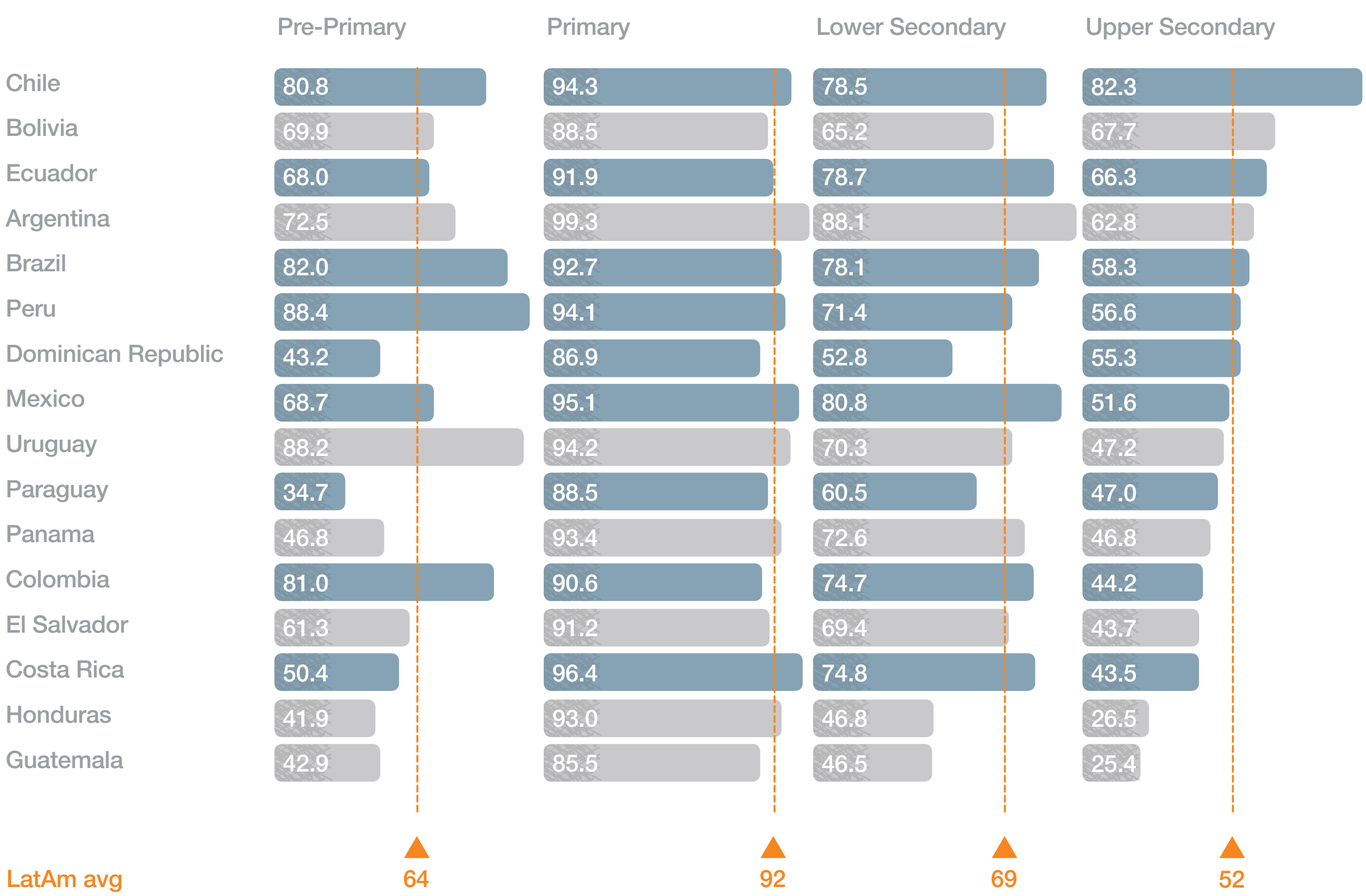
Looking beyond PISA, data from UNESCO show that enrollment rates in Latin America drop off sharply at the upper secondary level (typically age 15 or 16). This leaves more than 14 million Latin American children out of school (Exhibit 7).

Over the past several PISA cycles, Latin American reading, science, and math scores have improved. Reading has improved the most, up 6.6 percent change between 2006 and 2015. Science scores increased 4.1 percent and math 2.5 percent (Exhibit 8). It bears remembering that these improvements are from a low base, and are not enough to pull the continent as a whole out of the "poor" performance band.

EXHIBIT 07: LATIN AMERICAN COUNTRIES STRUGGLE WITH SECONDARY ENROLLMENT

Net enrollment rate by level of education,[1] 2015[2]
(%)

PISA 2015 participant



1 As defined according to the International Standard Classification of Education (ISCED): pre-primary: ISCED level 0 includes preschool and kindergarten programs; primary: ISCED level 1 typically begins between ages 5 and 7 and lasts for 4-6 years; lower secondary: ISCED level 2 begins around the age of 11, the equivalent of intermediate school, middle school, or junior high school; upper secondary: ISCED level 3 immediately follows lower-secondary education and includes general (academic), technical, and vocational education, the equivalent of high school.
2 If 2015 was unavailable, latest data available were used.
Source: UNESCO

EXHIBIT 08: READING AND SCIENCE SCORES HAVE IMPROVED MORE THAN MATH SCORES SINCE 2006

Change in average Latin America PISA score over time
PISA score

Source: PISA 2015

Looking at the country level, Colombia and Peru stand out for sustained performance improvements. Only Chile, however, has climbed out of the "poor" performance band (Exhibit 9).

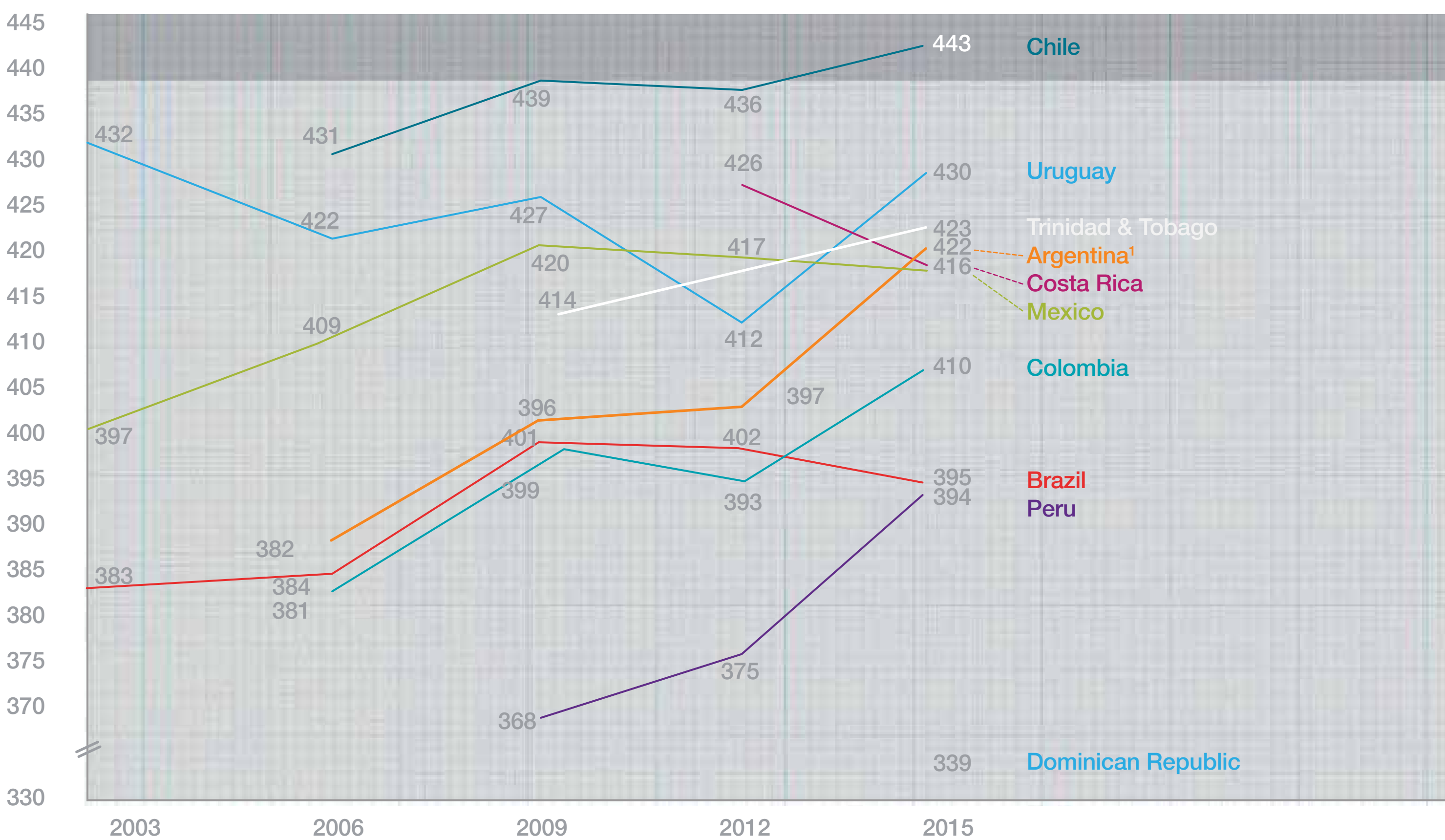
In terms of equity, there have been some meaningful improvements in narrowing the performance gap between wealthy and poor students since 2006 (Exhibit 10).[5]

These improvements are heartening, but the pace is slow. In our 2010 report, we showed that fast-improving systems moved up to the next level—that is, from poor to fair to good to great to excellent—every six years. At current rates of progress, even Latin America's top improvers will take 10 to 12 years to reach the next level.

EXHIBIT 09: IMPROVEMENT HAS BEEN UNEVEN

PISA composite score (average of science, reading, and math scores)

Fair Poor



1 Argentina results in 2015 have sampling issues therefore trend should not be fully trusted.
Source: PISA 2015

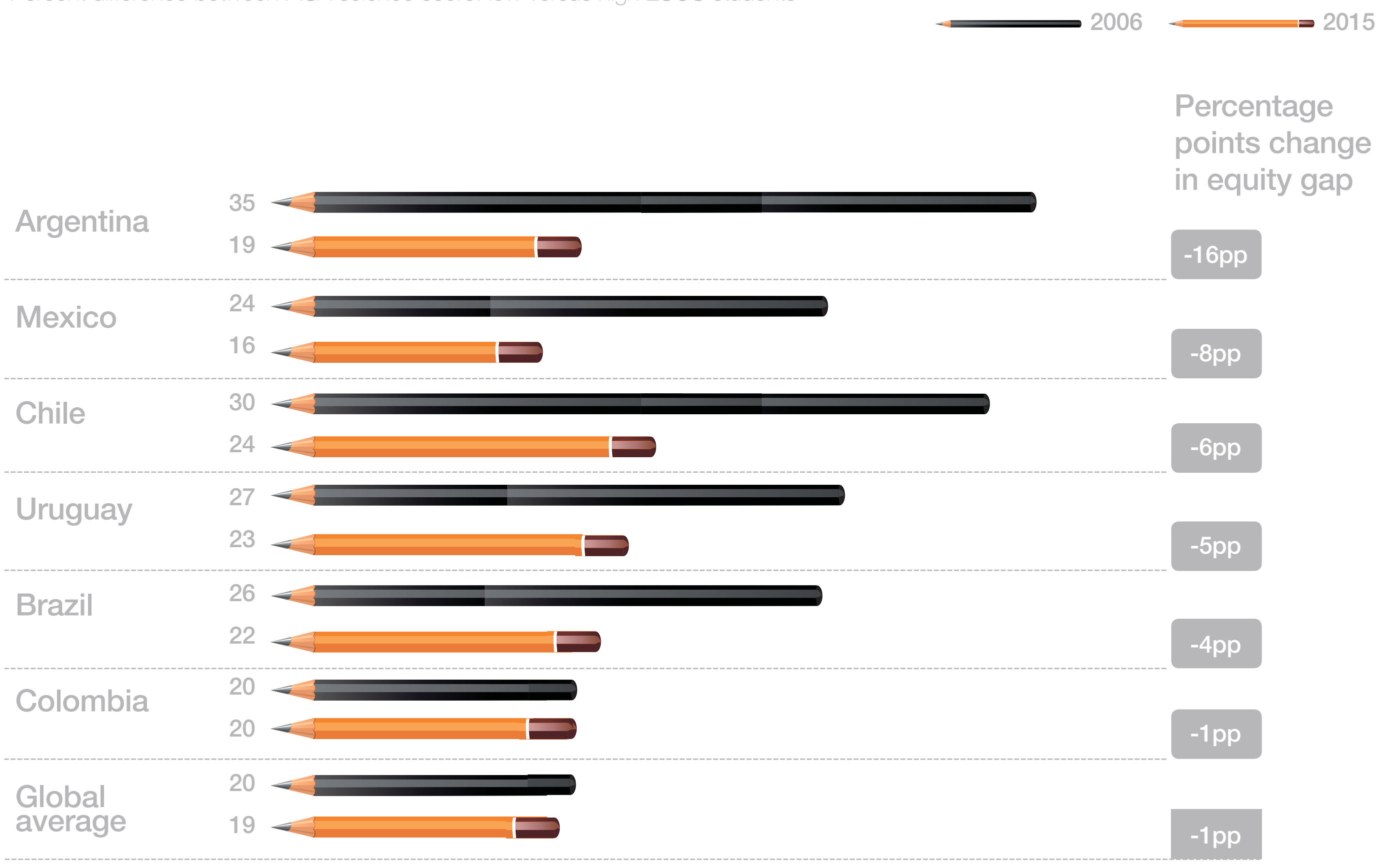
For school systems in the poor-to-fair stage of improvement—meaning everywhere in Latin America except Chile—the 2010 report defined three priorities: enrolling students, getting all schools to a minimum quality level, and providing motivation and training for low-skilled teachers. In addition, we highlighted six interventions that are important at every stage: revising curriculum and standards; reviewing reward and remunerations structure; building technical skills; assessing students; using student learning data, and establishing policy documents and education laws.

The insights from this report delve deeper on a few of these system priorities, and add new insights gained from student level analysis. What mindsets are most beneficial for students? What does great teaching

EXHIBIT 10: ALL LATIN AMERICAN COUNTRIES THAT TOOK PISA IN BOTH 2006 AND 2015 NARROWED THE EQUITY GAP

Equity gap in science scores from 2006-2015

Percent difference between PISA science score: low versus high ESCS students[1]



1 Low ESCS = Quartile 1 ESCS High ESCS = Quartile 4 ESCS. Numbers may not add due to rounding

look like? How long should students stay in school? What is the role of technology? When should education begin? The following five findings, based on the PISA data, complement our previous work by exploring these questions □

Finding 1: Student mindsets have almost double the impact of socioconomic background on outcomes

The role of mindsets in educational achievement is a nascent but intriguing field of study. In her 2006 book, *Mindset: The New Psychology of Success*, Carol Dweck argued that individuals with "growth mindsets"—that is, those who believed that their success was due to hard work and learning—were more resilient and likely to be motivated to succeed than those with "fixed mindsets"—those who believed that their innate abilities were static and could not be developed. Dweck also argued that growth mindsets could be taught. A large-scale 2016 Stanford study of all 10th graders in Chile—the largest to date—found that having a strong growth mindset rivals socioeconomic status in predicting achievement, and that low-income students with strong growth mindsets were able to achieve at the same level as high-income students with fixed mindsets.[6]

In 2016, Angela Duckworth highlighted the importance of "grit" as a predictor of performance in *Grit: The Power of Passion and Perseverance*. Others have explored the role of broader character traits like perseverance, curiosity, conscientiousness, optimism, and self-control in children's success. Other researchers, however, have questioned both the magnitude of the effect, and the usefulness of interventions in this area.[7]

We had three objectives in reviewing the role of mindsets: to quantify the impact of mindsets on student performance; to assess which mindsets matter most; and to understand which types of schools and students benefit the most from certain mindsets.

To quantify the impact of mindsets, we sorted the 100 most predictive variables (see the analytical appendix for more detail) emerging from the PISA surveys into a number of specific categories: mindset factors, home environment (including socioeconomic status), school factors, teacher factors, student behaviors, and others. We separated mindsets into two types: "subject orientation" and "general mindsets." Subject orientation refers to a student's attitudes about science as a discipline (science, specifically, because that was the focus of the 2015 PISA). General mindsets refer to a student's broader sense of belonging, motivation, and expectations.

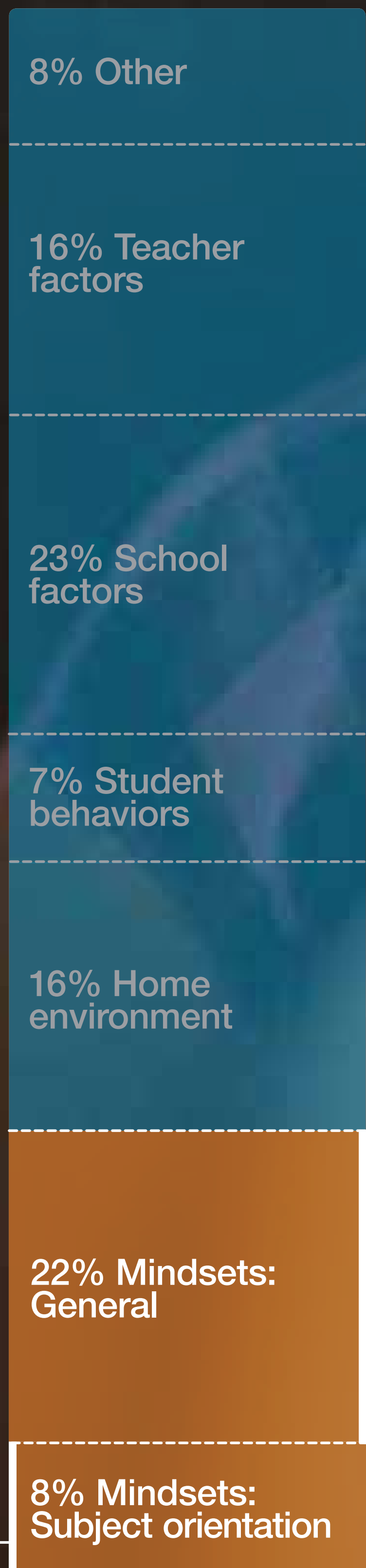
To be conservative, we excluded from the analysis variables where we believed the direction of causality was largely from score-to-mindset rather than from mindset-to-score. For example we judged that students' academic performance is more likely to influence their future educational expectations (whether they will complete college) than the other way around, and thus excluded this variable from our model.

We then determined how influential each category was in terms of predicting student performance. Our conclusion: controlling for all other factors, student mindsets are almost twice as powerful (at 30 percent of total predictive power) as home and demographic factors[8] (Exhibit 11). Furthermore, general mindsets accounted for two-thirds of the effect found. The same pattern held true in all five regions, reinforcing the importance of this finding.

EXHIBIT 11:
MINDSETS ECLIPSE EVEN HOME ENVIRONMENT IN PREDICTING STUDENT ACHIEVEMENT[9]

Factors driving LatAm students OECD PISA science performance 2015

% of predictive power by catagory of variable



“I have fun learning science.

I am interested in the universe and its history.

Air pollution will get worse over the next 20 years.”

“I see myself as an ambitious person.

What I learn in school will help get me a job.

I feel like I belong at school.

If I put in enough effort I can succeed.”

Source: OECD PISA 2015, McKinsey analysis

EXHIBIT 12: WHAT MINDSETS MATTER MOST?

LATAM score improvement for top general mindset measures[1]
Percent increase in PISA score

Mindset	Percent increase	Description
Motivation calibration	14	From low to high ability to identify what motivation looks like in day-to-day life
Growth mindset[2]	12	From fixed to strong growth mindset
Sense of belonging	8	From low to high belonging in school
Motivation	6	From low to high desire to succeed
Test anxiety	5	From high to low test anxiety

1 Statistically significant in regression with standard controls
2 Growth mindset not asked in 2015 thus using 2012 data
Source: OECD PISA 2015, McKinsey analysis

EXHIBIT 13: WHAT IS MOTIVATION CALIBRATION?

Student evaluation of the motivation of other students: "Is the following student motivated?"

"Mariana gives up easily when confronted with a problem and is often not prepared for class."

"Carlos mostly remains interested in the tasks he starts and sometimes does more than what is expected from him."

"Lucia wants to get top grades at school and continues working on tasks until everything is perfect."

Source: OECD PISA 2015, McKinsey analysis

Our research also found that some specific mindsets are more important than others in improving student outcomes (Exhibit 12).

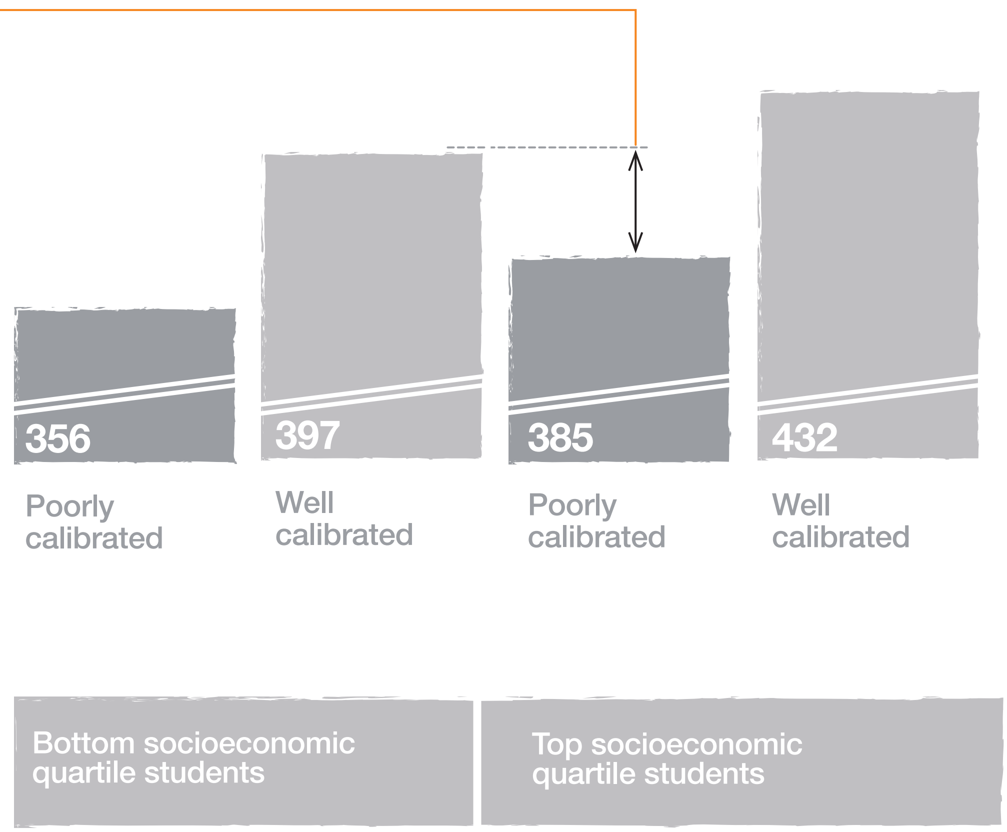
"Motivation calibration" is the most important factor. This term refers to the ability of students to correctly assess what motivation looks like, such as "working on tasks until everything is perfect" and "doing more than what is expected." To measure this, PISA asked test-takers to assess the motivation of three hypothetical students (Exhibit 13).

Based on the responses to these questions, we created an index of motivation calibration (see the analytical appendix). What we found was that simply understanding what motivation looks like in daily practice is a powerful performance indicator. Across Latin America, students who have good motivation calibration score 14 percent (or 55 PISA points) higher than poorly-calibrated students. This relationship holds even after controlling for socioeconomic status, location, and type of school. In contrast, students who self-identify as "wanting to be the best and wanting top grades" score just six percent higher than those who do not. Why is this the case? Our hypothesis is that students are more likely to be honest

EXHIBIT 14: HAVING A WELL-CALIBRATED MOTIVATION MINDSET IS EQUIVALENT TO LEAPFROGGING INTO A HIGHER SOCIO-ECONOMIC QUARTILE

Latin America poorly performing schools, average PISA science score

Within poor schools, students with low socioeconomic status and high motivation calibration perform better on PISA than students with high socioeconomic status who are poorly calibrated.[1]



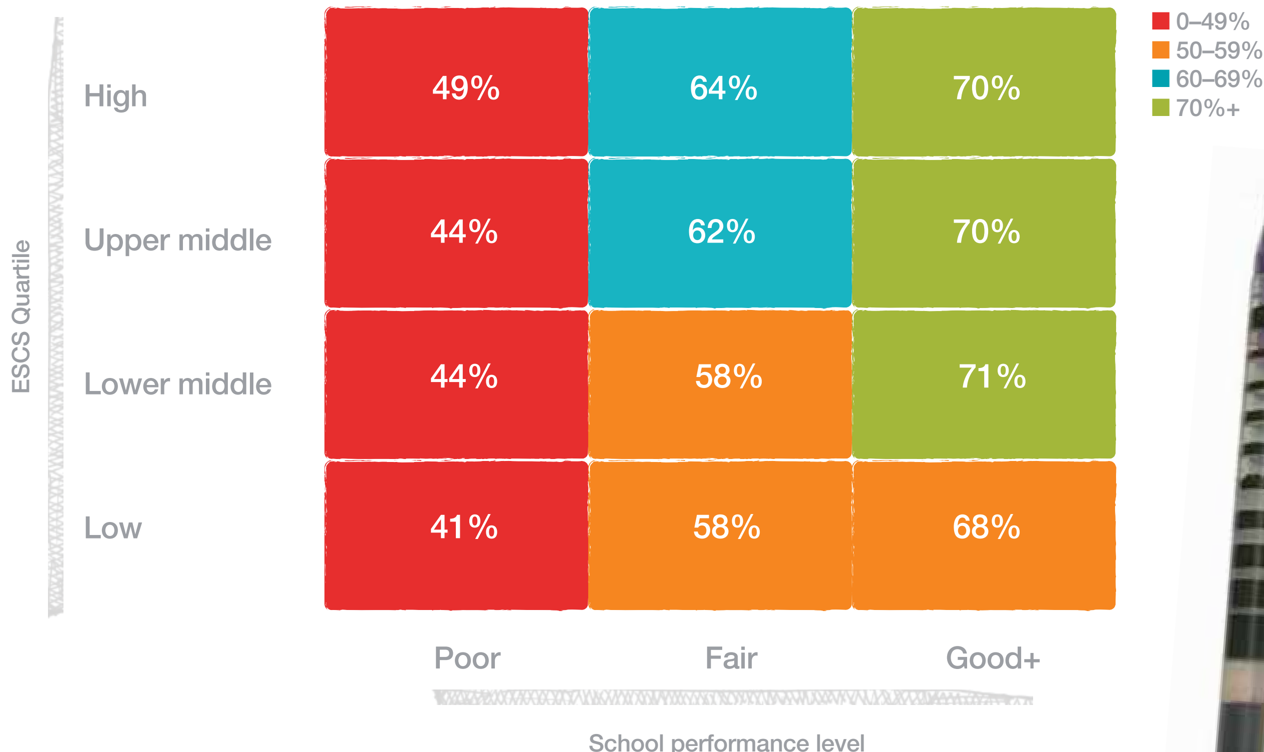
1 Using PISA's economic, social, and cultural status index as a proxy for socioeconomic status; looking within poorly performing schools, which serve 76% of Latin American students.
Source: OECD PISA 2015, McKinsey analysis

when talking about a third person versus directly assessing their own motivation, and that calibration itself is actually important. Students cannot exhibit positive behaviors if they do not know what they look like. Calibrating to a norm helps to improve students' actual study habits.

The relationship between motivation calibration and PISA scores is twice as strong for students in poorly performing schools as for those in fair or good schools. (More than three-quarters of Latin American students are in poor schools.) In fact, for those in poorly performing schools, having a well calibrated motivation mindset is equivalent to vaulting into a higher socioeconomic status. Students in the lowest socioeconomic status quartile who are well calibrated perform better than those in the highest socioeconomic status quartile who are poorly calibrated (Exhibit 14).

EXHIBIT 15: POOR STUDENTS IN POORLY PERFORMING SCHOOLS ARE THE LEAST LIKELY TO HAVE GOOD MOTIVATION CALIBRATION

% of LatAm students with well-calibrated motivation



Source: OECD PISA 2015, McKinsey analysis

Unfortunately, the students in poor schools who would most benefit from high motivation calibration are least likely to have it—only 41 percent of low-socioeconomic status students compared with 70 percent of high socioeconomic status students in good schools (Exhibit 15). Girls and boys also have difference prevalence of motivation calibration: while 51% of Latin American girls are well-calibrated just 46% of boys are.

These findings are consistent with those of previous PISA tests. In 2012, for example, PISA asked about growth versus fixed mindsets. Specifically, students answered questions about the extent to which they agreed that their academic results were fixed (“I do badly whether or not I study”) or could be changed through personal effort (“If I put in enough effort I can succeed” or “If I wanted to, I could do well”). Students with a strong growth mindset outperformed students with a fixed mindset by 12 percent. Growth mindsets were particularly predictive for students in poorly performing schools and those in lower socioeconomic quartiles.

Using the example of motivation calibration, we investigated how scores might improve across the region if mindsets could be changed. If the 51 percent of students with low motivation calibration could become well calibrated, and if the relationship between calibration and score held constant, outcomes would improve by 6.8 percent (28 PISA points), equivalent to three-quarters of a year of schooling.

To be clear, mindsets alone cannot overcome economic and social barriers. This research does suggest, however, that they are a powerful predictor of student outcomes, particularly for those living in the most challenging circumstances. The question is what, if anything, can be done to improve mindsets at a system-wide level. Research is being done to answer that question—albeit much of it focused on the United States—and there are promising indications that it may be possible for schools to make effective interventions.

For example, on growth mindsets, a 2015 study of 1,500 secondary school students in 13 different schools, rich and poor, from all over the United States, found that growth mindset and sense-of-purpose interventions delivered significant results. The researchers administered two 45-minute online modules to students over the course of a semester. The growth-mindset modules provided direct instruction on the physiological growth potential of the brain given hard work; they also guided students through writing exercises in which they summarized what they had learned

and coached a theoretical student who was losing confidence in his intelligence. In the sense-of-purpose module, students did a writing exercise on how they wished the world could be a better place; provided examples of why other students work hard; and finished with another writing exercise in which students explained how working hard could help them achieve their own goals. The results were positive: Students at risk of dropping out of high school, constituting a third of the sample, increased their grade point averages (GPA) in core academic courses by 0.13 to 0.18 (on a 4.0 scale), and their core course pass rates increased by 6.4 percent.[10]

Similarly, on motivation calibration, recent research suggests that meta-cognition and self-regulation strategies can improve student outcomes. Interventions to help students plan, monitor and evaluate their learning may be a promising way to improve student motivation and perseverance as they tackle challenging academic content.[11]

Such research is a work in progress, but these and other experiments indicate that harnessing the power of mindsets may be a promising way to support achievement—in addition, of course to teaching fundamental academic content. Academics and policy-makers in Latin America should be encouraged to design, implement, and evaluate further interventions □

Finding 2: Students who receive a blend of inquiry-based and teacher-directed instruction have the best outcomes

Teachers matter. Multiple research reports, including our own, have demonstrated that high-performing school systems require effective teachers and teaching. The challenge, then, is to determine what teaching practices work, and how teachers can deliver high-quality instruction.

We evaluated two types of science instruction to understand the relationship between teaching styles and student outcomes. The first is "teacher-directed instruction" where the teacher explains and demonstrates scientific ideas, discusses student questions, and leads class discussions. The second is "inquiry-based teaching," where students play a more active role, creating their own questions, designing experiments to test their hypotheses, drawing conclusions, and relating learning to their experiences (Exhibit 16) There is active debate over which approach is preferable.

EXHIBIT 16: OECD PISA ASKED STUDENTS HOW OFTEN THEY EXPERIENCED THE FOLLOWING TEACHING PRACTICES

How often does this happen in your school science class...

Teacher-directed teaching

- The teacher explains scientific ideas.
- A whole class discussion takes place with the teacher.
- The teacher discusses our questions.
- The teacher demonstrates an idea.

Inquiry based teaching

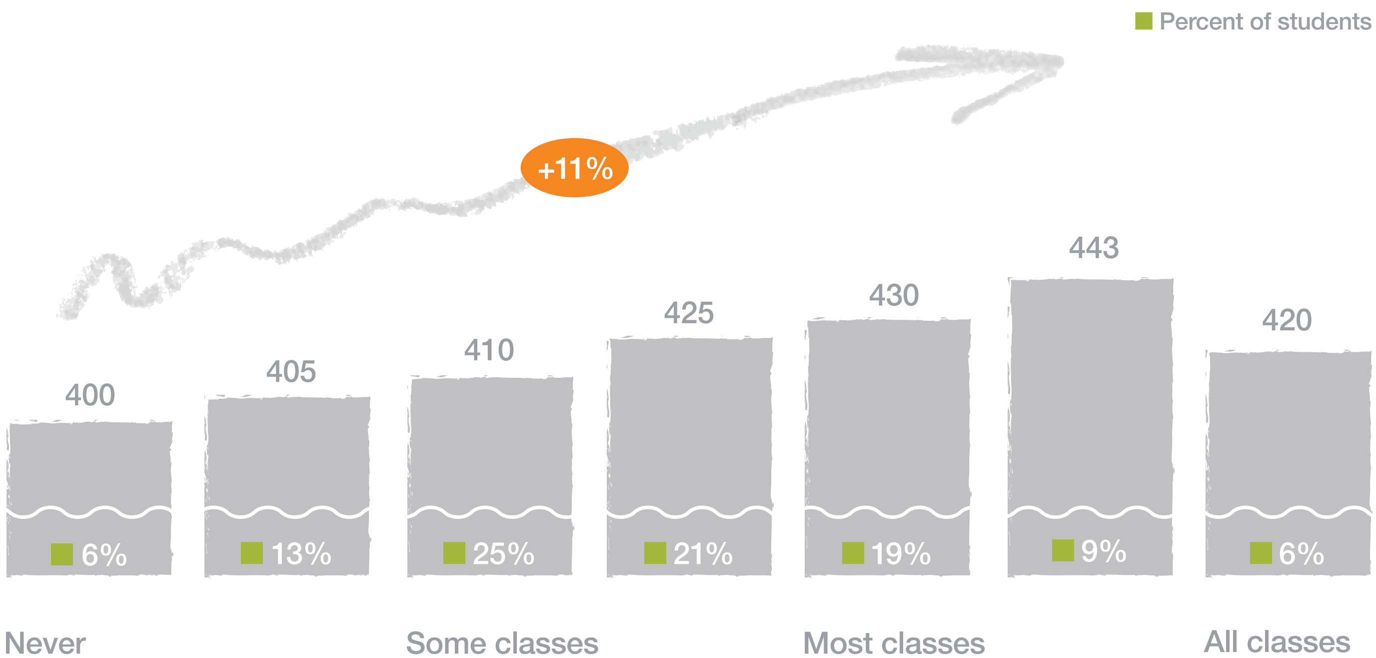
- Students are given opportunities to explain their ideas.
- Students spend time in the laboratory doing practical experiments.
- Students are required to argue about science questions.
- Students are asked to draw conclusions from an experiment
- The teacher explains science ideas can be applied
- Students are allowed to design their own experiments.
- There is a class debate about investigations.
- The teacher explains the relevance of concepts to our lives.
- Students are asked to do an investigation to test ideas.

Source: OECD PISA 2015, McKinsey analysis

EXHIBIT 17: WHEN TEACHERS TAKE THE LEAD, PISA SCORES ARE HIGHER

Impact of teacher-directed instruction

LatAm average PISA science score with different amounts of teacher directed instruction[1]



1 Trend statistically significant peaking between most and all lessons
Source: OECD PISA 2015, McKinsey analysis

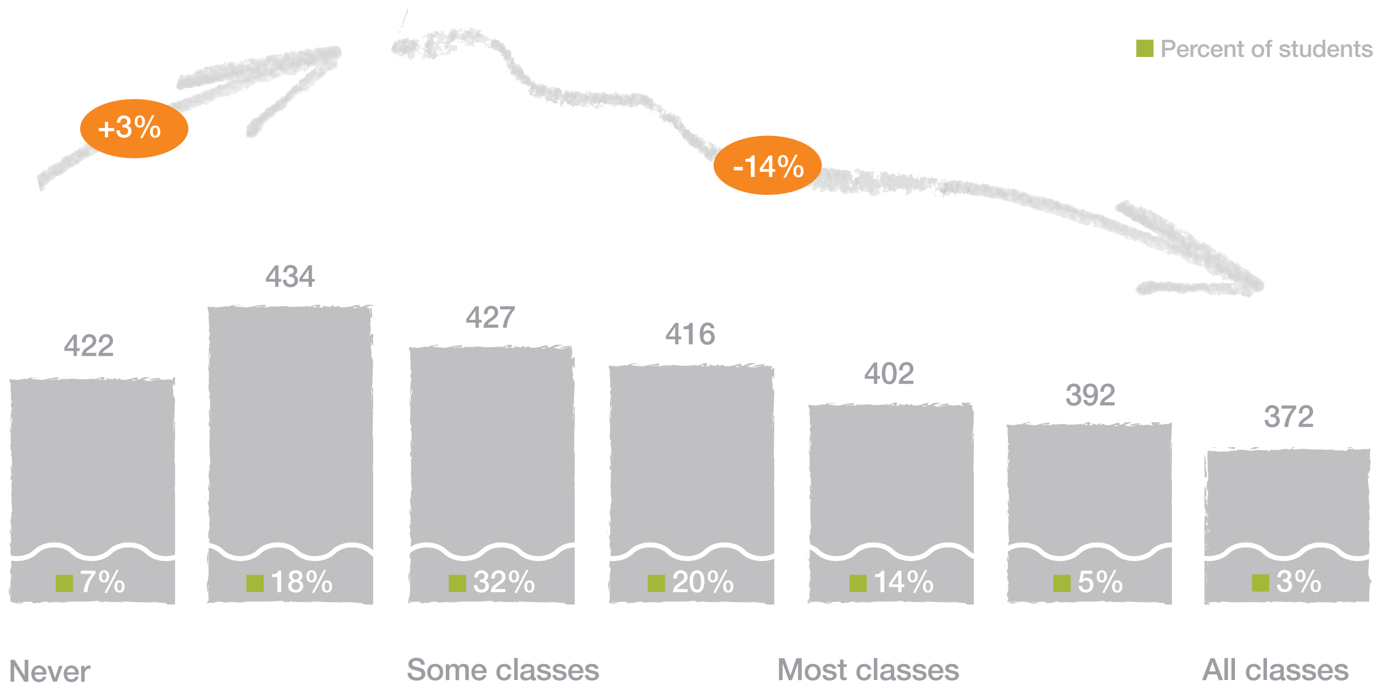
Based on the responses from Latin America, scores rise with increased teacher-directed instruction. There is an increase of 11 percent moving from a classroom where students report the use of teacher-directed instruction "never or hardly ever" to one where it is used "in most classes" (Exhibit 17).

The picture for inquiry-based learning is more complex. While scores initially rise with some inquiry-based teaching, they then decrease with more frequent use (Exhibit 18).

At first blush, then, inquiry-based teaching looks like a less effective choice. But when we dug into the data, we found a more interesting story: What matters is the interplay between the two types of teaching. In an ideal world, there is a place for both. Inquiry-based teaching can be effective—but only when strong teacher-directed instruction is in place. This suggests that teachers need to be able to clearly explain scientific concepts and students need to have content mastery to fully benefit from inquiry-based teaching. Based on the PISA results, the most effective combination appears to be teacher-directed instruction in most or almost all classes, with inquiry-based teaching in some of them. Students who

EXHIBIT 18: INQUIRY-BASED INSTRUCTION DELIVERS MIXED RESULTS

Impact of inquiry-based instruction
LatAm average PISA science score with different amounts of inquiry-based instructions

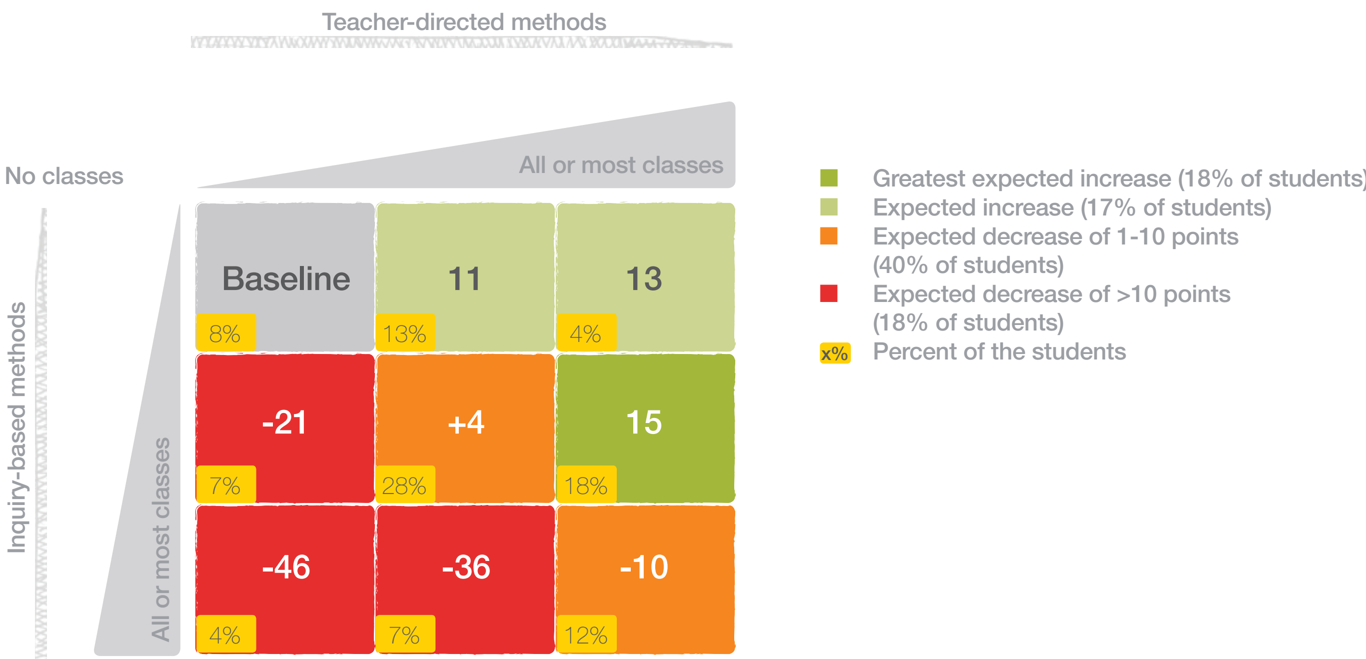


1 Trend statistically significant except in fifth bar (most classes) which is not significantly different from baseline of "never or hardly ever."
Source: OECD PISA 2015, McKinsey analysis

EXHIBIT 19: FINDING THE SWEET SPOT: THE BEST STUDENT OUTCOMES COMBINE BOTH TEACHING STYLES

Impact of teacher-direction and Inquiry-based combinations

Expected point increase in LatAm PISA science score relative to "No classes" for both practice types[1]



1 Statistically significant expected change in score controlling for ESCS, urban/rural, and private/public school

Source: OECD PISA 2015, McKinsey analysis

receive this blend of teaching practices outperform those who experience high levels of inquiry-based learning without a strong foundation of teacher-directed instruction by 50-60 PISA points (Exhibit 19). To put it another way, the more teacher-directed instruction there is, the better it supports inquiry-based learning.

In Latin America, most countries appear to be doing less teacher-directed instruction, and more inquiry-based teaching, than optimal. In fact, only 18 percent of students sit in the "sweet spot" of teacher-directed instruction in most-to-all classes, supported by inquiry-based teaching in some of them. We estimate that moving the remaining 82 percent of students into the sweet spot could result in a 4.6 percent, or 19 PISA point, increase across the region, equivalent to about half a school year.

This can be difficult to do. Even the best-performing school systems struggle to change teaching practices in the classroom. But even just moving all students to a "low inquiry-based, high teacher-directed" style (the upper right corner of the matrix) could result in a 4.1 percent, or 17 PISA point, increase across the

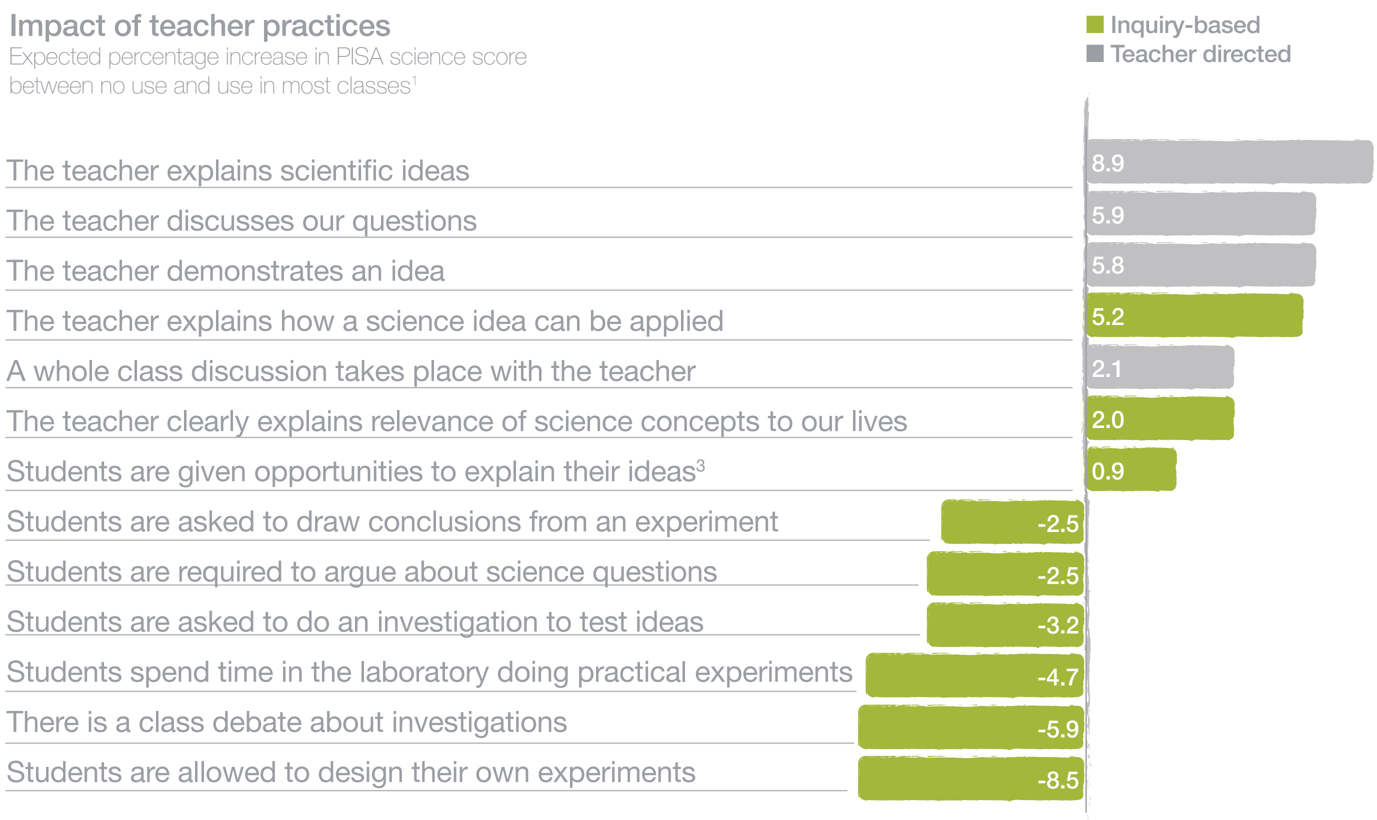
region. This would be much easier to do, by implementing lesson guides and reducing the emphasis on inquiry-based teaching.

These results do not take into account how good the teaching itself is. There are certainly quality gaps in teacher-directed classrooms. The gaps are even bigger, though, in inquiry-based classrooms, given the need to control the necessary chaos, set standards and limits, monitor progress, and support students of different capabilities.

Furthermore, inquiry-based and teacher-directed approaches are composed of specific practices, and these have discrete effects. In poor-performing schools in Latin America, having students design their own experiments had a negative effect on their PISA science scores, while other inquiry-based practices, such as applying science ideas to students' lives, had noticeably positive effects (Exhibit 20).

This finding may seem counter-intuitive, given that there is strong support for inquiry-based pedagogy. We offer two hypotheses for why it is not translating into better student outcomes. First, students cannot progress to inquiry-based methods without a strong foundational knowledge gained through teacher-directed learning. Second, inquiry-based teaching is more challenging to deliver, and teachers who

EXHIBIT 20: DIFFERENT TEACHING PRACTICES BRING DIFFERENT RESULTS



1 In a regression controlling for ESCS, public/private school and urban/rural location, normalized over regional average PISA score.
2 For inquiry based: in most lessons; For teacher-directed: in many lessons
3 Not statistically significant.
Source: OECD PISA 2015, McKinsey analysis

attempt it without sufficient training and support will struggle. This is especially true in poor-to-fair school systems, which account for over three quarters of Latin American schools. Our 2010 report also found that a more directed approach accelerated student learning for school systems in this performance band.

Knowing all this is only the start, and raises a slew of questions about how to find the right balance between teacher-directed and inquiry-based teaching, and how to improve the quality of each. At minimum, our research suggests that teachers need to fully understand the content they are teaching, and be able to explain it, before they can jump into inquiry-based exercises.

Well-designed classroom-based teacher coaching programs can bring results. For example, one Brazilian state implemented a standard teaching and supervision methodology, and provided high-quality lesson plans, and then supported teachers through a central and regional coaching team. The result was a 75 percent improvement in literacy rates in four years ◻

Finding 3: While technology can support student learning outside of school, its record inside school is mixed. The best results come when technology is placed in the hands of teachers.

The potential of technology is obvious. It can help to individualize learning, assist teachers with curriculum and lesson plans, and equip students with the digital skills that will be a big part of the 21st century economy. Spending on information and communications technology (ICT) in education is rising; so are the hopes that ICT can help to improve performance.

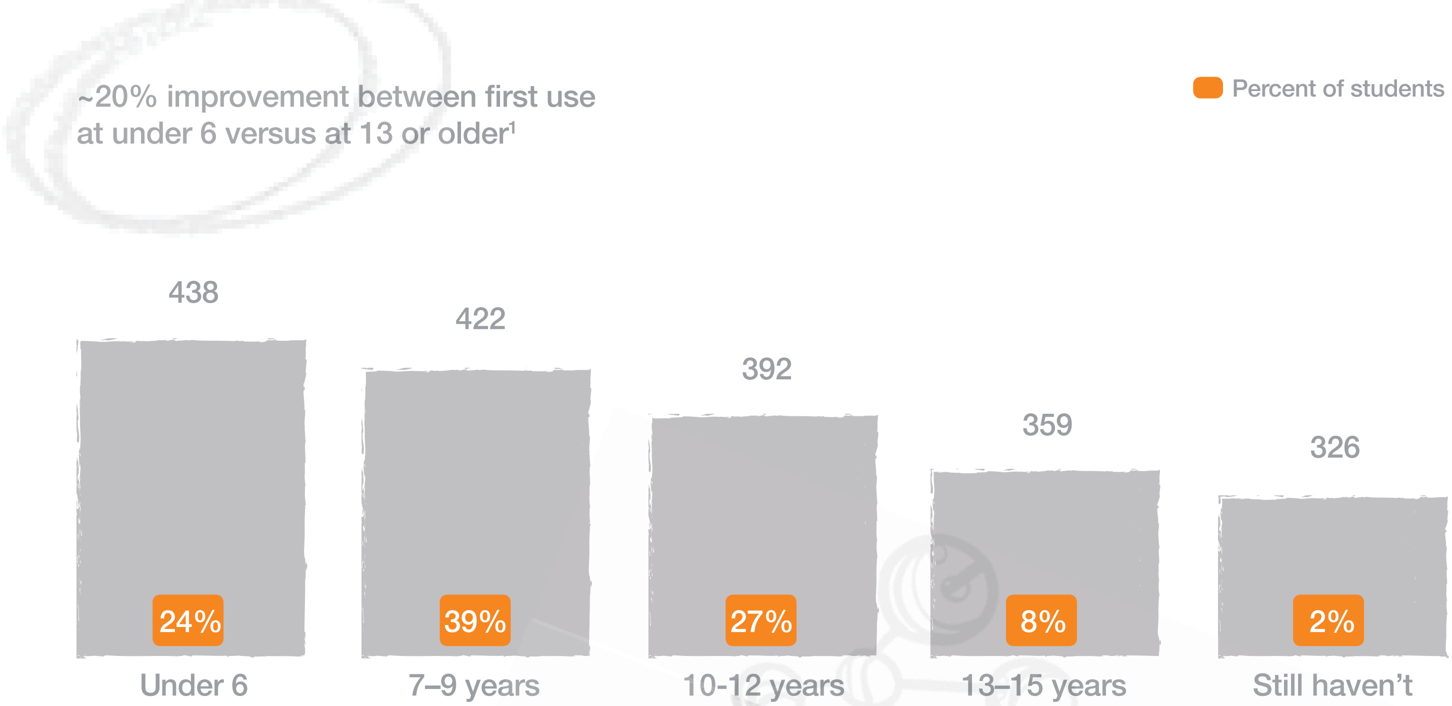
Several Latin American governments are investing in the use of ICT in the classroom. Beginning in 2011, the Brazilian government provided funding for 1.5 million laptops. Uruguay's Plan Ceibal has provided more than 500,000 laptops to public primary schools. Between 2010 and 2016, the Colombian government delivered 2 million laptops and tablets, and has allocated another $25 million for tablets and laptops in schools through the Computadores para Educar program.

Given all the money and attention ICT is getting, however, it is important to ask whether it actually improves learning. A 2015 OECD global report concluded that the evidence that it does is "mixed at best." Among countries that had invested heavily in ICT, the report[12] concluded, there was "no appreciable improvements in student achievement in reading, mathematics, or science." Others worry that technology in the classroom dehumanizes education and disempowers teachers.

Using the PISA data, we explored the impact of first exposure to ICT, and the impact of ICT on 15-year old students at home and in the classroom.

EXHIBIT 21: EARLY EXPOSURE TO ICT IS ASSOCIATED WITH HIGHER SCIENCE SCORES

How old were you when you first used a digital device?
LatAm average PISA Science Score



1 Statistically significant in a regression controlling for economic, social, and cultural status; public/private; and urban/rural school types.
Source: OECD PISA 2015, McKinsey analysis

Age of first ICT exposure:

The PISA survey asked students how old they were when they first used a digital device or computer. Students with digital exposure before the age six perform about 20 percent better than those exposed at age 13 or later[13] (Exhibit 21).

This pattern holds true regardless of socioeconomic status, but the effect is most pronounced for the more privileged. High-socioeconomic-status students who are exposed to digital devices at or before age six score 27 percent higher on PISA science than those exposed at age 13 or older. For low-socioeconomic status students, the difference is only 8 percent, and for lower- and upper-middle socioeconomic status, 13 and 19 percent, respectively. Not only do higher-status students get greater lift from early use of digital devices, they are also more likely to have started young. The implication is that ICT may actually be widening the equity gap.

It should be noted that 15-year-olds today reporting on their technology exposure before the age of six are referring to technology that is a decade old. The dynamic nature of the field means research like this is dated the moment it is published. Constant updates on the effects of technology are required to gain a more accurate picture.

