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HOW GOOD ARE CANADIAN 15-YEAR-OLDS AT SOLVING PROBLEMS?

FURTHER RESULTS FROM PISA 2012

Introduction

The skills and knowledge of a population are crucial to the well-being of both individuals and society. For individuals, high skill levels contribute to economic security and personal fulfillment; for society, they promote productivity and economic growth.

In Canada — as in most countries — education systems recognize that there is more to skills than simply competence in core subject areas. Skills also include cross-curricular abilities: creativity, interpersonal abilities, project management, and entrepreneurship, to name but a few. Successful learners will not only master these "soft skills" while in school, but will also carry them forward into the workplace and apply them as required.

These skills can broadly be categorized as "problem-solving skills." They encompass multiple sources of knowledge, which are brought together and applied using various types of reasoning (deductive, inductive, analogical, combinatorial). Their advantage lies in allowing individuals to process multiple sources of information in unfamiliar situations, where the solution to a problem is not readily apparent.

Developing such skills, in addition to cognitive abilities, is increasingly a goal of today's education systems. In our rapidly changing world, individuals are faced more and more with unfamiliar situations where rote learning fails to serve them, and which demand problem solving. In response, governments are investing heavily in education that includes these skills.

To evaluate this investment, the Organisation for Economic Co-operation and Development (OECD) measures the problem-solving skills of youth as part of the Programme for International Student Assessment (PISA). The overall aim of PISA is to assess the extent to which 15-year-olds in participating countries and economies have acquired the essential knowledge and skills to succeed in the future.

Organization of report

This report examines the most recent results of PISA in the area of problem solving. It begins by describing the concept of problem-solving skills and PISA. It then presents the performance of Canadian youth in problem solving in a global context, explains results in terms of proficiency levels, and examines differences in problem-solving skills between provinces and among certain populations. The report finishes with a discussion of the relationship between problem-solving skills and skills in mathematics, reading, and science, and then a summary of findings.

How is problem solving assessed in PISA?

Problem solving was first tested in PISA in 2003, when it was added to the core domains of mathematics, reading, and science. Selected students were asked to test their problem-solving skills using a paper-based assessment, and Canadian students performed significantly above the OECD average. Only four of the 40 participating countries achieved a higher score than Canada.[1]

In 2012, testing was enriched by the introduction of a computer-based assessment. Problem-solving skills in this latest iteration of PISA were defined as follows:

…an individual's 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.[2]

In total, 470,000 15-year-olds from 65 countries and economies participated in PISA in 2012, of whom approximately 21,000 were from Canada.[3] Out of these countries, only 44 participated in the problem-solving option of PISA 2012.

Although 65 countries and economies participated in the PISA 2012 assessments of mathematics, reading, and science, the number participating in the problem-solving assessment was lower, at 44. The 28 participating OECD countries were: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Japan, Korea, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Turkey, United Kingdom, and United States. The 16 non-OECD countries and economies comprised: Brazil, Bulgaria, Chinese Taipei, Colombia, Croatia, Cyprus, Hong Kong-China, Macao-China, Malaysia, Montenegro, Russian Federation, Serbia, Shanghai-China, Singapore, United Arab Emirates, and Uruguay.

Canadian students performed well in problem solving

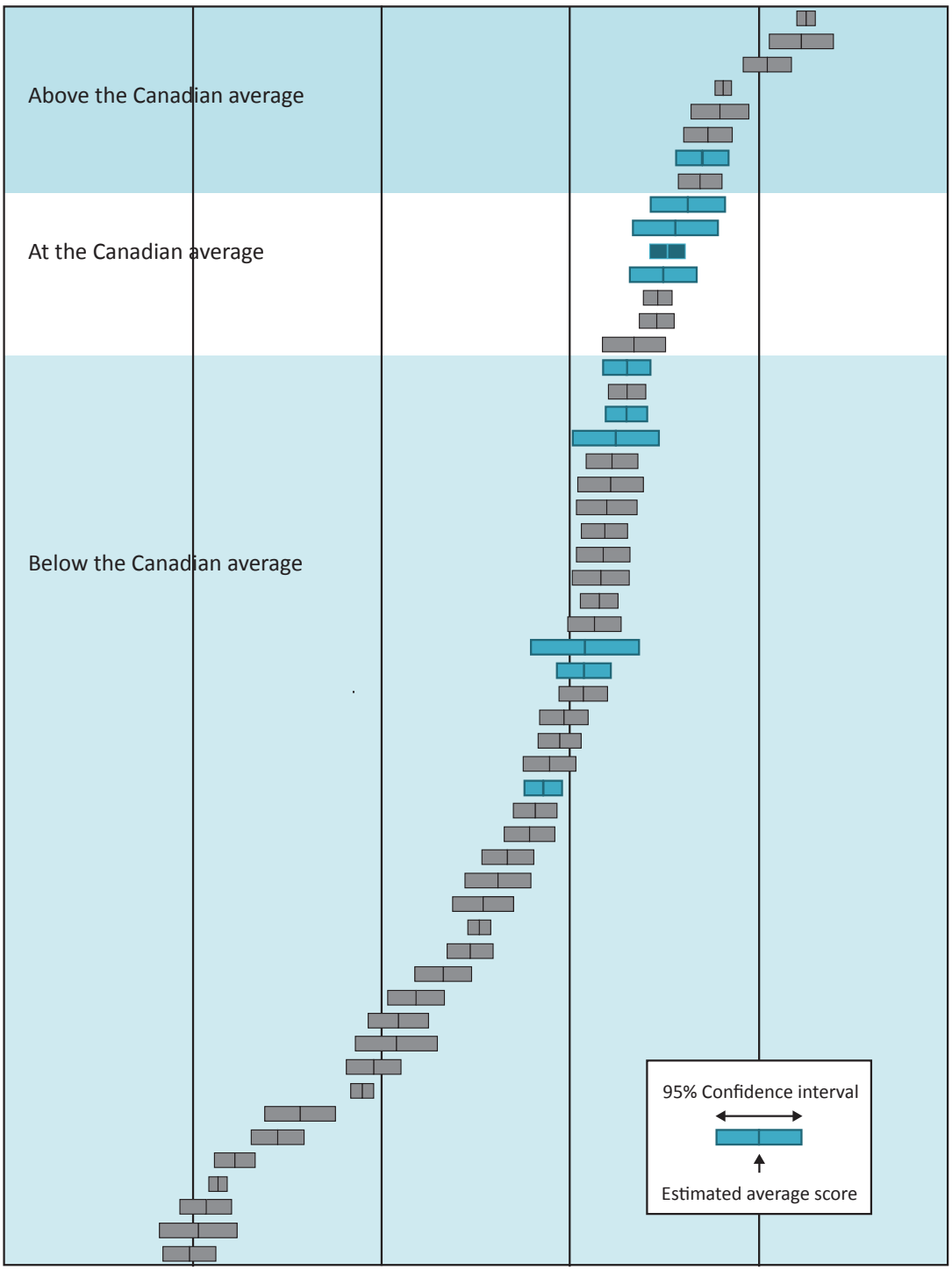
Overall, Canadian 15-year-olds demonstrated high levels of problem-solving skills. They attained an average score of 526, which is well above the OECD average of 500, and were outperformed by students from only two other OECD countries — Korea and Japan. Five non-OECD members also outperformed Canada (Singapore, Macao-China, Hong Kong-China, Shanghai-China, and Chinese Taipei).

[1] Bussière, P., Cartwright, F. and Knighton, T. (2004). *Measuring up: Canadian results for the OECD PISA study. The performance of Canada's Youth in mathematics, reading, science and problem solving*. Ottawa: Ministry of Industry.

[2] OECD. (2013). *PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy.* Paris: Author.

[3] Brochu, P., M-A. Deussing, K. Houme and M. Chuy. (2013). *Measuring up: Canadian results for the OECD PISA study. The performance of Canada's Youth in mathematics, reading, science and problem solving. 2012 First Results for Canadians Aged 15.* Toronto: Council of Ministers of Education, Canada.

Figure 1 **Estimated average scores and confidence intervals for countries and provinces in problem solving**

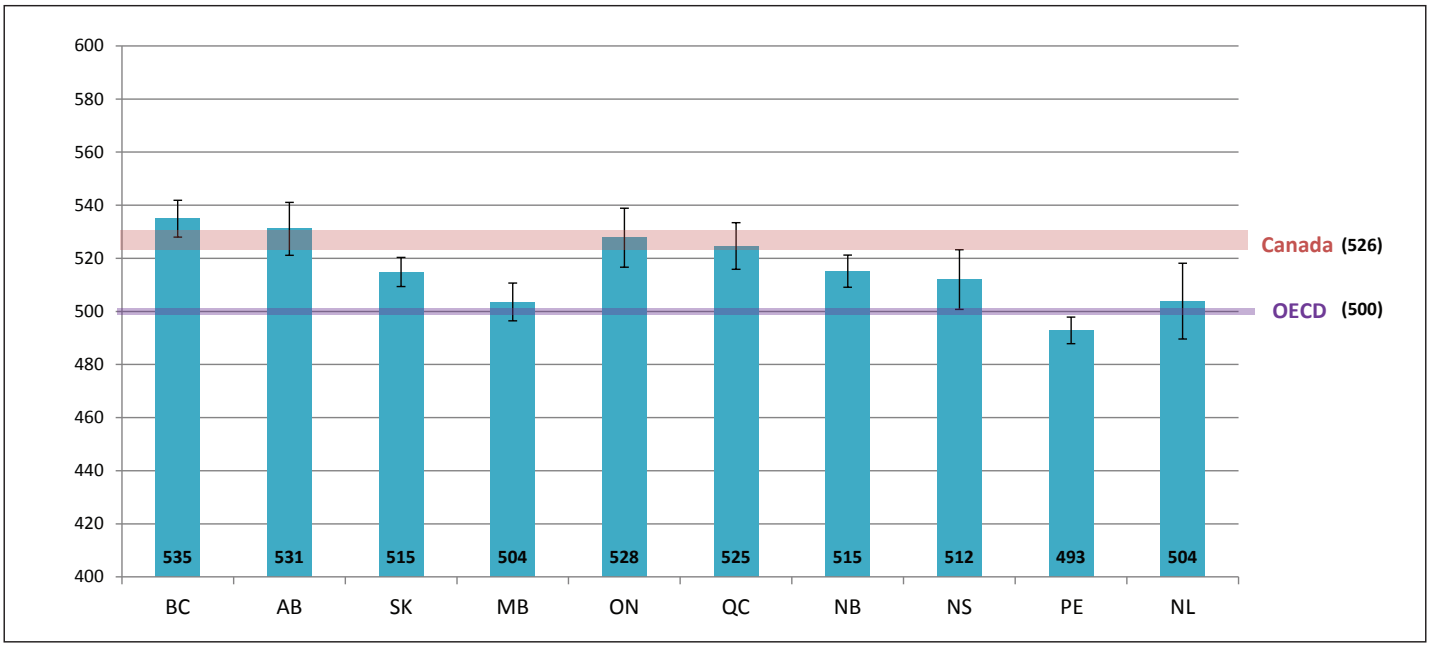


Countries and provinces	Average	S.E.
Singapore	562	(1.2)
Korea	561	(4.3)
Japan	552	(3.1)
Macao-China	540	(1.0)
Hong Kong-China	540	(3.9)
Shanghai-China	536	(3.3)
British Columbia	*535*	*(3.5)*
Chinese Taipei	534	(2.9)
Alberta	*531*	*(5.1)*
Ontario	*528*	***(5.7)***
Canada	**526**	**(2.4)**
Quebec	*525*	*(4.5)*
Australia	523	(1.9)
Finland	523	(2.3)
United Kingdom	517	(4.2)
New Brunswick	515	(3.1)
Estonia	515	(2.5)
Saskatchewan	*515*	*(2.8)*
Nova Scotia	*512*	*(5.7)*
France	511	(3.4)
Netherlands	511	(4.4)
Italy	510	(4.0)
Czech Republic	509	(3.1)
Germany	509	(3.6)
United States	508	(3.9)
Belgium	508	(2.5)
Austria	506	(3.6)
Newfoundland and Labrador	*504*	*(7.3)*
Manitoba	*504*	*(3.6)*
Norway	503	(3.3)
Ireland	498	(3.2)
Denmark	497	(2.9)
Portugal	494	(3.6)
Prince Edward Island	*493*	*(2.6)*
Sweden	491	(2.9)
Russian Federation	489	(3.4)
Slovak Republic	483	(3.6)
Poland	481	(4.4)
Spain	477	(4.1)
Slovenia	476	(1.5)
Serbia	473	(3.1)
Croatia	466	(3.9)
Hungary	459	(4.0)
Turkey	454	(4.0)
Israel	454	(5.5)
Chile	448	(3.7)
Cyprus	445	(1.4)
Brazil	428	(4.7)
Malaysia	422	(3.5)
United Arab Emirates	411	(2.8)
Montenegro	407	(1.2)
Uruguay	403	(3.5)
Bulgaria	402	(5.1)
Colombia	399	(3.5)

Canada showed marked variation in problem-solving skills at the provincial level.[4] Students in British Columbia registered a score of 535, which was above the Canadian average, while those in Alberta, Ontario, and Quebec scored at the Canadian average. Students in the remaining provinces scored below the Canadian average, with Prince Edward Island's score (493) the only one below the OECD average of 500. Appendix A, