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Are 15-year-olds creative problem-solvers?

- To do well on PISA's first assessment of creative problem-solving skills, students need to be open to novelty, tolerate doubt and uncertainty, and dare to use intuition to initiate a solution.
- Just because a student performs well in core school subjects doesn't mean he or she is proficient in problem solving. In Australia, Brazil, Italy, Japan, Korea, Macao-China, Serbia, England (United Kingdom) and the United States, students perform significantly better in problem solving, on average, than students in other countries who show similar performance in reading, mathematics and science.
- Many of the best performers in problem solving are Asian countries and economies, where students demonstrate high levels of reasoning skills and self-directed learning. Meanwhile, compared to students of similar overall performance, students in Brazil, Ireland, Korea and the United States perform strongest on interactive problems that require students to uncover useful information by exploring the problem situation and gather feedback on the effect of their actions.

In modern societies, all of life is problem solving. With constant changes in society, the environment, and in technology, what we should know in order for us to live a full life is evolving rapidly too. Adapting, learning, daring to try out new things and always being ready to learn from mistakes are essential for being resilient and successful in an unpredictable world.

Are today's 15-year-olds acquiring the problem-solving skills needed in the 21st century? New results from the PISA 2012 assessment of problem solving, which was conducted on computer and involved about 85 000 students in 44 countries and economies, help answer this question.

Large proportions of 15-year-olds lack basic problem-solving skills.

Results show that students in Singapore and Korea, followed by students in Japan, score higher in problem solving than students in all other participating countries and economies. Four more East Asian partner economies rank between 4th and 7th place: Macao-China, Hong Kong-China, Shanghai-China, and Chinese Taipei (in descending order of their mean scores). Canada, Australia, Finland, England (United Kingdom), Estonia, France, the Netherlands, Italy, the Czech Republic, Germany, the United States and Belgium (in descending order of their mean scores) all score above the OECD average, but below the former group of countries.

PISA IN FOCUS

How does PISA define problem solving?

Problem-solving competence is defined as the capacity to engage in cognitive processing to understand and resolve problem situations where a method of solution is not immediately obvious. It includes the willingness to engage with such situations in order to achieve one's potential as a constructive and reflective citizen.

The assessment uses simulated real-life problem situations – such as an unfamiliar vending machine, or a malfunctioning electronic device – to measure students' reasoning skills, their ability to regulate problem-solving processes, and their willingness to do so. These problem-solving skills are key to success in all pursuits, and can be developed in school through curricular subjects.

In the two best-performing countries – Korea and Singapore – 15-year-old students are able to engage with moderately complex situations in a systematic way. For example, 56% of students in Korea and Singapore but only 31% of students in OECD countries, on average, can troubleshoot an unfamiliar device that is malfunctioning (a task at Level 4 on the PISA proficiency scale). They grasp the links among the elements of the problem situation; they can plan a few steps ahead and adjust their plans in light of feedback; and they can form a hypothesis about why a device is malfunctioning and describe how to test it. By contrast, in the lowest-performing countries, more than 50% of students are only able to solve very simple problems that do not require them to think ahead and that are cast in familiar settings – such as determining, through trial-and-error, which solution among a limited set of alternatives best meets a single criterion (tasks at Level 1 on the proficiency scale). In Japan and Korea, only 7% of students perform below Level 2. PISA reveals that even in the best-performing countries, significant numbers of 15-year-olds do not have the basic problem-solving skills considered necessary to succeed in today's – let alone tomorrow's – world.

Problem-solving performance among participating countries/economies and regions

	Mean score	Range of ranks
Singapore	562	1 – 2
Korea	561	1 – 2
Japan	552	3
Macao-China	540	4 – 6
Hong Kong-China	540	4 – 7
Shanghai-China	536	4 – 7
Chinese Taipei	534	5 – 7
North West (Italy)	533	–
Western Australia (Australia)	528	–
North East (Italy)	527	–
Canada	526	8 – 10
Australian Capital Territory (Australia)	526	–
New South Wales (Australia)	525	–
Flemish Community (Belgium)	525	–
Victoria (Australia)	523	–
Australia	523	8 – 11
Finland	523	8 – 11
Queensland (Australia)	522	–
German-speaking Community (Belgium)	520	–
South Australia (Australia)	520	–
England (United Kingdom)	517	9 – 16
Estonia	515	11 – 15
Centre (Italy)	514	–
Northern Territory (Australia)	513	–
France	511	11 – 19
Netherlands	511	11 – 21
Italy	510	12 – 21
Czech Republic	509	12 – 20
Germany	509	12 – 21
United States	508	12 – 21
Belgium	508	14 – 21
Madrid (Spain)	507	–
Austria	506	13 – 22
Alentejo (Portugal)	506	–
Norway	503	16 – 23
OECD average	500	–
Ireland	498	20 – 24
Denmark	497	21 – 25
Basque Country (Spain)	496	–
Portugal	494	22 – 26
Sweden	491	23 – 27
Tasmania (Australia)	490	–
Russian Federation	489	23 – 27
Catalonia (Spain)	488	–
South Islands (Italy)	486	–
French Community (Belgium)	485	–
Slovak Republic	483	25 – 29
Poland	481	26 – 31
Spain	477	27 – 31
Slovenia	476	28 – 31
South (Italy)	474	–
Serbia	473	29 – 32
Croatia	466	31 – 33
Hungary	459	32 – 35
Dubai (United Arab Emirates)	457	–
Turkey	454	33 – 36
Israel	454	33 – 37
Chile	448	34 – 37
Southeast Region (Brazil)	447	–
Central-West Region (Brazil)	441	–
South Region (Brazil)	435	–
Brazil	428	38 – 39
Medellín (Colombia)	424	–
Manizales (Colombia)	423	–
Malaysia	422	38 – 39
Sharjah (United Arab Emirates)	416	–
United Arab Emirates	411	40 – 41
Bogotá (Colombia)	411	–
Montenegro	407	40 – 42
Uruguay	403	41 – 44
Bulgaria	402	41 – 44
Colombia	399	42 – 44
Cali (Colombia)	398	–
Fujairah (United Arab Emirates)	395	–
Northeast Region (Brazil)	393	–
Abu Dhabi (United Arab Emirates)	391	–
North Region (Brazil)	383	–
Ajman (United Arab Emirates)	375	–
Ras al-Khaimah (United Arab Emirates)	373	–
Umm al-Quwain (United Arab Emirates)	372	–

Notes: OECD countries are shown in bold black. Partner countries and economies are shown in bold blue. Regions are shown in black italics (OECD countries) or blue italics (partner countries).

Countries, economies and subnational entities are ranked in descending order of mean performance in problem solving.

Source: OECD, PISA 2012 Database, Figure V.2.4.

StatLink http://dx.doi.org/10.1787/888933003573

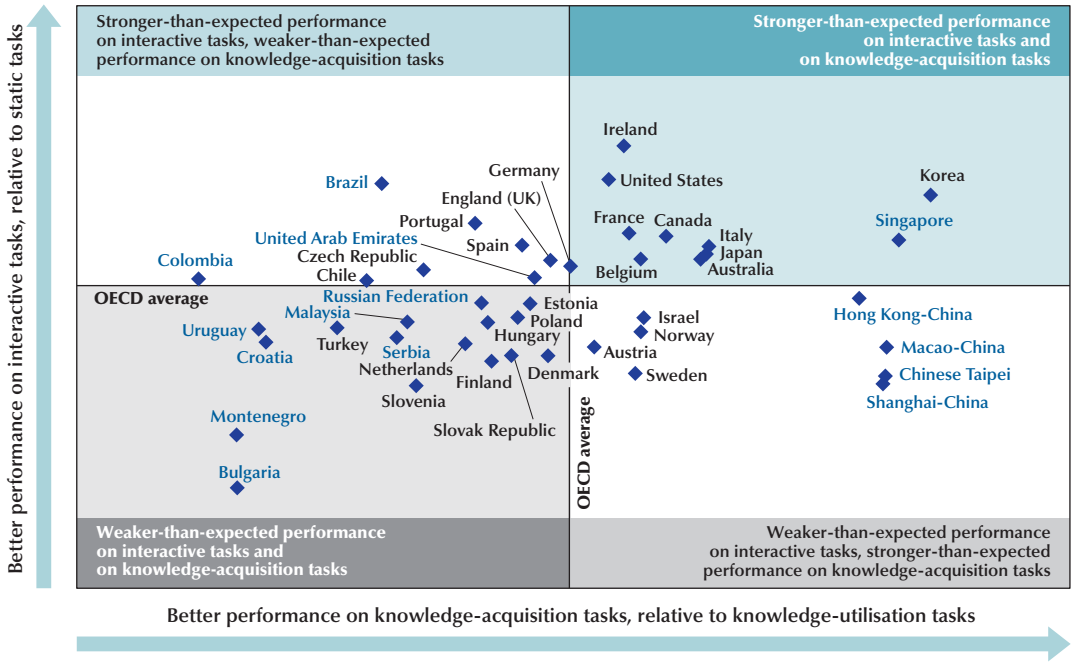
Many of the best-performing countries and economies in problem solving are those with better-than-expected performance on knowledge-acquisition tasks, which require high levels of reasoning skills and self-directed learning. Meanwhile, compared to students of similar overall performance, students in Brazil, Ireland, Korea and the United States perform strongest on interactive problems, which require students to uncover useful information by exploring the problem situation and gathering feedback on the effect of their interventions. In order to solve interactive problems, students need to be open to novelty, tolerate doubt and uncertainty, and dare to use intuition to initiate a solution.