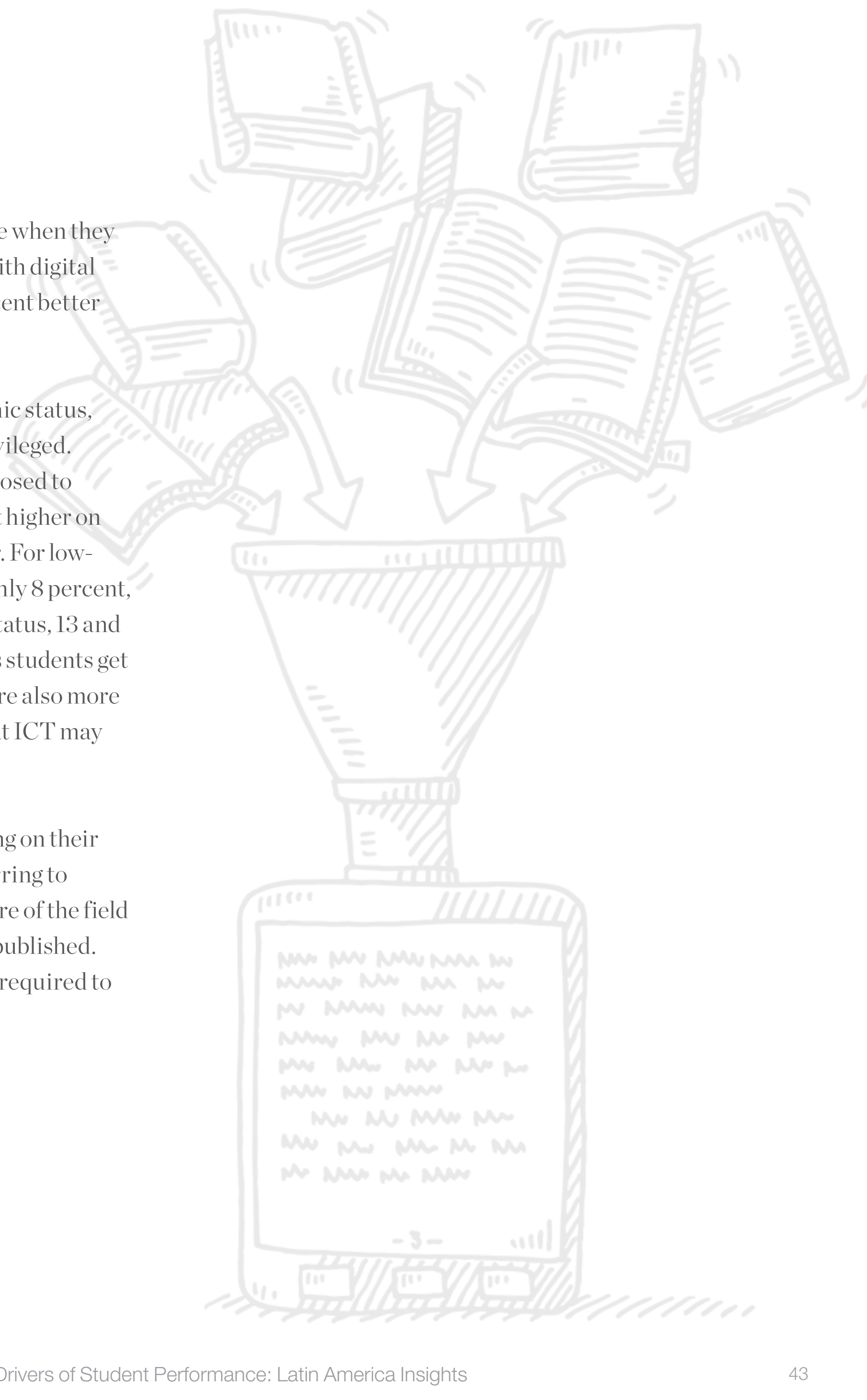
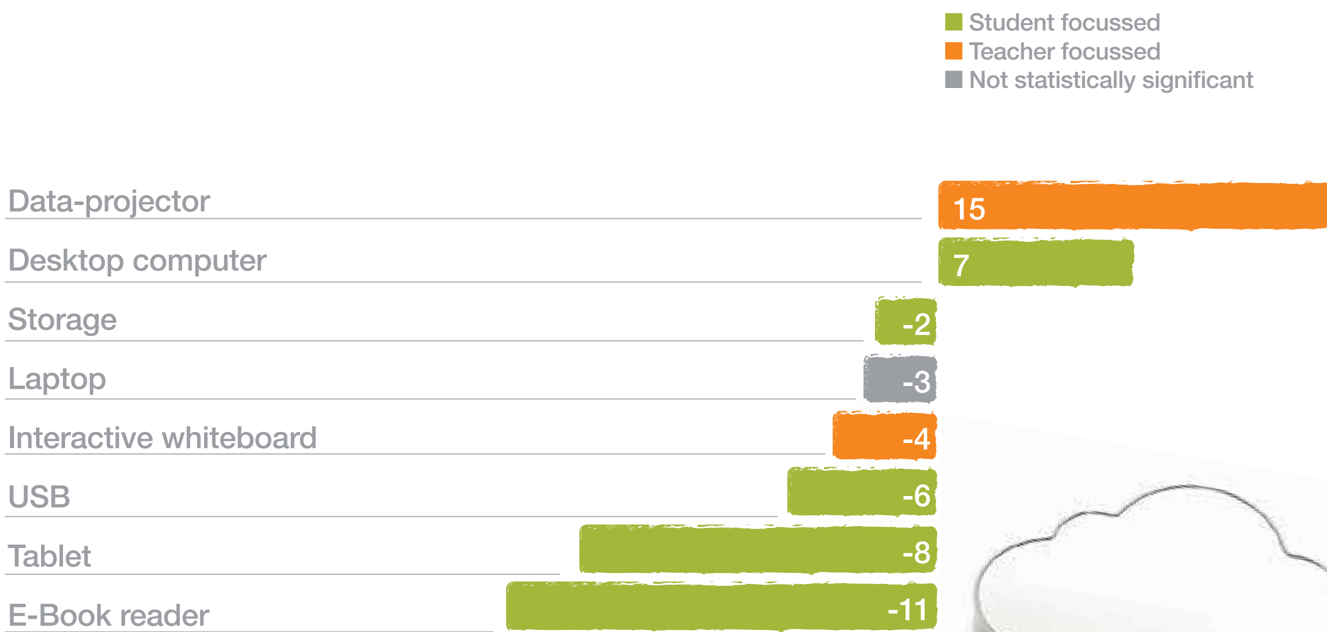


EXHIBIT 22: TECHNOLOGY DIRECTED TO TEACHERS IS MOST EFFECTIVE AT IMPROVING LEARNING

Impact of using specific technology use by students at school[1]
LatAm percent change in PISA science score between “No” and “Yes and Use”



1 Statistically significant in a regression controlling for ESCS, public/private, and urban/rural school types, except for laptop effect
Source: OECD PISA 2015, McKinsey analysis

How students spend their time also matters. External research has demonstrated that going online for educational purposes and interactive game-based learning have positive effects, while participation in social media appears to be negative.

ICT at home:

Across Latin America, and after controlling for socioeconomic status, school type, and location, students using the Internet from two to four hours a day scored 46 PISA points higher than those with no use. More than half the benefit of Internet use at home—about 29 PISA points—is captured with just 31 to 60 minutes of use per day. Beyond four hours, the positive effects tend to decline, and six hours of use or more is associated with negative behaviors, such as missing school.

How students spend their time also matters. External research has demonstrated that going online for educational purposes and interactive game-based learning have positive effects, while participation in social media appears to be negative not only on student scores, but also on student well-being.[14]

ICT at school:

Regarding ICT use during school, the impact of digital exposure on student outcomes is more mixed. Regardless of the type of school or student, we found that ICT deployed to teachers and in support of teaching is more beneficial than ICT provided directly to students. For example, based upon the PISA principal survey, adding one data projector per classroom leads to a 10.4-point increase on science scores—equivalent to about one-third of a grade level of learning. By contrast, adding one student computer per classroom adds just 0.3 PISA points, and one teacher computer adds 2.7 PISA points. The student survey reinforced these results. Again, the greatest impact came from using a data projector; moreover, the survey found that as currently used, access to some student-based technologies, such as tablets and e-book readers, actually seem to hurt learning (Exhibit 22).

Country spotlight – Mexico's IT program

Mexico's experience demonstrates the potential benefits of combining information technology (IT) with a teacher- and curriculum-based approach.

Between 2014 and 2016, the Ministry of Education began to implement @prende, a program to provide content across different devices to fifth- and sixth-grade students. It distributed 2 million devices, most of them tablets, to students.

On evaluating the program, the ministry found that students in wealthy homes already owned digital devices and those in poorer homes could not guarantee their safety. Furthermore, teachers were unsure of how to integrate these tools into the classroom and were concerned that the devices themselves were becoming disruptive as students used them for non-academic purposes.[15] These findings reinforce our own conclusion that technology alone does not translate into better outcomes.

According to the PISA data, a large proportion of Mexican students have access to technology in the classroom. About half use Internet-connected desktop computers at school, while 20 percent use laptops, and 12 percent use tablets. Forty-one percent are in classrooms equipped with data-projectors.

After controlling for socioeconomic status and school type, we found that student-centered devices, including tablets and e-readers, correlate negatively with academic performance in Mexico. On the other hand, the use of teacher-centered technology yields positive results. Exposure to data projectors, for example, provides a 35-point increase in the PISA science score, after controlling for socioeconomic status and school type. The use of desktop and Internet-connected computers, which are usually used in computer labs, also appear to yield slightly positive results. These patterns are consistent with our broader Latin American analysis.

Based upon their own evaluations, the Mexican Ministry of Education has recently refined its approach. Known as @prende 2.0, the new program seeks to ensure that IT is tightly integrated with the curriculum, and to provide more structured computer-lab-based access to technology. It is also identifying committed teachers to support the rollout.

Given the evidence of the negligible or even negative impact of student-centered technology, school systems might be tempted to abandon their ICT efforts. Not so fast. The PISA survey describes the impact of education technology as currently implemented, not its eventual potential. First, the results tell us only about hardware, not software or specific interventions like well-executed personalized learning. Second, education technology is evolving rapidly and it is possible that specific interventions, including software and implementation strategies, can raise achievement at the system level.

Nevertheless, Latin American school-system leaders should be careful not to assume that all technology is beneficial or even neutral to student achievement. They should work to ensure that ICT is fully integrated with instruction and to support teachers to enable them to use ICT effectively □

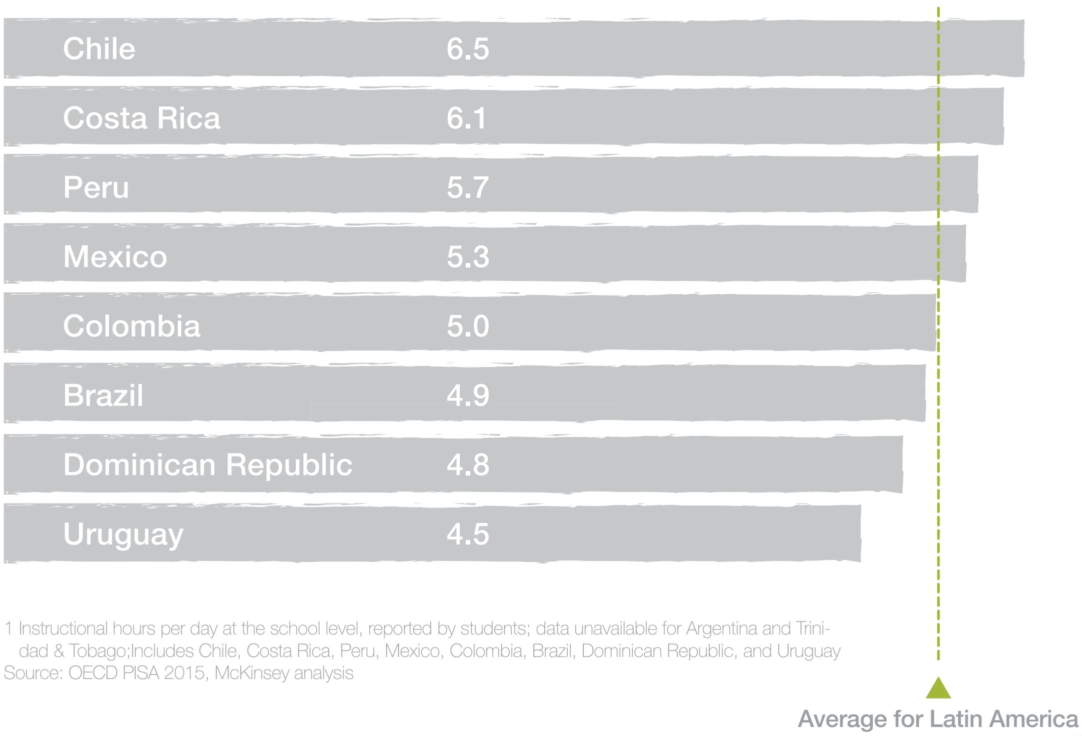
Finding 4: Increasing the school day improves outcomes, up to seven hours per day. Significant gains can also be made from using existing time better.

The average school day in Latin America is about five hours, but about 15 percent of schools provide fewer than 4.5 hours of instruction a day, and 6 percent provide more than seven hours. There are also significant variations from country to country (Exhibit 23).

Many Latin America countries, then, are attempting to lengthen the school day. In the Dominican Republic, 73 percent of primary schools and 65 percent of secondary schools still operate on a shift basis, with two sets of students sharing the same facilities daily. In Brazil, several states are attempting to eliminate evening instruction, in which secondary school students use primary school facilities in the evening. In 2015, the Colombian government began Jornada Única, an initiative to extend the school day to seven hours.[16]

EXHIBIT 23: THE AMOUNT OF TIME SPENT IN SCHOOL VARIES SIGNIFICANTLY

Average reported school day by country; Hours per day[1]



1 Instructional hours per day at the school level, reported by students; data unavailable for Argentina and Trinidad & Tobago;Includes Chile, Costa Rica, Peru, Mexico, Colombia, Brazil, Dominican Republic, and Uruguay

Source: OECD PISA 2015, McKinsey analysis

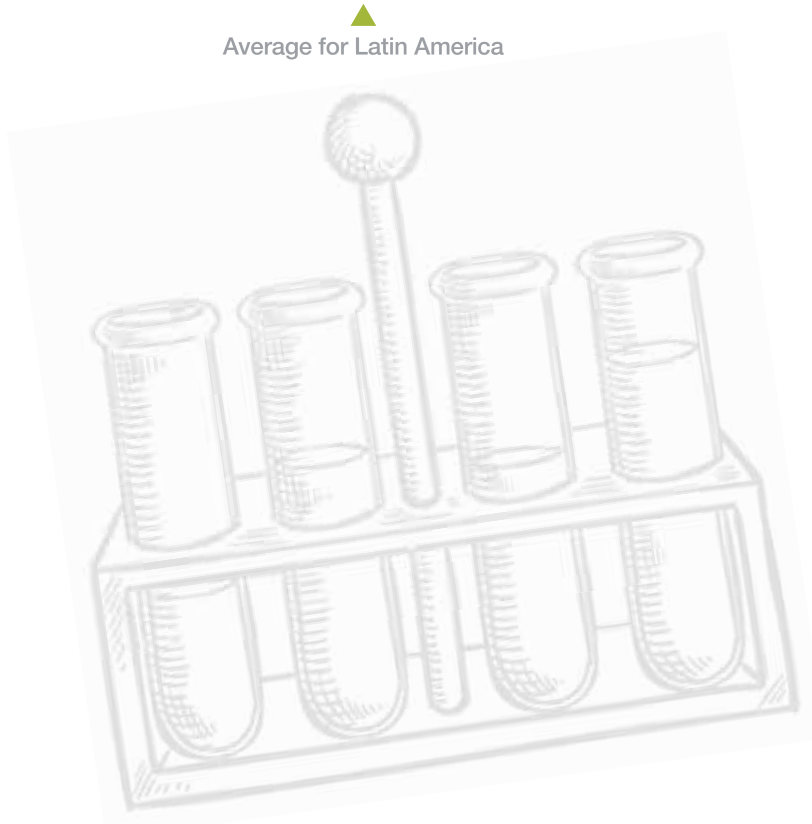
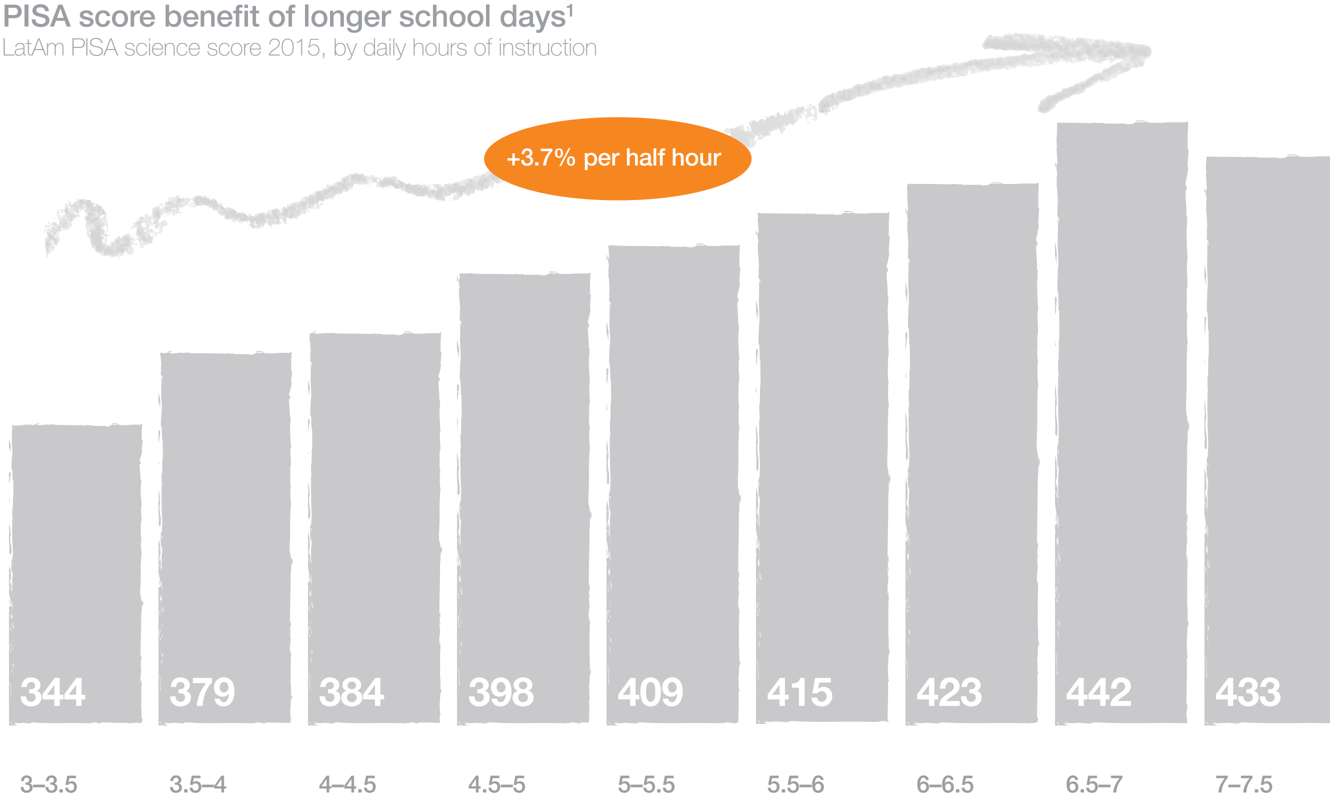


EXHIBIT 24: EACH ADDITIONAL HALF HOUR OF INSTRUCTION UP TO 6.5 TO 7 HOURS PER DAY IMPROVES STUDENT OUTCOMES

PISA score benefit of longer school days[1]

LatAm PISA science score 2015, by daily hours of instruction

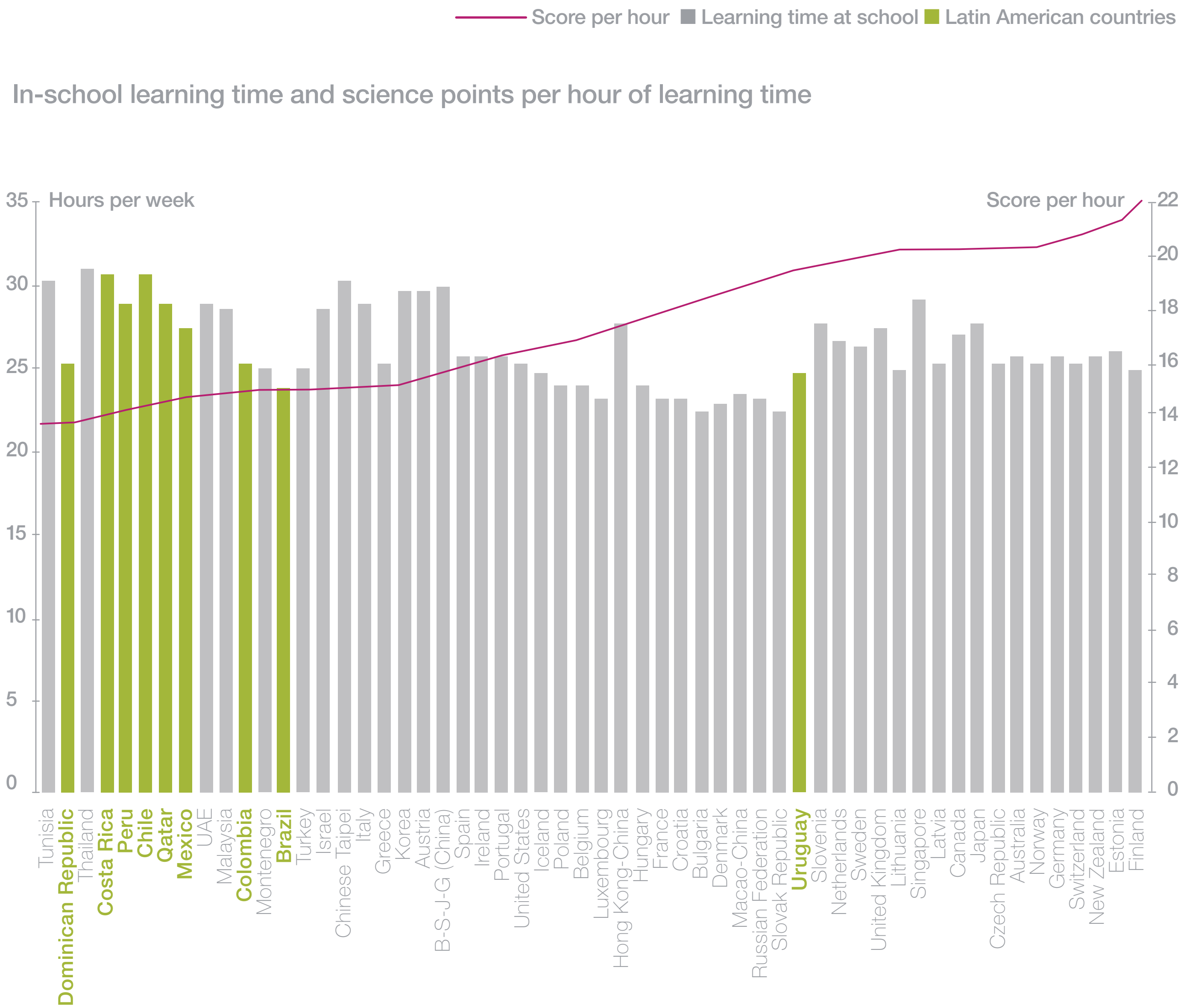


1 All increases statistically significant, includes Chile, Costa Rica, Peru, Mexico, Colombia, Brazil, Dominican Republic, and Uruguay
Source: OECD PISA 2015, McKinsey analysis

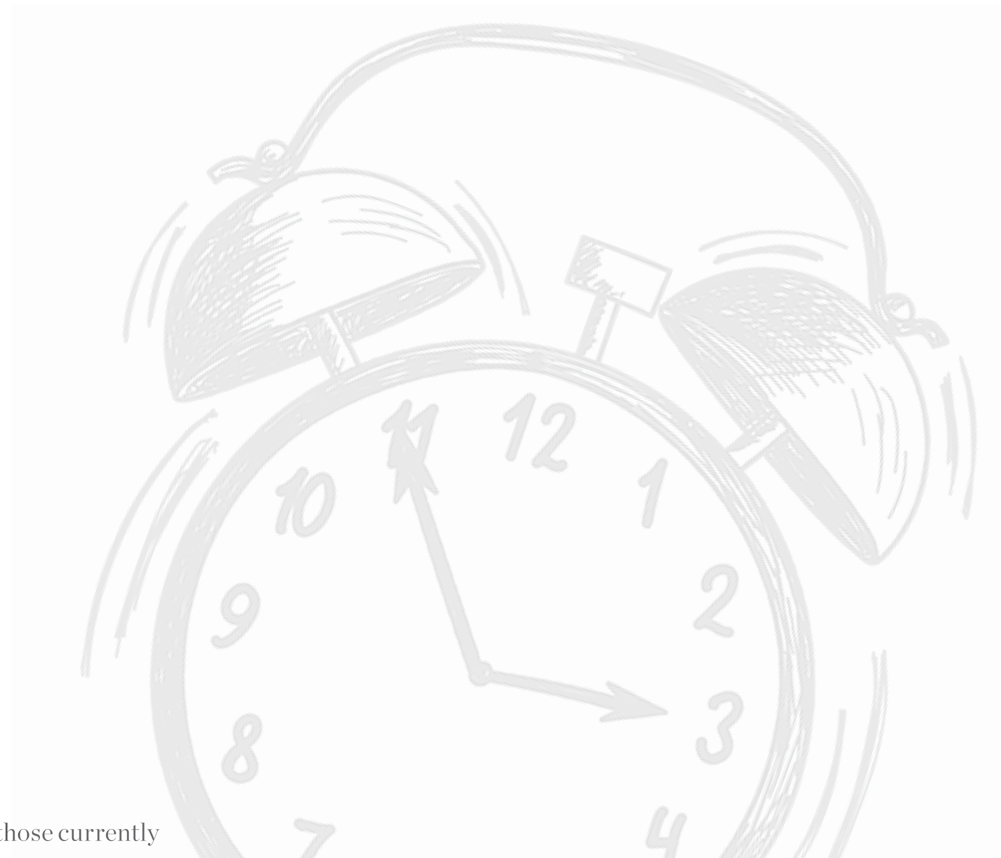
The striking variation in the length of the school day in Latin America can help us understand the implications of increasing the hours of instruction. We looked to the PISA data set to understand the academic impact of each half hour of additional instruction.

It makes intuitive sense that spending more time in school should improve academic outcomes, and the PISA results bear that out. Across Latin America, PISA science scores increase 3.7 percent (or 14 PISA points) for every 30 minutes of additional daily classroom instruction, up to seven hours per day. Additional time beyond 6.5 to 7 hours per day does not lead to higher scores, suggesting diminishing returns as the limits of student stamina are reached. This relationship holds, even after controlling for economic, social, and cultural status, and type of school (Exhibit 24).

EXHIBIT 25: MOST LATIN AMERICAN COUNTRIES DO NOT USE THEIR CLASSROOM TIME PRODUCTIVELY



Source: OECD PISA 2015, McKinsey analysis



If all students received similar outcomes to those currently receiving 6.5 to 7 hours of instruction per day, average PISA science scores across the region would increase by 35 PISA points. But there are no guarantees that the relationship with score would hold, and increasing hours of instruction would be costly. In addition to having to pay for additional teaching time, extending the school day could require new buildings and other infrastructure. One alternative to longer school days is to impose a longer school year. Research in Mexico found that adding more days of instruction slightly improved student performance, but exhibited diminishing marginal returns with lower improvements in poorer schools.[17] This suggests that, at present levels of quality, increasing the number of days spent in the classroom is not enough.

How time is used is therefore critical. The OECD recommends that 85 percent of classroom time be used for learning; no Latin American country reaches this benchmark. Colombia was the closest (65 percent), followed by Brazil (64 percent) and Honduras (64 percent).[18] It is difficult to measure the quality of learning time, but one useful metric is PISA points per hour of instruction. By this admittedly limited standard, Latin American school systems fall short, comprising five of the ten least productive countries in the PISA data set (Exhibit 25).

Educators, then, have to make a trade-off, at least in the short- to medium-term, between investing to increase the number of total school day hours versus getting more and better instruction out of existing time. By raising the share of classroom time used for learning, and improving instruction quality through teacher coaching and professional development, Latin America could significantly improve student learning for every existing hour in school □

Country spotlight: A cost-benefit analysis of increased hours of instruction in Brazil

In Brazil, about half of schools provide fewer than five hours of instruction, and many of them share their buildings—for example, with primary schools in the morning and secondary schools in the afternoon. Several regions, including Pernambuco and São Paulo[19], are trying to extend the school day, but the jury is still out on the relative costs and benefits of these interventions.

Looking at the PISA Brazil data, it appears there could be real benefits to a longer school day; every additional half hour of instruction between 3 and 6.5 hours provides a 2.9 percent increase in the PISA science score. This pattern holds controlling for socioeconomic status and type of school, with the highest scores achieved by students in schools with between 6.5 and 7 hours of instruction.

The costs, however, are high. Using existing infrastructure, adding additional hours of instruction to bring every part-time student up to 5 hours per day would cost $530 million to $610 million[20], or about 0.6 percent of total public education spending. Assuming that the relationship between hours of instruction and score holds, that would lead to a 2.8 percent net improvement in national PISA scores.

If additional infrastructure is required, the costs increase significantly. Changing all existing shift schools into full-time programs with 6.5 hours of instruction would cost between $3.1 billion to $3.6 billion, or 3.8 percent of total public education spending.[21] This could improve national PISA scores by up to 4.1 percent.[22] In either case, the efforts could fall short if the additional hours are not used well, in terms of teachers and instructional content.

Finding 5: Early childhood education had a positive academic impact on today's 15 year olds, however low income students received less benefit than high income ones

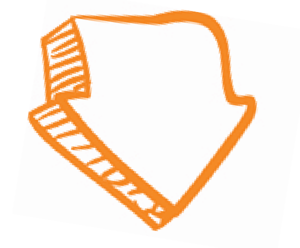
More than half of the synaptic connections that allow people to think, see, hear, and speak are formed before age three.[23] Although brain plasticity persists into adulthood, the brain is most receptive to interventions in early childhood. That is the promise of quality early-childhood education (ECE), and indeed such programs have been shown to improve academic and social outcomes, especially for disadvantaged children.[24] Although there are some concerns about fade-out in later years, good ECE programs can help to narrow the achievement gap by helping disadvantaged children gain cognitive, social, and other skills before starting kindergarten.

Many Latin American governments recognize the potential of ECE. For example, Brazil has made this a priority and is on track to meet its goal of universal ECE for four-year-olds by 2024. The challenge is how to capture the benefits of ECE in a cost-effective manner, and how to balance access with quality.

The PISA survey asked students how old they were when they started formal education. Parents in Chile, Dominican Republic, and Mexico also answered detailed questions about their children's early education. On the basis of these answers, our findings highlight the trade-off between increasing access and ensuring quality.

EXHIBIT 26: ECE DOES NOT APPEAR TO WORK AS WELL FOR LOWER SOCIOECONOMIC STATUS STUDENTS IN LATIN AMERICA

	Impact of ECE on score Increase in PISA Science Score[1]	Students with no ECE Percent of students
High socioeconomic status	+11%	7%
Upper middle socioeconomic status	+7%	11%
Lower middle socioeconomic status	+5%	13%
Low socioeconomic status	+4%	16%



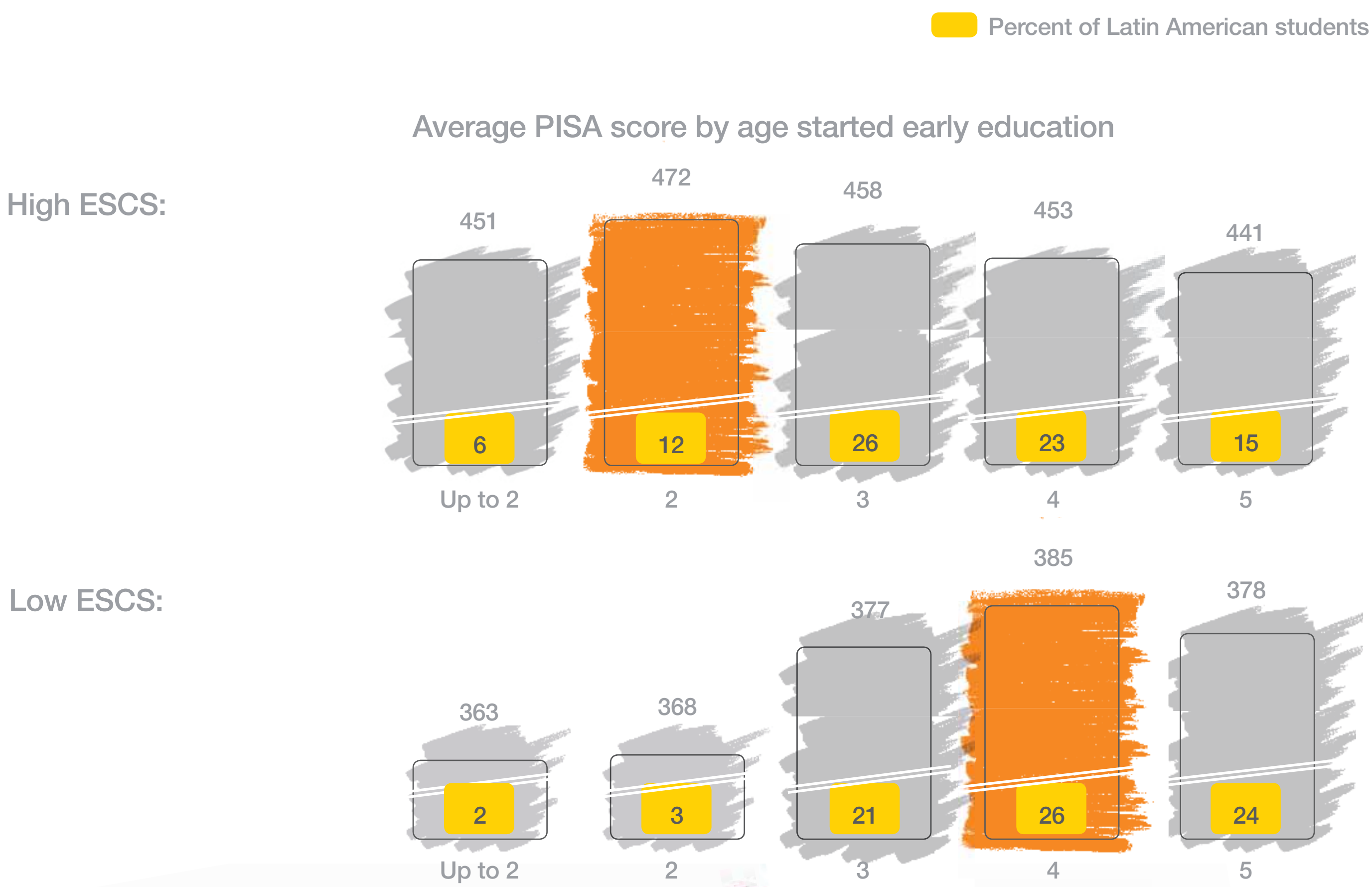
1 Statistically significant in regression with standard controls, when compared against scores of students with no early childhood exposure
Source: OECD PISA 2015, McKinsey analysis

Across Latin America, 78 percent of students told PISA they had received some form of ECE by age five. Those with some ECE scored eight percent (or 30 PISA points) higher on the PISA science assessment than those with none. Controlling for student socioeconomic status, and school location and type students still get a benefit of 8 PISA points. While students with ECE perform better overall, there are substantial differences between students from different socioeconomic backgrounds. Specifically, early-childhood programs do not appear to be narrowing the achievement gap between lower- and higher-socioeconomic status students. Poorer students are less likely to get ECE in the first place, and those who do see a smaller impact on their PISA scores (Exhibit 26).

Even more troubling is the fact that low-socioeconomic-status children who start ECE at three years or younger actually do worse than those who start at age four or five. In contrast, high-socioeconomic-status children do best when they start ECE at age two or three (Exhibit 27).

This raises serious questions about the quality of ECE available to lower-socioeconomic-status children. A recent Inter-American Development Bank (IDB) report[25] highlighted the importance of quality care and found that programs for younger children sometimes led to worse outcomes than no ECE at all.

EXHIBIT 27: HIGH SOCIOECONOMIC STATUS CHILDREN BENEFIT MOST FROM STARTING ECE AT AROUND AGE TWO; LOW SOCIOECONOMIC STATUS CHILDREN DO NOT SEEM TO BENEFIT FROM STARTING EARLY



Note: Benefit of ECE statistically significantly positive for High ESCS at age 2, 3,and 4 with highest lift at age 2 (95% confidence). Significantly positive for low ESCS at age 4 only (75% confidence). ECE statistically significantly worse than no ECE when starting at age 2 years or younger for low ESCS
Source: OECD PISA 2015, McKinsey analysis

This raises the question: What is "quality" in ECE? How can it be measured? The elements are clear: a focus on not just cognitive skills but also social and emotional skills and physical and mental health; trained teachers; low staff-to-child ratios; adequate infrastructure; clear learning standards; and positive student-teacher relationships. Several accepted assessments of quality exist based on both measurement of minimum standards and direct-observation toolkits.[26] The IADB has found that Latin America falls short on many of these assessments.

Of course, ECE is about more than scoring well on PISA tests many years later. Non-cognitive attributes like physical and mental health, as well as social and emotional development, are also important. Furthermore more than a decade has passed since these students were in early childhood education and several countries have made significant investments over that timeframe. Nonetheless, our analysis of the PISA data suggests that Latin American systems may have a trade-off to consider between quality and reach of their early education provision. As systems stretch resources to enroll younger children, they should consider what alternatives this care is replacing, and should carefully monitor the quality of both public and private ECE programs □

Conclusion

Our research has mapped some areas previously blank, and also identified new territories worthy of further exploration. For each of the five findings, there is a clear need for additional research. Within mindsets, the priority is to determine what system-level interventions can make a difference in shifting student mindsets, and what effect these interventions have on student outcomes. For teaching practices, more research is needed into how to effectively combine teacher-directed and inquiry-based learning. In ICT, we need more rigorous longitudinal studies that consider not only what hardware works, but also what software and system supports lead to successful outcomes. Across the board, more research is needed on how to strike the right balance between increasing access and improving quality. This is particularly relevant in terms of increasing hours of instruction in systems with shared infrastructure and in rolling out government-provided ECE. In an important sense, then, this report—like our previous two—is part of a longer journey.

With its emphasis on data and analysis, this research aims to help Latin American school systems move from poor to fair to good and beyond. Even a survey as large and rigorous as the PISA data set provides only some of the answers. But we believe that the five findings outlined here, combined with the conclusions of our 2010 report on the world's most improved school systems, provide useful insights to guide Latin American policymakers as they make their way to their ultimate destination—improving the education and thus the lives of the region's students ■

analytical appendix

To analyze the PISA dataset, we used a variety of modern machine learning and traditional statistical techniques.

First, we used SparkBeyond, an automated feature-discovery engine that uses large-scale combinatorial testing of millions of transformations on raw data to identify relevant drivers of outcomes—in our case, PISA student scores. SparkBeyond can create features from numeric, time series, text, and other inputs, and works best with complex data sets with thousands of variables and millions of data points. For the 2015 OECD PISA data, this entailed testing more than 1,000 survey variables derived from student, teacher, parent, and principal surveys for the approximately 540,000 students who took the PISA examination. This identified variables and groups of variables that were most predictive of student performance.

We excluded from our SparkBeyond and subsequent analysis highly predictive variables where the direction of causality was strongly in question, including grade repetition, student self-efficacy, environmental awareness, expected educational attainment, and epistemological beliefs.

We then carried out traditional descriptive and predictive statistical analyses on the identified features that were most important in determining performance both within 2015 dataset and across the PISA surveys since 2000.

For every analysis, we tested whether findings held in a regression controlling for economic, social, and cultural status (ESCS), type of school (SC013Q01: is your school a public or private school school?) and location of school (SC001Q01: which of the following definitions best describes the community in which your school is located?).

Where the regression results were consistent with the descriptive analysis, we have used the descriptive analysis in the report. Where the regression tells a different story from the description, we have reported regression coefficients to preserve the rigor of our findings.

School Performance Levels

For the 2015 OECD PISA data, this entailed testing more than 1,000 survey variables derived from student, teacher, parent, and principal surveys for the approximately 540,000 students who took the PISA examination.

We also tested our insights by school and student segment, creating two more screens—specifically, school performance level and student socioeconomic status.

School performance:
we used the numerical cut-offs from our 2010 report to define poor, fair, good, great, and excellent school systems. Each category represents approximately one school-year equivalent, or 40 PISA points.

- Excellent: >560 points
- Great: 520-560 points
- Good: 480-520 points
- Fair: 440-480 points
- Poor: <440 points

Then we applied these cut-offs to individual schools as well as to school systems. We did this because there may be pockets of poorly performing schools in otherwise

Distribution of students by school performance level

Students	Poor (%)	Fair (%)	Good (%)	Great (%)	Excellent (%)
N America	14	23	39	18	5
Latin America	76	15	6	2	0
W Europe	25	19	26	18	13
E Europe	22	24	34	16	5
MENA	89	8	2	1	0
Asia	43	16	15	13	13

Distribution of schools by school performance level

Schools	Poor (%)	Fair (%)	Good (%)	Great (%)	Excellent (%)
N America	7	19	40	25	9
Latin America	75	13	8	3	1
W Europe	19	21	32	19	10
E Europe	43	21	20	10	6
MENA	78	11	7	4	1
Asia	24	17	24	20	15

good systems. In these schools, the interventions applicable to poor systems may apply, even if they are in a country that on the whole performs at a "good" level. Based on this analysis, we could determine the percentage of students in differently performing schools for each region and country

Student socioeconomic status:

We use the term "student-socioeconomic-status quartile" throughout the report. This refers to PISA's ESCS indicator that integrates a number of measures related to students' backgrounds, including their parents' occupations, education levels, and possessions. We created ESCS quartiles by region based upon student weights.

Target variables and plausible values

We used the 2015 PISA science score as the target variable because the 2015 test focused on science both for the assessment and survey questions (in 2012, PISA focused on math, and in 2009, on reading). To calculate the PISA science score at the student level, we averaged the results of all the plausible values for science (PV1 to PV10 for science).

To roll up scores at the regional level, we used student weights to represent each country based on its student population. For example, the Latin American numbers all refer to weighted average student scores across Latin America; the same is true for all other regions.

For consistency with OECD publications, we used a slightly different methodology in the overview of historical regional performance. This approach creates a country-level average, first using student weights (such as "average score for Brazil"), but then takes the straight average of the scores of countries in a particular region or a group (such as "all OECD countries").

Description of specific variables

In addition to using existing OECD PISA variables and indices, we created our own indices for some analyses.

Motivation calibration:

Motivation calibration is a measure of a student's ability to recognize motivation in others, or the extent to which the student's definition of motivation agrees with the standard definition. Specifically, we took the PISA question ST121, which presented three student archetypes and asked the respondent to what extent they agree that each archetype is motivated on a four-point scale, ranging from "strongly disagree" to "strongly agree."

Based on our assessment of the motivation level of each archetype, we assigned a weight of -2 to the first student (NAME 1—highly unmotivated), +1 to the second student (NAME 2—somewhat motivated), and +2 to the third student (NAME 3—highly motivated).

For example, a student who strongly disagreed that <NAME 1> is motivated, agreed that <NAME 2> is motivated, and strongly agreed that <NAME 3> is motivated would accumulate the following score:

- 1 * -2 = -2: one point for strongly disagree with a weight of -2 for <NAME 1>
- 3 * 1 = 3: three points for agree with a weight of 1 for <NAME 2>
- 4 * 2 = 8: four points for strongly agree with a weight of 2 for <NAME 3>
- Total score: -2 + 3 + 8 = 9

ST121 **Please read the descriptions about the following three students. Based on the information provided here, how much would you disagree or agree with the statement that this student is motivated?** (Please select one response in each row.)

		Strongly disagree	Disagree	Strongly Agree	Agree
ST121Q01NA	<NAME 1> gives up easily when confronted with a problem and is often not prepared for his classes. <Name 1> is motivated.	☐1	☐2	☐3	☐4
ST121Q02NA	<NAME 2> mostly remains interested in the tasks she starts and sometimes does more than what is expected from her. <Name 2> is motivated.	☐1	☐2	☐3	☐4
ST121Q03NA	<NAME 3> wants to get top grades at school and continues working on tasks until everything is perfect. <Name 3> is motivated.	☐1	☐2	☐3	☐4

ST034 **Thinking about your school: to what extent do you agree with the following statements?** (Please select one response in each row.)

		Strongly disagree	Disagree	Strongly Agree	Agree
ST034Q01TA	I feel like an outsider (or left out of things) at school.	☐1	☐2	☐3	☐4
ST034Q02TA	I make friends easily at school.	☐1	☐2	☐3	☐4
ST034Q03TA	I feel like I belong at school.	☐1	☐2	☐3	☐4
ST034Q04TA	I feel awkward and out of place in my school.	☐1	☐2	☐3	☐4
ST034Q05TA	Other students seem to like me.	☐1	☐2	☐3	☐4
ST034Q06TA	I feel lonely at school.	☐1	☐2	☐3	☐4

ST119 **To what extent do you disagree or agree with the following statements about yourself?** (Please select one response in each row.)

		Strongly disagree	Disagree	Strongly Agree	Agree
ST119Q01NA	I want top grades in most or all of my courses.	☐1	☐2	☐3	☐4
ST119Q02NA	I want to be able to select from among the best opportunities available when I graduate.	☐1	☐2	☐3	☐4
ST119Q03NA	I want to be the best, whatever I do.	☐1	☐2	☐3	☐4
ST119Q04NA	I see myself as an ambitious person.	☐1	☐2	☐3	☐4
ST119Q05NA	I want to be one of the best students in my class.	☐1	☐2	☐3	☐4

We defined a cutoff of 8 points in the aggregated score, which ensures that only the following students are classified as having a strong motivation calibration:

- Students who strongly agree that <NAME 3> is motivated, and whose agreement on <NAME 1>'s motivation does not exceed their agreement on <NAME 2>'s motivation
- –OR— Students who agree that <NAME 3>'s is motivated; agree that <NAME 2> is motivated, and strongly disagree that <NAME 1> is motivated
- –OR— Students who agree that <NAME 3> is motivated; strongly agree that <NAME 2> is motivated, and disagree or strongly disagree that <Name 1> is motivated

Sense of belonging:

We grouped the index BELONG (based on ST034) as follows:

- Low belonging: BELONG < 0
- High belonging: BELONG >=0

Motivation:

We grouped the index MOTIVAT (based on ST119) as follows:

- Low belonging: MOTIVAT < 0
- High belonging: MOTIVAT >=0

Test anxiety:

We grouped the index ANXTEST (based on ST118) as follows:

- Low belonging: ANXTEST < 0
- High belonging: ANXTEST >=0

Instrumental motivation:

We grouped the index INSTSCIE (based on ST113) as follows:

- **Low instrumental motivation: INSTSCIE < 0**
- **High instrumental motivation: INSTSCIE >=0**

Growth vs. fixed mindset:

To assess the impact of a growth versus fixed mindset, we used selected 2012 PISA survey question ST43 and ST91 from the student survey.

We created an index by adding the response values for each of the four sub-questions related to growth versus fixed mindsets, after reversing the sequence of response values for the last question to account for the negative framing of the prompt.

The resulting index takes values from 4 to 16, with lower scores representing a growth mindset and higher scores representing a fixed mindset. Looking at the distribution of students globally, we devised the following definitions.

- **Strong growth mindset: students with a score of 4 or 5 reflect a growth mindset on at least three of the sub-questions, and are directionally aligned on the remaining question. These represent 23 percent of the global population.**
- **Neutral or weak growth mindset: students with a score of 6 to 9 reflect a neutral or weak growth mindset and represent 69 percent of the global population.**

ST118 **To what extent do you disagree or agree with the following statements about yourself?** (Please select one response in each row.)

		Strongly disagree	Disagree	Strongly Agree	Agree
ST118Q01NA	I often worry that it will be difficult for me taking a test.	☐ 1	☐ 2	☐ 3	☐ 4
ST118Q02NA	I worry that I will get poor <grades> at school.	☐ 1	☐ 2	☐ 3	☐ 4
ST118Q03NA	Even if I am well prepared for a test I feel very anxious.	☐ 1	☐ 2	☐ 3	☐ 4
ST118Q04NA	I get very tense when I study for a test.	☐ 1	☐ 2	☐ 3	☐ 4
ST118Q05NA	I get nervous when I don't know how to solve a task at school.	☐ 1	☐ 2	☐ 3	☐ 4

ST113 **How much do you agree with the statements below?** (Please select one response in each row.)

		Strongly disagree	Disagree	Strongly Agree	Agree
ST113Q01TA	Making an effort in my <school science> subject(s) is worth it because this will help me in the work I want to do later on.	☐ 1	☐ 2	☐ 3	☐ 4
ST113Q02TA	What I learn in my <school science> subject(s) is important for me because I need this for what I want to do later on.	☐ 1	☐ 2	☐ 3	☐ 4
ST113Q03TA	Studying my <school science> subject(s) is worthwhile for me because what I learn will improve my career prospects.	☐ 1	☐ 2	☐ 3	☐ 4
ST113Q04TA	Many things I learn in my <school science> subject(s) will help me to get a job.	☐ 1	☐ 2	☐ 3	☐ 4

ST043 **Thinking about your math lessons: to what extent do you agree with the following statements?** (Please select one response in each row.)

		Strongly disagree	Disagree	Strongly Agree	Agree
(a)	If I put in enough effort I can succeed in mathematics	☐ 1	☐ 2	☐ 3	☐ 4
(b)	Whether or not I do well in maths is up to me	☐ 1	☐ 2	☐ 3	☐ 4
(c)	If I wanted to, I could do well in mathematics	☐ 1	☐ 2	☐ 3	☐ 4
(d)	I do badly in mathematics whether or not I study for my exams	☐ 1	☐ 2	☐ 3	☐ 4

SC004

The goal of the following set of questions is to gather information about the student-computer ratio for students in the <national modal grade for 15-year-olds> at your school.
(Please enter a number for each response. Enter “0” [zero] if there are none.)

		Number
SC004Q01TA	At your school, what is the total number of students in the <national modal grade for 15-year-olds>?	
SC004Q02TA	Approximately, how many computers are available for these students for educational purposes?	
SC004Q03TA	Approximately, how many of these computers are connected to the Internet/ World Wide Web?	
SC004Q04NA	Approximately, how many of these computers are portable (e.g. laptop, tablet)?	
SC004Q05NA	Approximately how many interactive whiteboards are available in the school altogether?	
SC004Q06NA	Approximately how many data projectors are available in the school altogether?	
SC004Q07NA	Approximately how many computers with internet connection are available for teachers in your school?	

ST125

How old were you when you started <ISCED 0>?
(Please choose from the drop-down menu to answer the question.)

Years

Please choose ▼
Option A
Option B
Option C
Option …

Drop-down menu, offering answers “1 year or younger”, 2 years, 3 years, 4 years, 5 years, “6 years or older”, “I did not attend <ISCED 0>”, “I do not remember”.

- Fixed mindset: students with a score of 10 to 16 have an average response of 2.5 or more on the four questions, meaning that they tend to be misaligned with the principles of a growth mindset. They represent 8 percent of the global population.

We compared students with a fixed mindset to students with a strong growth mindset in our analysis. In addition, we found that incremental gains were seen at each stage from fixed to neutral and from weak growth to strong growth.

Teaching practices:

To assess teaching practices, the PISA survey asked a series of questions about teacher-directed instruction (ST103) and inquiry-based instruction (ST098). This question does not allow us to assess the intensity of the teaching practices in a given class, but only the frequency with which they occur.

Students responded on a frequency scale that was slightly different for each set of questions:

Teacher-directed learning (ST103)
1 = Never or almost never
2 = Some lessons
3 = Many lessons
4 = Every lesson or almost every lesson

Inquiry-based learning (ST098)
1 = In all lessons
2 = In most lessons
3 = In some lessons
4 = Never or hardly ever

We consolidated each student's responses into averages on a scale from 1 to 4—one average for teacher-directed instruction and another for inquiry-based instruction (with the numbers reversed to be comparable). These averages form the basis for our analysis of teaching practices.

The OECD also created a numerical index of teacher-directed (TDTEACH) and inquiry-based learning (IBTEACH), which is calibrated such that the OECD average is 0 and the standard deviation is 1. When we ran regressions on the TDTEACH and IBTEACH variables, our results were consistent with theirs. However, we chose to present the data using our own indices because we believed these gave a clearer picture what was happening in the classroom.

ICT at school:

to create a like-for-like comparison of the impact of ICT hardware, we used the survey questions asked of school principals from SC004 and normalized the results by classroom size and student-to-teacher ratio. This allowed us to evaluate the effect adding one projector, student computer, or teacher computer to an average class size of 36 students.

Early childhood:

To understand the impact of early-childhood education (ECE) we used the student survey question ST125. We excluded from the analysis students who could not remember when they started ECE. With the remaining students, we counted them as having attended ECE if they started at five years or younger. Students who started at six years or older or who responded "no early-childhood education" we counted as not having attended ECE. Note we did not use the simpler question ST124 ("Did you attend early-childhood education," as only 15 percent of students globally answered this question (versus 82 percent who answered ST125). We also cross-checked results against similar questions in the parent survey for the subset of countries that took the parent survey; the results were consistent ■

1 These five stages inform McKinsey's Universal Scale of education system performance, which takes available assessments like PISA, TIMSS, TERCE, or local tests. We normalized the data, creating new units that are equivalent to 2000 PISA scores, and then broke down the results into five categories: poor, fair, good, great and excellent (see the analytical appendix for more, and also http://www.mckinsey.com/industries/social-sector/our-insights/how-the-worlds-most-improved-school-systems-keep-getting-better).

2 The 2015 computer-based assessment was designed as a two-hour test comprising four 30-minute clusters. Students took two science clusters, plus two others across reading, math, and collaborative problem-solving.

3 Argentina, Kazakhstan, and Malaysia were excluded from PISA 2015 report, but are included in our analyses. The PISA 2015 sample for Malaysia did not meet PISA response-rate standards; the PISA 2015 sample from Argentina did not cover the full target population; and the results from Kazakhstan are based only on multiple-choice items. Because our report analyzes achievement drivers at the student level based on examining individual items, and reports are generated at a regional basis rather than comparing the performance of individual countries, we have included these countries in our analysis. Albania was excluded from our analysis because, due to the ways in which the data were captured, it was not possible to match the data in the test with the data from the student questionnaire. As our report is entirely based on the drivers from the student questionnaire, we could not include Albania in our analysis.

4 We used the full Argentina results, despite some concerns about data reliability, because they were more reflective of full-country performance than the Buenos Aries (CABA) results. Official OECD reports include only the CABA results.

5 The OECD measures equity in terms of the percent of score variation that depends on student socioeconomic status, which we have represented on an earlier chart. Here we represent the equity gap by the percent difference between scores of students in the highest socioeconomic quartile and the lowest socioeconomic quartile.

6 Claro, S., Paunesku, D., & Dweck, C. S. (2016). "Growth mind-set tempers the effects of poverty on academic achievement." Proceedings of the National Academy of Sciences, 113(31), 8664-8668. doi:10.1073/pnas.1608207113

7 Credé, M., Tynan, M. C., & Harms, P. D. (2016). "Much Ado About Grit: A Meta-Analytic Synthesis of the Grit Literature." Journal of Personality and Social Psychology. doi:10.1037/pspp0000102 and Education Endownment Foundation (2013) The impact of noncognitive skills on outcomes for young people: https://educationendowmentfoundation.org.uk/public/files/Publications/EEF_Lit_Review_Non-CognitiveSkills.pdf.

8 To attain statistically-meaningful results, we selected the top 100 variables using a feature-identification machine-learning algorithm. Recognizing that the regression wouldn't distinguish collinearity across variables, we mitigated by placing variables very likely to be collinear in the same category. We cannot control for collinearity between categories.

9 Each category was composed of several sub-variables. For example: **home environment:** parent education and occupation, home possessions, language at home; **student behaviors:** skipping school, activities before school, ICT use out of school; **school factors:** class size, school size, school resource level and funding, school autonomy; **teacher factors:** teacher qualifications, teacher professional development, teaching practices.

10 Paunesku, David, et al. "Mindset Interventions Are a Scalable Treatment for Academic Underachievement." Psychological Science 1-10. https://web.stanford.edu/~paunesku/articles/paunesku_2015.pdf.

11 https://educationendowmentfoundation.org.uk/pdf/generate/?u=https://educationendowmentfoundation.org.uk/pdf/toolkit/?id=138&t=Teaching%20and%20Learning%20Toolkit&e=138&s=

12 OECD (2015), Students, Computers and Learning: Making the Connection, OECD Publishing, Paris.DOI: http://dx.doi.org/10.1787/9789264239555-en.

13 Early exposure here is defined as under six-years-old. Note that PISA is silent on the impact of technology on younger children; other literature does suggest limiting use for infants and toddlers due to negative impact on sleep, BMI, cognitive, language, and emotional processing, and limited positive benefits.

14 See for example: http://digitalcommons.kent.edu/flapubs/72/; http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=3446&context=libphilprac; https://www.researchgate.net/publication/262156457_The_Effects_of_Online_Interactive_Games_on_High_School_Students'_Achievement_and_Motivation_in_History_Learning; http://surface.syr.edu/cgi/viewcontent.cgi?article=1061&context=cfs_etd; http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.902.5638&rep=rep1&type=pdf; http://ijoc.org/index.php/ijoc/article/view/5586/1742.

15 "SEP cancela entrega de tablets a las primarias." Excelsior. September 10, 2016. http://www.excelsior.com.mx/nacional/2016/09/10/1116078; Program aprende 2.0

16 http://www.mineducacion.gov.co/1759/articles-359520_recurso_41.pdf; http://www.colombiaaprende.edu.co/html/micrositios/1752/w3-propertyname-3203.html

17 Jorge Aruero (2013) "Test-Mex: Estimating the effects of school year length on student performance in Mexico," Journal of Development Economics. http://econpapers.repec.org/article/eeedeveco/v_3a103_3ay_3a2013_3ai_3ac_3ap_3a353-361.htm

18 Achieving world-class education in Brazil:the next agenda; World Bank 2012. Table 9: (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.364.5184&rep=rep1&type=pdf)

19 Folha de Pernambuco, August 29, 2016. Pernambuco is experimenting with seven-hour average school days, made up of three days with the regular five hours and two days of 10 hours. Another group of reference schools in that state has pushed school days to nine hours. São Paulo is attempting a similar program, offering up to 9.5 hours of instruction per day in more than 250 schools

20 Based upon average annual cost per student for raising every part-time student to five hours of instruction. Cost estimates based on simulations from Initial Quality-Adjusted Student Cost (Custo Aluno-Qualidade Inicial, CAQi), a methodology referenced in the National Education Plan of 2014 based on the work of Verhine and Farenzena (2006).

21 Based upon average hourly cost when raising part-time students to a full-time program with 6.5 hours of instruction per day and already full-time students up to 6.5 hours of instruction per day.

22 Audit of full-time school programs by State Audit Office, 2016 (Tribunal de Contas do Estado de Sao Paulo, report TC – 3.554/026/15) 2 Initial Quality-adjusted Student Cost (Custo Aluno-Qualidade Inicial, CAQi), a methodology referenced in the National Education Plan of 2014 based on the work of Verhine and Farenzena (2006). 3 UNDIME, undime.org.br/noticia/escola-em-tempo-integral-comeca-a-avancar-no-brasil).

23 Shonkoff, Jack P. and Deborah A. Phillips, eds. From Neurons to Neighborhoods: the Science of Early Development. Board on Children, Youth, and Families: National Research Council and Institute of Medicine. National.

24 Carneiro and Heckman 2003; Minnesota Federal Reserve Bank, "The Region" December 2003; Arthur Reynolds et al., "Age 21 Cost Benefit analysis of the Title 'Chicago Child-Parent Center Programs." Waisman Center – University of Wisconsin Madison, June 2001 : Mann, E., Reynolds, A., Robertson, D., and Temple, J. "Age 26 Cost-Benefit Analysis of the Title I Chicago Child-Parent Center Program." HighScope: "Lifetime Effects: The High Scope Perry Preschool Study Through Age 40" (2005); The Carolina Abecedarian Project: website; Carneiro and Heckman 2003; Center for Public Education website; HeadStart fade out: https://ies.ed.gov/ncee/wwc/EvidenceSnapshot/636; https://www.acf.hhs.gov/opre/resource/head-start-impact-study-final-report-executive-summary)

25 The Early Years: Child Well-Being and the Role of Public Policy (2015), edited by Samuel Berlinski and Norbert Schady.

26 National Institute for Early Education Research (NIEER) National Quality Standards Checklist; Infant and Toddlers Environment Rating Scale, (ITERS-R) (Harms, Cryer, and Clifford 1990); the Early Childhood Environment Rating Scale (ECERS-R) (Harms and Clifford 1980; Harms, Clifford, and Cryer 1998); and the Family Child Care Environment Rating Scale (FCCERS-R) (Harms and Clifford 1989); Classroom Assessment Scoring System (CLASS) (Pianta, La Paro, and Hamre 2008a; La Paro, Hamre, and Pianta 2012; Hamre and others 2014); Knowledge of Infant Development Inventory (KIDI) (MacPhee 1981).

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