THE DEEPEST LEARNERS:

WHAT PISA CAN REVEAL ABOUT THE LEARNING THAT MATTERS

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ALLIANCE FOR
EXCELLENT EDUCATION

At a time when the United States has committed itself to ensuring that all students graduate from high school ready for college and careers, there is concern that far too few high school students currently have the knowledge and skills they need to succeed in postsecondary education and training. However, there is little evidence about the extent to which U.S. students possess the competencies needed for success, and whether other education systems are better able to equip their youth with those abilities.

One place to look for such evidence is the Programme for International Student Assessment (PISA), a test administered every three years by the Organisation for Economic Co-operation and Development (OECD) to fifteen-year-olds in more than sixty countries. In contrast to other international assessments, PISA is designed to measure whether students can use their knowledge to think critically, solve problems, and communicate what they understand. These abilities, known as deeper learning, are precisely the kinds of abilities needed for college and the workplace. PISA thus provides an important window into deeper learning and nations' success in preparing students for life after high school.

In 2012, the OECD administered PISA to students in sixty-five countries and education systems, as well as three U.S. states.[1] The test measured students' abilities in reading literacy, mathematical problem solving, and science. Much of the attention to the results will likely focus on the international rankings, which show which countries, on average, performed best, and which countries improved their relative performance (or declined) since the last administration of the test, in 2009. In addition, the OECD is producing a report that will examine the results in light of the U.S. Common Core State Standards in mathematics.

This report will examine what PISA reveals about deeper learning. It will describe the competencies associated with deeper learning and the evidence of their importance in students' lives after high school. It will show the ways that PISA measures these competencies. And it will show the 2012 results: which countries appear to be more successful in getting more of their students to develop deeper learning competencies, and how these results compare with those in the United States. It will also show which countries appear to produce greater equity in their educational outcomes—those countries with the narrowest gaps between high-performing and low-performing students.

The report will look at evidence about the countries with large numbers of top performers to discover policies and practices that seem to be associated with their ability to enable more students to develop deeper learning competencies. It will also show new data from the 2012 mathematics assessment that indicates the extent to which students have had the opportunity to learn the kinds of skills measured by PISA. It will conclude with implications for the United States and recommendations for policy.

A note of caution is in order. PISA is a test administered at a single time. It does not measure all of the abilities students should demonstrate. And it provides a snapshot of a nation's performance; it cannot definitively link

policies and practices to results. Yet through the results and the extensive data gathered from student and school questionnaires, it provides important insights into policies and practices that can inform policymakers as they continue to refine their education systems. The findings on deeper learning can provide some guidance to the United States as states move forward to implement standards for college and career readiness.

THE DEEPER LEARNING COMPETENCIES AND WHY THEY MATTER

Deeper learning competencies are not new. For centuries, schools have taught students to develop deep content knowledge, to use that knowledge to think critically and solve problems, to be able to communicate in a variety of media, to collaborate with peers, to reflect on their own learning, and to develop appropriate academic mind-sets.

An extensive study by the National Research Council found that these competencies are associated with improved educational, career, and health outcomes for adults.[2] The study found that deeper learning, which the report defined as the ability to transfer knowledge to new settings, a critical goal for education, can develop these competencies. The report also found that cognitive competencies can be taught in ways that promote transfer.

There also is increasing evidence that such abilities are necessary for all students, not just for a select few. A study by Anthony Carnevale and his colleagues at Georgetown University's Center for Education and the Workforce found that in 2018 two-thirds of U.S. jobs will require some postsecondary education, including four-year colleges, two-year colleges, and workplace training programs, compared with just over half in 1992 and one third in 1973. Only 10 percent of jobs will be able to be done by high school dropouts, the study found.[3]

Why? In large part because technology has changed the workplace. The ubiquity of computers means that routine tasks—the kind that can be performed by people with little education—have declined in importance; computers can perform those tasks or they can be outsourced to countries that pay workers far less than the United States. But tasks that require expert thinking and complex communication are increasingly important. That means that workers with higher levels of educational attainment and skills are in demand, while those who lack such skills are not.[4]

Virtually all states have embraced college and career readiness—and, by implication, deeper learning—as a goal for the education system. Forty-six states and the District of Columbia have adopted the Common Core State Standards, which spell out the knowledge and skills all students should demonstrate each year. The standards include numerous expectations for deeper learning; for example, in English language arts/literacy, they require students to be able to construct and evaluate evidence-based arguments and to demonstrate complex communications. In mathematics, the standards require students to solve non-routine problems and to reason from evidence.

The states that have adopted the standards are currently implementing them in classrooms by developing and acquiring curriculum materials, preparing teachers for the new expectations, and developing new assessments to measure students' abilities against the standards. Two state consortia, the Partnership for the Assessment of Readiness for College and Careers (PARCC) and the Smarter Balanced Assessment Consortium, are developing assessments intended to measure student learning against the standards. These assessments, which are expected to be administered for the first time in the 2014–15 school year, are likely to assess deeper learning competencies more extensively than do current state tests.[5]

HOW PISA MEASURES DEEPER LEARNING

Unlike many tests, including other international assessments, PISA was designed from the outset explicitly to measure many deeper learning competencies. PISA questions test whether students can apply their knowledge to real-world problems "and to analyse, reason and communicate effectively as they pose, interpret and solve problems in a variety of situations."[6]

In addition, PISA also includes an extensive student questionnaire that asks students about their motivations to learn and their attitudes about learning, which are also key deeper learning competencies. In 2012, for the first time, the questionnaire included items that asked students whether they had encountered problems that asked them to apply mathematics in real-world settings, the kind of problems PISA emphasizes.

Students who score at the highest levels on PISA demonstrate deeper learning competencies. PISA scores are reported in two ways: scale scores and performance levels. The scale scores are similar to those used on the National Assessment of Educational Progress (NAEP). They measure student performance on a scale of 0 to 1,000, with a mean score of 500.

In addition, PISA also reports the proportion of students who perform at six performance levels, which are based on the difficulty of the tasks students are asked to perform. Those at Levels 5 and 6, who can complete the most cognitively complex tasks, are considered "top performers."

A study conducted by the OECD found that top performance on PISA, particularly in reading, leads to positive outcomes for young people. For six years the study followed Canadian students who had taken PISA in 2000 at age fifteen. It found that, even after controlling for background characteristics, such as parental education and other demographic factors, students who had reached Level 5 or above in reading on PISA were much more likely than those who did not reach that level to be in college at age twenty-one. High performance in reading was also associated with higher earnings in the workplace.[7]

PISA QUESTIONS TEST WHETHER STUDENTS CAN APPLY THEIR KNOWLEDGE TO REAL-WORLD PROBLEMS "AND TO ANALYSE, REASON AND COMMUNICATE EFFECTIVELY AS THEY POSE, INTERPRET AND SOLVE PROBLEMS IN A VARIETY OF SITUATIONS."

Deeper learning in mathematics

The descriptions of student knowledge and skills at the top performance levels show the deeper learning competencies that they can demonstrate. For example, in mathematics, a student at Level 5 can

> develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare and evaluate appropriate problem-solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations,

> and insights pertaining to these situations. They begin to reflect on their work and can formulate and communicate their interpretations and reasoning.

As an example of a task that exemplifies performance at Level 5, consider the following, from a set of tasks called "Climbing Mount Fuji":

> Toshi wore a pedometer to count his steps on his walk along the Gotemba trail. His pedometer showed that he walked 22,500 steps on the way up.
>
> Estimate Toshi's average step length for his walk up the 9 km Gotemba trail. Give your answer in centimeters (cm).

Although the calculation for this problem is relatively straightforward, students must be able to rearrange the conventional formula (distance = average step length x number of steps) and convert units from kilometers to centimeters.

Level 6 is even more cognitively challenging. Students who perform at that level in mathematics can

> conceptualise, generalise and use information based on their investigations and modelling of complex problem situations, and can use their knowledge in relatively non-standard contexts. They can link different information sources and representations and move flexibly among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understanding, along with a mastery of symbolic and formal mathematical operations and relationships, to develop new approaches and strategies for addressing novel situations. Students at this level can reflect on their actions, and can formulate and precisely communicate their actions and reflections regarding their findings, interpretations and arguments, and can explain why they were applied to the original situation.

The following is an example of a problem typifying performance at Level 6:

> Helen rode her bike from her home to the river, which is 4 km away. It took her 9 minutes. She rode home using a shorter route of 3 km. This took her only 6 minutes.
>
> What was Helen's average speed, in km/h, for her trip to the river and back?

Here, students must know the mathematical definition of "average speed," or apply proportional reasoning, and convert units from minutes to hours.

Deeper learning in reading

In reading, tasks at top-performing levels require students to demonstrate deeper learning as well. At Level 5,

> [t]asks . . . that involve retrieving information require the reader to locate and organise several pieces of deeply embedded information, inferring which information in the text is relevant. Reflective tasks require critical evaluation or hypothesis, drawing on specialised knowledge. Both interpretative and reflective tasks require a full and detailed understanding of a text whose content or form is unfamiliar. For all aspects of reading, tasks at this level typically involve dealing with concepts that are contrary to expectations.

At Level 6,

> [t]asks . . . typically require the reader to make multiple inferences, comparisons and contrasts that are both detailed and precise. They require demonstration of a full and detailed understanding of one or more texts and may involve integrating information from more than one text. Tasks may require the reader to deal with unfamiliar ideas, in the presence of prominent competing information, and to generate abstract categories for interpretations.

Reflect and evaluate tasks may require the reader to hypothesise about or critically evaluate a complex text on an unfamiliar topic, taking into account multiple criteria or perspectives, and applying sophisticated understandings from beyond the text. A salient condition for *access and retrieve* tasks at this level is precision of analysis and fine attention to detail that is inconspicuous in the texts.

An example of a task exemplifying this level of performance asks students to read the first few pages of a play by the Hungarian dramatist Ferenc Molnár and asks, "What were the characters in the play doing *before* the curtain went up?"

This task is particularly challenging because it requires students to make an interpretation based on their understanding of what the play states. While a clue can be found in the text itself, it is located in the middle of the passage, rather than at the beginning, where most students making a literal interpretation would look for it.

Deeper learning in science

Top performers in science, likewise, can demonstrate deeper learning. At Level 5,

> students can identify the scientific components of many complex life situations, apply both scientific concepts and knowledge about science to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed inquiry abilities, link knowledge appropriately, and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis.

A problem that exemplifies performance at that level shows two graphs, one presenting trends in carbon dioxide emissions over time and the other presenting trends in average earth temperatures over time. The problem states, "André concludes from these two graphs that it is certain that the increase in the average temperature of the Earth's atmosphere is due to the increase in the carbon dioxide emission." It then asks, "Another student, Jeanne, disagrees with André's conclusion. She compares the two graphs and says that some parts of the graphs do not support his conclusion. Give an example of a part of the graphs that does not support André's conclusion. Explain your answer."

This question involves critical thinking, because it asks students to use evidence to support a conclusion; in this case, students must use evidence to refute a conclusion. Students must also communicate effectively in order to explain their reasoning. Students who do not explain their answer sufficiently receive partial credit.

Level 6 indicates a higher level of deeper learning. At Level 6,

> students can consistently identify, explain and apply scientific knowledge and knowledge about science in a variety of complex life situations. They can link different information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social or global situations.

A problem that exemplifies this level is also related to the climate change graphs. In this case, the problem states that

> André persists in his conclusion that the average temperature rise of the Earth's atmosphere is caused by the increase in the carbon dioxide emission. But Jeanne thinks that his conclusion is premature. She says: "Before accepting this conclusion you must be sure that other factors that could influence the greenhouse effect are constant". Name one of the factors that Jeanne means.

IN SHANGHAI-CHINA, 56 PERCENT OF STUDENTS WERE TOP PERFORMERS IN AT LEAST ONE SUBJECT AREA, AND 19.6 PERCENT WERE TOP PERFORMERS IN ALL THREE.

This problem requires students to identify scientific issues and to explain phenomena scientifically. It thus requires a deep understanding of core content, in addition to critical thinking and communication.

THE DEEPEST LEARNERS ON THE 2012 PISA

In almost all countries, only a small percentage of students in 2012 reached the top levels and demonstrated deeper learning competencies. However, there were wide variations among nations. In Shanghai-China, 56 percent of students were top performers in at least one subject area, and 19.6 percent were top performers in all three. Among the industrialized nations in the OECD, on average 16.2 percent were top performers in at least one subject and 4.4 percent were top performers in all three. However, there were some variations among the countries. In Finland, for example, 24 percent were top performers in at least one subject and 7.4 percent were top performers in all three; in Japan, 30 percent were top performers in at least one subject and 11.3 percent in all three; and in Canada, 21.9 percent were top performers in at least one subject and 6.5 percent in all three. In the U.S., 12 percent of students were top performers in at least one subject and 4.7 percent were top performers in all three.

Mathematics had the highest proportion of students performing at top levels. On average among OECD nations, 9.3 percent of students performed at Level 5 and 3.3 percent performed at Level 6. Many countries had much higher proportions of students at top levels. In Shanghai-China, 24.6 percent of students performed at Level 5 and 30.8 percent performed at Level 6. In Singapore, 21 percent performed at Level 5 and 19 percent performed at Level 6.

Among European nations, the Netherlands stood out, with 14.9 percent at Level 5 and 4.4 percent at Level 6. In Switzerland, 14.6 percent performed at Level 5 and 6.8 percent at Level 6. Traditionally high-performing Finland came in somewhat lower, with 11.7 percent at Level 5 and 3.5 percent at Level 6. In the Western Hemisphere, Canada led the pack with 12.1 percent at Level 5 and 4.3 percent at Level 6.

In the U.S., 6.6 percent of students attained Level 5, about the same proportion as Latvia, Lithuania, and Sweden, while 2.2 percent performed at Level 6, comparable to Hungary, Israel, and Italy.

In several countries, the number of top performers in mathematics has declined over time. In Finland, for example, the proportion of students at Level 5 or above dropped from 23.4 percent in 2003 to 15.3 percent in 2012. In Poland, by contrast, the proportion of top performers shot up from 10.1 percent to 16.7 percent over that period. In the U.S., the proportion of top performers declined from 10.1 percent—the same level as Poland—to 8.8 percent, just above Latvia, Lithuania, and Sweden, and just below Hungary.

In reading, on average among OECD countries, 7.3 percent of students reached Level 5 and 1.1 percent reached Level 6. The number of countries far exceeding that level was smaller than in mathematics. In Shanghai-China, 21.3 percent of students reached Level 5 and 3.8 percent reached Level 6. In Singapore, 16.2 percent attained Level 5 and 5.0 percent reached Level 6.

Some 11.3 percent of Finland's fifteen-year-olds performed at Level 5 and 2.2 percent reached Level 6, while in Canada, 10.8 percent reached Level 5 and 2.1 percent reached Level 6.

In the U.S., 6.9 percent reached Level 5 and 1 percent attained Level 6. Those proportions were similar to those reached in Sweden and slightly lower than the proportion of top performers in the United Kingdom.

As in mathematics, several countries showed declines in top performance in reading. Australia's top performers dropped from 17.6 percent in 2000 to 11.7 percent in 2012, while Finland's dropped from 18.5 percent to 13.5 percent over that period. Poland again showed a big increase, from 5.9 percent to 10 percent, and France's top performers increased from 8.5 percent to 12.9 percent. In the U.S., the number of top performers in reading declined from 12.2 percent in 2000 to 7.9 percent in 2012.

In science, the picture is similar to that in reading. Among OECD countries, on average 7.2 percent of fifteen-year-olds performed at Level 5 and 1.2 percent performed at Level 6. Shanghai-China again stood out, with 23 percent at Level 5 and 4.2 percent at Level 6. Other high performers included Singapore, with 16.9 percent at Level 5 and 5.8 percent at Level 6; Finland, with 13.9 percent at Level 5 and 3.2 percent at Level 6; and Australia, with 10.9 percent at Level 5 and 2.6 percent at Level 6.

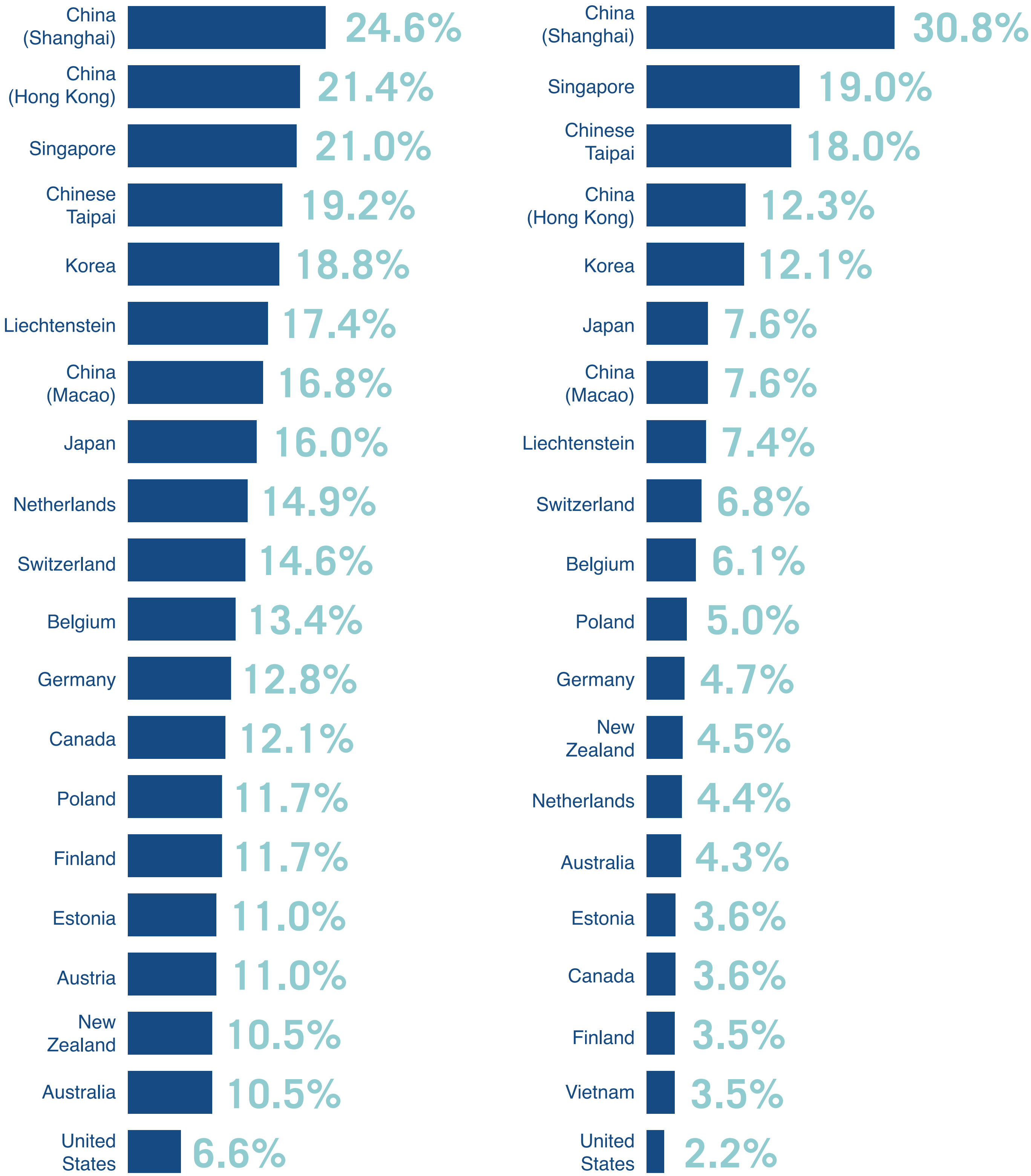
The U.S. again trailed the international average, with 6.3 percent at Level 5 and 1.1 percent at Level 6, comparable to the performance of the Czech Republic, Denmark, and Norway.

The decline in top performance in the U.S. in science was less severe than in mathematics and reading, and was not statistically significant. But New Zealand's top performers dropped from 17.6 percent in 2006 to 13.4 percent in 2012, and Chinese Taipei's declined from 14.6 percent to 8.3 percent over the same period. Poland again showed an increase.

PERCENTAGE OF POPULATION SCORING AT LEVELS 5 AND 6 IN MATH

Percentage of Population Scoring at Level 5 in Math

Percentage of Population Scoring at Level 6 in Math



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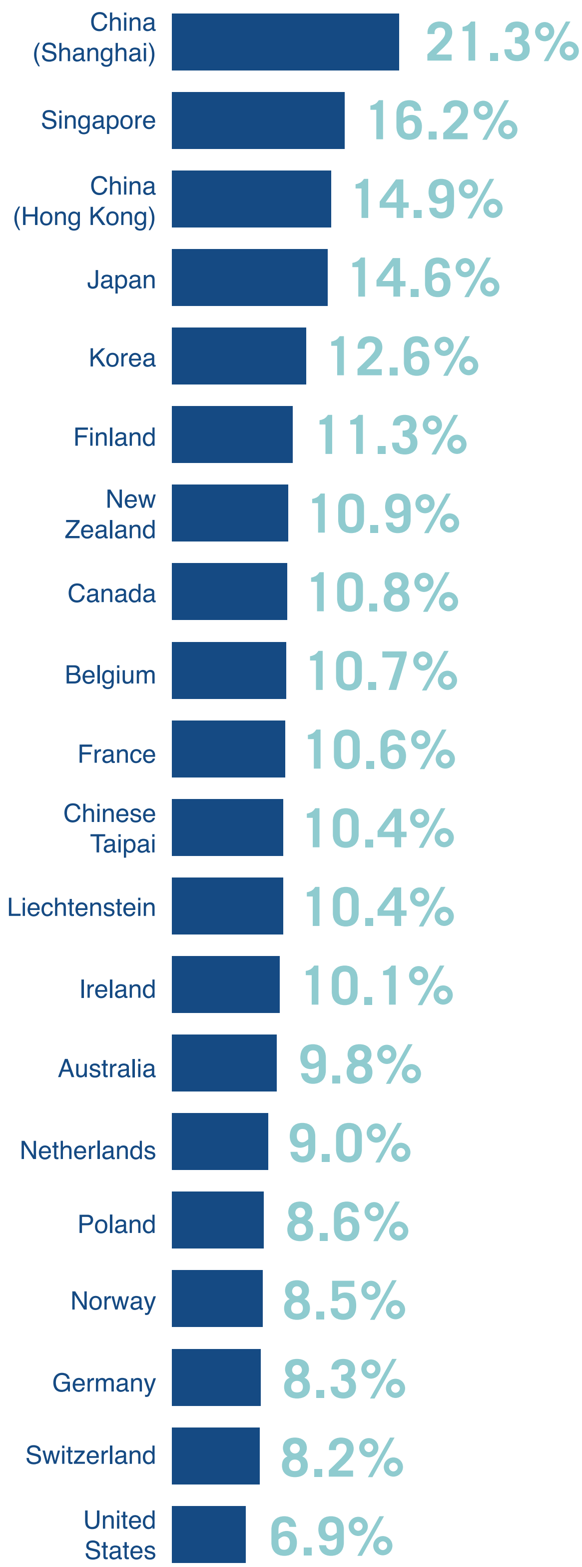
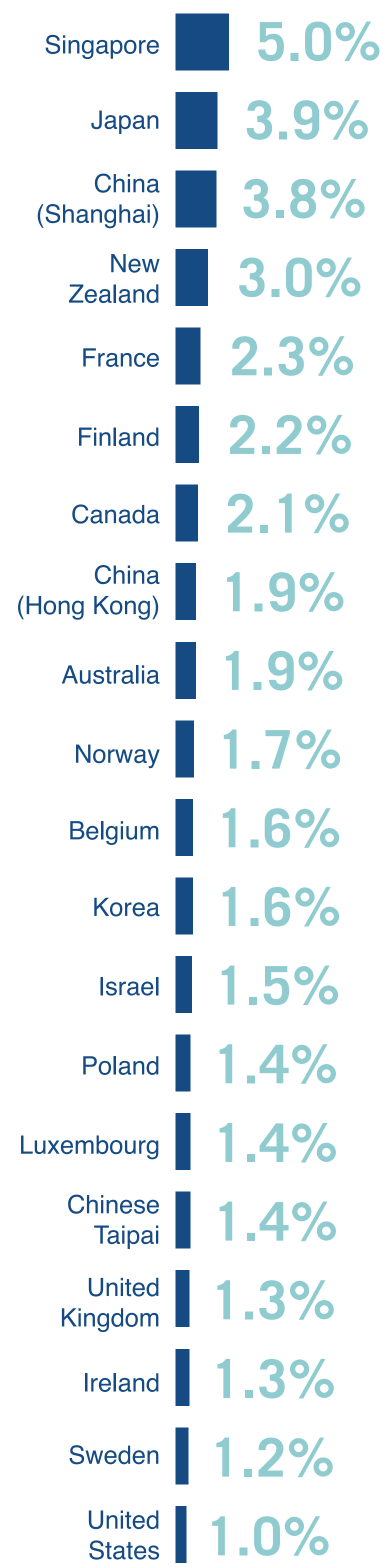
PERCENTAGE OF POPULATION SCORING AT LEVELS 5 AND 6 IN READING

Percentage of Population Scoring at Level 5 in Reading



Percentage of Population Scoring at Level 6 in Reading



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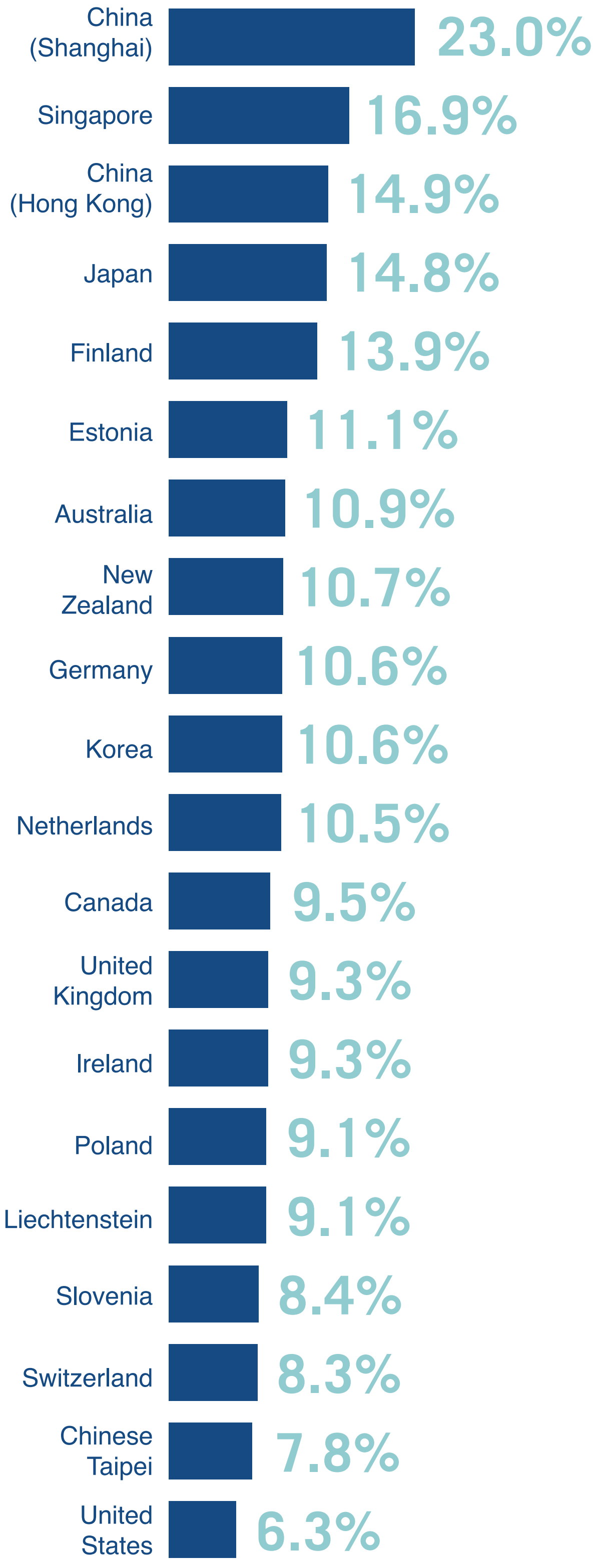
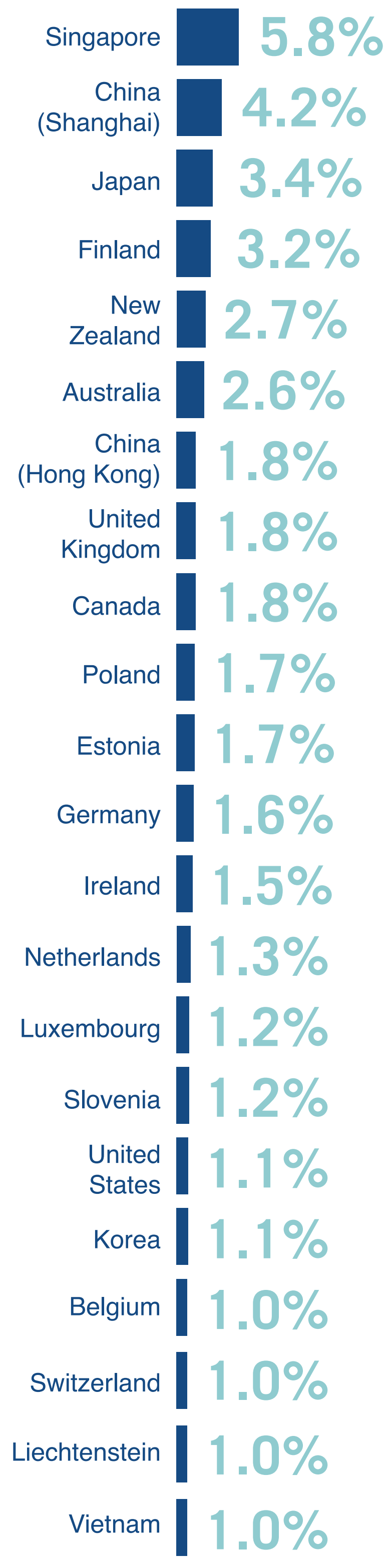
PERCENTAGE OF POPULATION SCORING AT LEVELS 5 AND 6 IN SCIENCE

Percentage of Population Scoring at Level 5 in Science



Percentage of Population Scoring at Level 6 in Science



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ACHIEVEMENT GAPS ON THE 2012 PISA

In addition to showing the extent of top performance, the PISA data also shows the extent of achievement gaps: specifically, the gaps between high and low performance. Because high performance represents a demonstration of deeper learning competencies, a small gap between high and low performance indicates that countries are not leaving large numbers of students behind while enabling top performers to succeed.

In a few countries, the proportion of top performers far exceeds the proportion of low performers (those at Level 2 and below). In mathematics, Shanghai-China had by far the biggest positive gap, with 55.4 percent top performers and only 3.8 percent low performers. In Singapore, 40 percent of students were top performers and 8.3 percent were low performers. Other countries, such as Japan and Switzerland, had about twice as many high performers as low performers.

In several other high-performing nations, the proportion of top performers in mathematics exceeded that of low performers, but only slightly. In Finland, for example, 15.3 percent of students scored at Level 5 or above, while 12.3 percent scored at Level 2 or below. In Canada, 16.4 percent performed at top levels, while 13.8 percent scored at the lowest levels.

In the U.S., the number of low performers in mathematics far exceeded the number of top performers: 25.8 percent were at Level 2 or below, while only 8.8 percent reached the top levels.

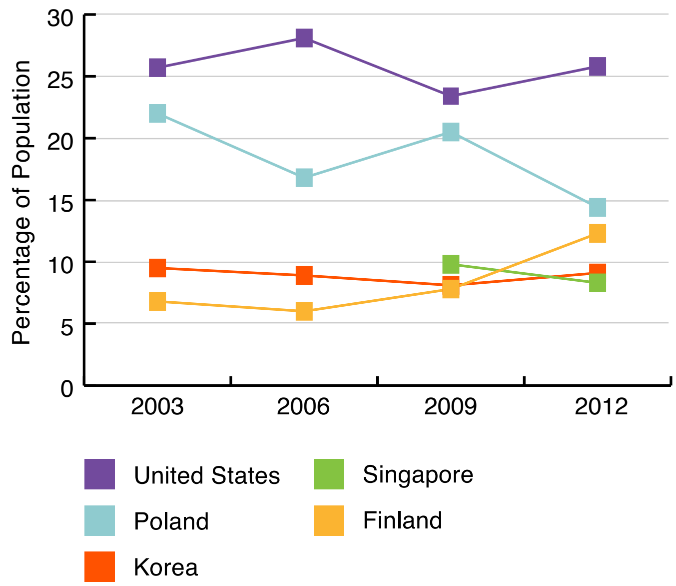
In reading, the story is similar, though the gaps are less extreme. In Shanghai-China, 25.1 percent of students were top performers and 2.9 percent were low performers; in Singapore, 21.2 percent were top performers and

9.9 percent were low performers; in Finland, 13.5 percent were top performers and 11.3 percent were low performers; and in Canada, 12.9 percent were top performers and 10.9 percent were low performers.

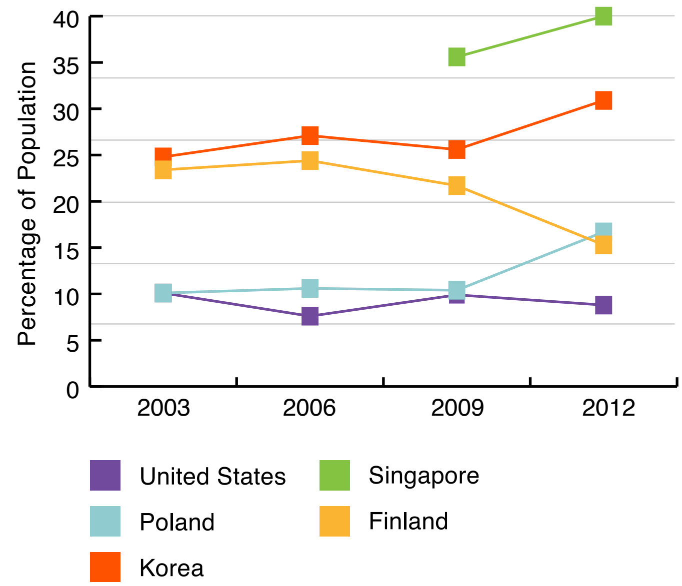
In the U.S., 7.9 percent were top performers and 16.6 percent were low performers. While the proportion of top performers has declined, as noted above, the proportion of low performers has dropped as well. In 2000, 17.9 percent of students scored at Level 2 or below.

The situation is similar in science. One big difference was in Finland, where 17.7 percent of students scored in the top levels and only 7.7 percent scored at Level 2 or below. However, the proportion of top performers in Finland has declined since 2006 and the proportion of low performers has grown. In the U.S., 7.5 percent were top performers (down from 9.1 percent) and 18.1 percent were low performers (down from 24.4 percent).

Percentage of Population Scoring at or Below Level 2 on PISA Math by Country Over Time



Percentage of Population Scoring at or Above Level 5 on PISA Math by Country Over Time



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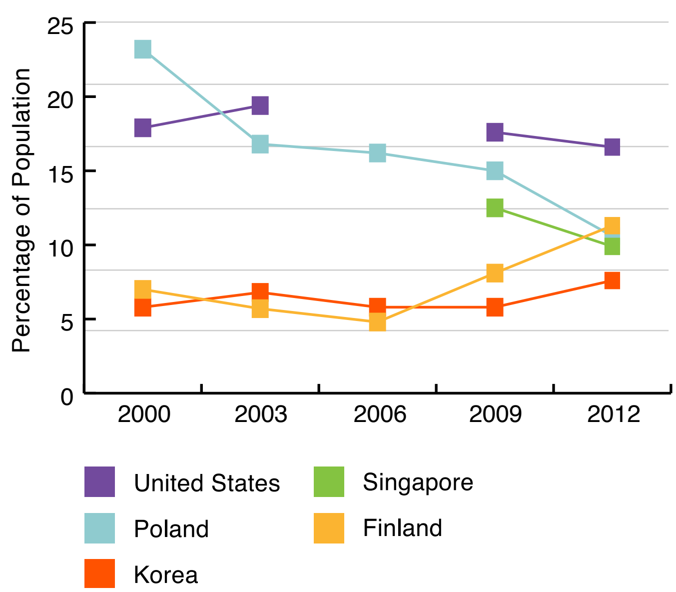
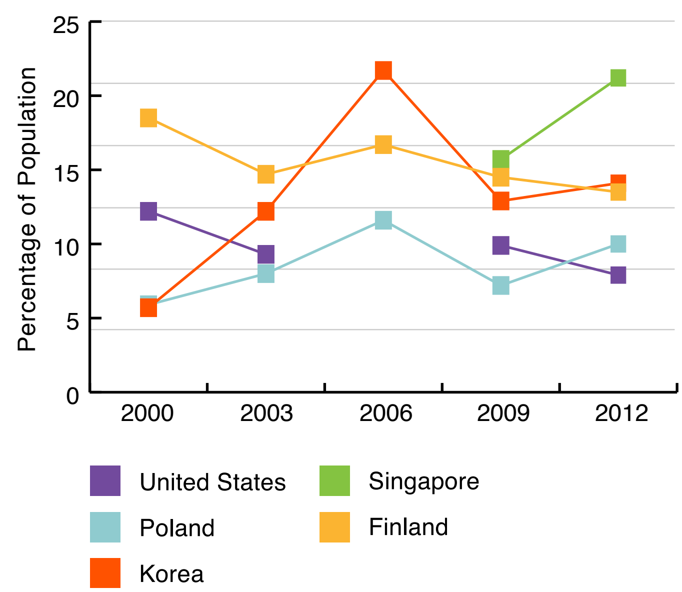
Percentage of Population Scoring at or Below Level 2 on PISA Reading by Country Over Time



Percentage of Population Scoring at or Above Level 5 on PISA Reading by Country Over Time



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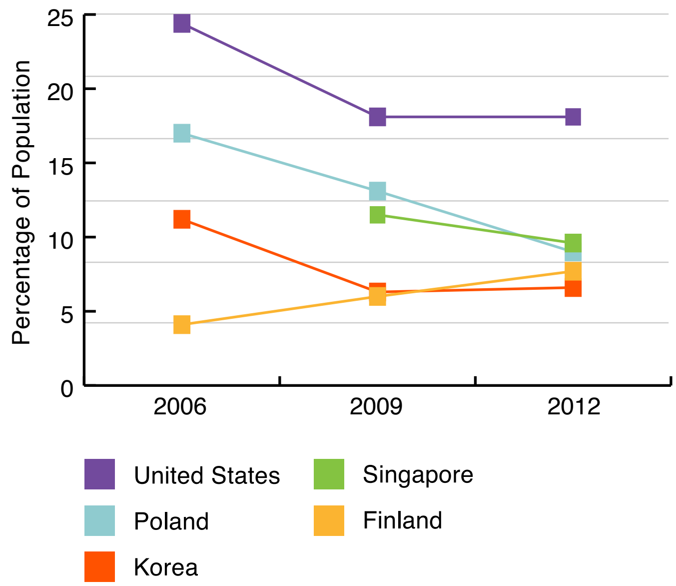
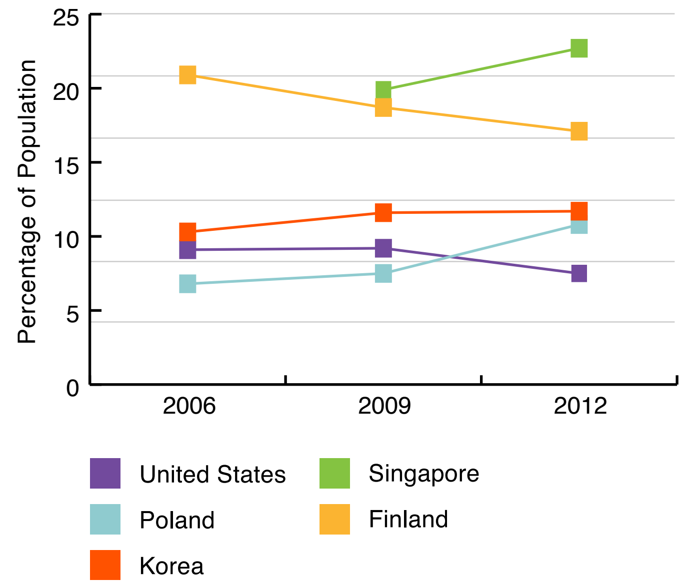
Percentage of Population Scoring at or Below Level 2 on PISA Science by Country Over Time



Percentage of Population Scoring at or Above Level 5 on PISA Science by Country Over Time



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CHARACTERISTICS OF THE DEEPEST LEARNERS

The 2012 data clearly shows that some countries produce large numbers of students who can perform at the top levels on PISA and demonstrate deeper learning. These countries tend to be ones with high overall performance. However, there might be factors that lead to top performance as well. What is it about countries that produce top performers that enables them to do so in such large numbers? What policies and practices do they employ that lead to deeper learning?

PISA is a limited tool for answering these questions. Yet an extensive body of research already exists that describes the conditions and practices in high-performing nations.

While this research generally focuses on reasons for these countries' overall success on assessments like PISA, it can also point to some factors that might be associated with their success in producing top performers. In addition, the 2012 PISA also included an extensive student survey that provides some clues.

One policy the nations with top performers appear to share is clear expectations for student learning that include an emphasis on the ability to use knowledge to solve real-world problems. Such an emphasis might seem unlikely in Asian countries, which have reputations for a focus on drill and rote learning, but these nations, too, have shifted to curricula and assessments that address critical thinking, problem solving, communication, and other deeper learning competencies.

ONE POLICY THE NATIONS WITH TOP PERFORMERS APPEAR TO SHARE IS CLEAR EXPECTATIONS FOR STUDENT LEARNING THAT INCLUDE AN EMPHASIS ON THE ABILITY TO USE KNOWLEDGE TO SOLVE REAL-WORLD PROBLEMS.

For example, Singapore in 2004 launched an initiative called Teach Less, Learn More, which was aimed at addressing concerns that Singapore's students were too passive as learners and uninspired. The initiative aimed to

> touch the hearts and minds of learners by promoting a different learning paradigm in which there is less dependence on rote learning, repetitive tests and instruction, and more on engaged learning, discovery through experiences, differentiated teaching, learning of lifelong skills, and the building of character through innovative and effective teaching approaches and strategies.[8]

Similarly, Shanghai-China revised its curriculum in 1998 to place a greater emphasis on active inquiry by students. Toward that end, the curriculum includes an inquiry-based component, made up mostly of extracurricular activities, aimed at engaging students in research projects that enable them to think creatively and critically.[9]

Poland, which has seen a sharp increase in the proportion of top performers, launched a major education reform in 1999 that focused in part on eliminating a tracking system in which large numbers of students were shunted to low-level vocational programs and instead providing all students with a rigorous curriculum that taught the competencies needed for a twenty-first-century knowledge economy. Since 2000, Poland's overall PISA scores have risen dramatically and the proportion of top performers has increased by nearly 50 percent.[10]

The 2012 top performers also tend to use assessments that measure deeper learning competencies. These assessments are generally tied closely to the curriculum and are used either in the classroom to guide instruction or externally, at the end of secondary school, to determine entry into college. Most countries rely on teachers to score the exams, and they include substantial open-ended tasks that require students to solve complex problems and communicate their knowledge.

In Finland, where scores have declined but still show a large number of top performers, for example, the only "standardized" test is a set of voluntary examinations students take to gain entry into universities. Students choose which examinations to take, as well as which questions to answer in each exam. (For example, the mathematics examination has fifteen problems, of which students must solve ten.)

As with PISA, the Finnish exams stress critical thinking and real-world problems. The following is a problem from the basic mathematics exam:

> A solution of salt and water contains 25% salt. Diluted solutions are obtained by adding water. How much water must be added to one kilogram of the original

solution in order to obtain a 10% solution? Work out a graphic representation which gives the amount of water to be added in order to get a solution with 2–25% of salt. The amount of water (in kilograms) to be added to one kilogram of the original solution must be on the horizontal axis; the salt content of the new solution as a percentage must be on the vertical axis.[11]

In Singapore, courses include classroom-based projects, scored by teachers, that count for up to 20 percent of an examination grade. These projects are intended for students to be able to

1. Follow a detailed set or sequence of instructions and use techniques, apparatus, and materials safely and effectively;
2. Make and record observations, measurements, methods, and techniques with precision and accuracy;
3. Interpret and evaluate observations and experimental data; and
4. Identify a problem, design and plan investigations, evaluate methods and techniques, and suggest possible improvements in the design.[12]

In addition to creating expectations for student learning that include deeper learning and employing assessments that measure those outcomes, countries with top performers also ensure that teachers are deep learners themselves and are capable of leading classrooms in which students think critically, solve problems, and communicate effectively. Essentially, the method of teacher preparation and development models the kind of learning these countries expect of students.

A number of studies have shown that high-performing countries recruit top students into teaching and provide them with extensive preparation. The content of the preparation appears to make a difference as well. In Finland, for example, teachers spend a considerable amount of time in clinical practice in model schools. As Linda Darling-Hammond notes,

> Within these model schools, student teachers participate in problem-solving groups, a common feature in Finnish schools. The problem-solving groups engage in a cycle of planning, action, and reflection/evaluation that is reinforced throughout the teacher education program and is, in fact, a model for what teachers will plan for their own students, who are expected to use similar kinds of research and inquiry in their own studies.[13]

Similarly, when Singapore revamped its curriculum to focus more on critical thinking and problem solving, the National Institute of Education, which is responsible for teacher education and professional development, redesigned its preparation programs to be able to produce teachers who have developed those competencies and who are able to create learning environments in which students can develop them as well.[14]

COUNTRIES WITH TOP PERFORMERS ALSO ENSURE THAT TEACHERS ARE DEEP LEARNERS THEMSELVES AND ARE CAPABLE OF LEADING CLASSROOMS IN WHICH STUDENTS THINK CRITICALLY, SOLVE PROBLEMS, AND COMMUNICATE EFFECTIVELY.

OPPORTUNITIES TO LEARN PISA COMPETENCIES

Data from the 2012 PISA suggests that these intentions are borne out in classrooms. In addition to the assessment tasks, PISA also includes an extensive student questionnaire that provides a wealth of data on students' backgrounds and school practices. The 2012 questionnaire included a number of questions designed to get at the issue of opportunity to learn—that is, whether students' mathematics classrooms and tests, for example, focused on the kinds of abilities the assessment was intended to measure. Researchers combined the data into three indexes: students' exposure to word problems; students' exposure to formal mathematics; and students' exposure to applied mathematics.

On average, students in OECD countries said they had instruction in word problems and applied mathematics "sometimes," and in formal mathematics somewhat less frequently, although on some topics of formal mathematics students said they had encountered them often. But the frequency with which students had encountered such problems varied significantly, with some students saying that they "never" encountered applied mathematics, while others said they did so frequently.

In forty-seven of the sixty-five countries that participated in the 2012 PISA—including virtually all of the countries with large numbers of top performers—the frequency of exposure to applied mathematics is related to performance on PISA. That is, students who said they encountered such problems more frequently tended to do better than those who did not, and schools in which students had been exposed to such problems outperformed schools in which students had limited exposure to applied mathematics. However, this relationship did not hold in all countries; in sixteen countries, including the United States, there was no relationship between exposure to applied mathematics and performance on PISA. This may be because, in these countries, low-performing students are assigned to low-track curricula that have a heavy emphasis on applied mathematics.

Countries also varied widely in the extent to which students had exposure to real-world problems. For example, when asked about a problem involving calculating travel times using a train schedule, three-fifths of fifteen-year-olds in Finland said they sometimes encountered such problems, and another one-fifth said they frequently did. By contrast, in the U.S., fewer than half of students said they sometimes or frequently encountered such problems.

IMPLICATIONS FOR THE UNITED STATES

The growing evidence of the importance of deeper learning has led to a growing interest in policies and practices that ensure that all students develop deep understanding of content and the ability to apply their knowledge to solve problems, think critically, and communicate effectively. The results from the 2012 PISA show that some countries enable large numbers of students to develop those competencies, while in other countries, such as the U.S., far fewer do so. Further, in the U.S., the proportion of students attaining top performance has declined over time. Fewer than 9 percent of U.S. students reached top levels in mathematics and fewer than 8 percent did so in reading and science. The proportion at top levels in several other countries was far higher.

Existing research and the PISA data suggest some implications for policy and practice in the United States.

- **States should develop and implement standards for student performance that include expectations that students can use knowledge to solve problems, think critically, and communicate effectively.** The U.S. has made a strong start toward this goal with the development and adoption, by forty-six states and the District of Columbia, of the Common Core State Standards. As noted above, these standards set clear expectations for deeper learning, for example by expecting students to use evidence to justify conclusions in writing and to explain reasoning in mathematics.

  Yet while the standards set important targets for student learning, they must be implemented in classrooms to ensure that students can meet them. Teachers must understand the standards and be provided with tools and professional development to understand how to change their practice; states and districts need to develop and adopt new materials that reflect the standards; and states and districts need to put in place new assessments aligned to the standards. All states that have adopted the standards are taking steps in all of these areas, but their implementation varies. States need to stay the course and provide the professional development and materials all teachers and students need.

- **States should adopt and implement assessments that measure deeper learning competencies.** Here, too, states have made a strong start. Two state consortia, PARCC and Smarter Balanced, are developing assessments to measure student performance against the Common Core State Standards, and a study by two of the nation's leading assessment researchers found that the consortia's designs and sample tasks measure a substantially higher depth of knowledge than do current state tests.[15]

  However, some states have elected not to participate in the consortia or to use their assessments, because of concerns over cost or other factors. But whatever assessment these states choose needs to measure a broad range of competencies if students are to develop the abilities they need to succeed in college and the workplace. The Council of Chief State School Officers has created a set of criteria states can use in adopting assessments; by adhering to these criteria, states can ensure that their tests reflect what they expect for students.

- **States and higher education institutions should revamp teacher preparation programs and professional development programs to ensure that teachers are prepared to enable students to develop deeper learning competencies.** While some preparation programs have embraced the Common Core State Standards and provide teacher candidates with the preparation they need, not all have done so. And while states have been implementing teacher evaluation systems to measure the performance of practicing teachers, not all of these systems reflect the expectations for students. Unless the expectations for students and teachers are aligned, students will not develop the abilities they need.

  As the experience in high-performing countries shows, effective preparation and professional development not only provides teachers with the knowledge and skills they need to help students succeed, it also models the kind of learning expected of students. Preparation programs and professional development need to involve inquiry and problem solving and provide time for teachers to develop hypotheses, test them out, and make adjustments. To that end, teachers need time in the school day to collaborate with their peers and hone their practice.

- **The federal government should support deeper learning through legislation and competitive grants.** A reauthorization of the Elementary and Secondary Education Act should make clear that the goal of the law is to enable all students to graduate from high school ready for college and a career and that this goal requires the development of deeper learning competencies. The law should also support state efforts to set standards for college and career readiness that include deeper learning competencies and assessments that measure these abilities.

  In addition, competitive grant programs should award points to states and districts that propose innovative ways of developing deeper learning competencies among a larger proportion of students. The Race to the Top–District competition has made a start in this direction; future grants should continue this trend.

A NEW START IN 2015?

The steps under way in the United States to implement new standards, assessments, and teacher development programs have the potential to produce significant changes in classroom practice and student outcomes over the next few years. These changes could, in turn, result in significant improvement in PISA scores in the next round, in 2015.

Such improvement could be important in and of itself. A study by Eric Hanushek and Ludger Woessmann found that even modest improvements in PISA performance (for example, 25 points over twenty years) could result in large gains in the U.S. gross domestic product over the next few decades.[16]

More importantly, improvement in PISA performance would also signal that more students in the United States have developed the knowledge and skills they need to succeed in an increasingly complex world. The nation is moving toward that goal, and the importance of achieving it has never been greater.

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*The **Alliance for Excellent Education** is a Washington, DC–based national policy and advocacy organization dedicated to ensuring that all students, particularly those traditionally underserved, graduate from high school ready for success in college, work, and citizenship. www.all4ed.org*

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ENDNOTES

[1] Some jurisdictions, such as Shanghai-China and Chinese Taipei, participated as independent jurisdictions, and their results are reported separately. The three U.S. states that participated were Connecticut, Florida, and Massachusetts. Their results are reported independently; the results from the U.S. national sample are reported as U.S. results.

[2] National Research Council, *Education for Life and Work* (Washington, DC: National Academies Press, 2012).

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[4] F. Levy and R. J. Murnane, *Dancing with Robots: Human Skills for Computerized Work* (Washington, DC: Third Way, 2013).

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[6] OECD, *PISA 2009 Results: What Students Know and Can Do—Student Performance in Reading, Mathematics, and Science, Volume I* (Paris: Author, 2010), p. 18.

[7] OECD, *Pathways to Success: How Knowledge and Skills at Age 15 Shape Future Lives in Canada* (Paris: OECD Publishing, 2010).

[8] Quoted in V. Stewart, "Singapore: A Journey to the Top, Step by Step," in *Surpassing Shanghai: An Agenda for American Education Built on the World's Leading Systems*, ed. M. S. Tucker (Cambridge, MA: Harvard Education Press, 2011), p. 120.

[9] K. Cheng, "Shanghai: How a Big City in a Developing Country Leaped to the Head of the Class," in *Surpassing Shanghai: An Agenda for American Education Built on the World's Leading Systems*, ed. M. S. Tucker (Cambridge, MA: Harvard Education Press, 2011).

[10] S. Bin Mahfooz and K. Hovde, *Successful Education Reform: Lessons from Poland*, Europe and Central Asia Knowledge Brief, vol. 34 (Washington, DC: World Bank, November 2010).

[11] L. Darling-Hammond and L. Wentworth, *Benchmarking Learning Systems: Student Performance Assessment in International Context* (Stanford, CA: Stanford University, Stanford Center for Opportunity Policy in Education, 2010).

[12] Ibid.

[13] L. Darling-Hammond, *The Flat World and Education* (New York: Teachers College Press, 2010).

[14] Stewart, "Singapore."

[15] Herman and Linn, *On the Road to Assessing Deeper Learning*.

[16] E. Hanushek and L. Woessmann, *The High Cost of Low Educational Performance* (Paris: OECD, 2010).

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