Results show that school curricula – and teachers – make a difference in imparting problem-solving skills.

Students who do well in mathematics, reading and science also tend to show strong performance in problem solving and do well when confronted with unfamiliar problems in contexts outside of school subjects. These students are better equipped than other students to develop coherent mental representations of problem situations, plan ahead in a focused way, and show flexibility in incorporating feedback and in reflecting on problems and their solution. Similarly, those countries that better prepare students to use their knowledge in real-life contexts are also those whose students are most at ease with the cognitive processes that are required to solve everyday problems, such as interacting with unfamiliar technological devices.

Nevertheless, performance in problem solving, among both students and school systems, is not identical to that in other assessed subjects. In Australia, Brazil, Italy, Japan, Korea, Macao-China, Serbia, England (United Kingdom) and the United States, students perform significantly better in problem solving than students in other countries who show similar performance in mathematics, reading and science.

Students' strengths and weaknesses in problem solving



In interactive tasks, students must uncover some of the information required to solve the problem; static tasks have all the necessary information disclosed at the outset.

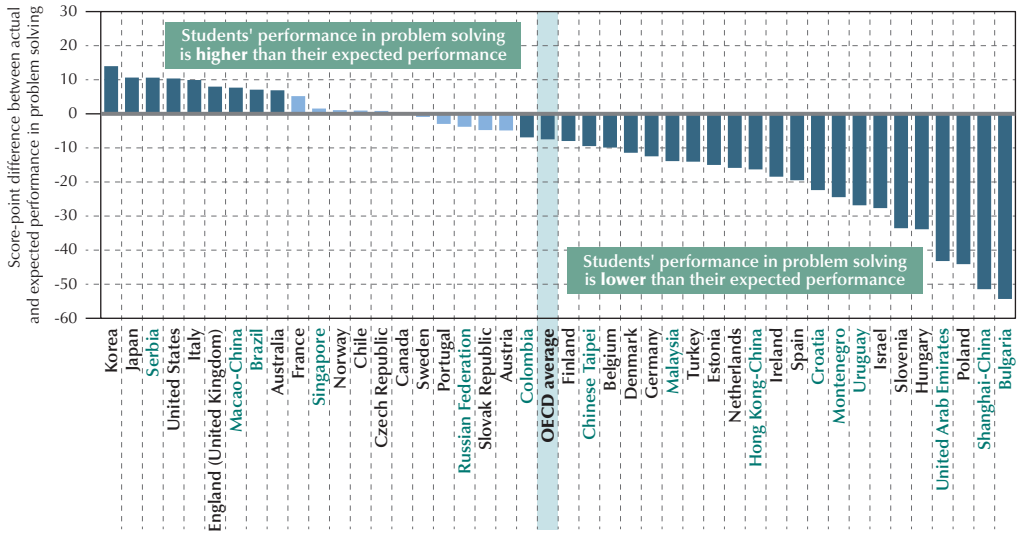
For each country/economy and for each set of tasks, expected performance is based on the country's/economy's overall performance in problem solving and on the relative difficulty of tasks, as measured across OECD countries.

Source: OECD, PISA 2012 Database, Tables V.3.1 and V.3.6.

StatLink http://dx.doi.org/10.1787/888933003592

In countries with high overall performance, stronger-than-expected performance in problem solving may imply that such countries manage to provide learning opportunities that prepare students particularly well for handling complex, real-life problems in contexts that they do not usually encounter at school. In countries with low overall performance, stronger-than-expected performance in problem solving may indicate that such countries do not make the most of student potential in the core school subjects.

Relative performance in problem solving



Notes: Statistically significant differences are shown in a darker tone.

Each student's expected performance is estimated, using a regression model, as the predicted performance in problem solving given his or her score in mathematics, reading and science.

Countries and economies are ranked in descending order of the score-point difference between actual and expected performance.

Source: OECD, PISA 2012 Database, Table V.2.6.

StatLink http://dx.doi.org/10.1787/888933003573

The bottom line: In countries and economies that rank at the top in problem-solving proficiency, students not only learn the required curriculum, they also learn how to turn real-life problems into learning opportunities – creatively devising solutions and purposely reasoning outside of school contexts. Results from the PISA assessment of problem solving show that teachers and schools can foster students' ability to confront – and solve – the kinds of problems that are encountered almost daily in 21st century life.

For more information

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See OECD (2014), *PISA 2012 Results: Creative Problem Solving: Students' Skills in Tackling Real-Life Problems* (Volume V), PISA, OECD Publishing, Paris.

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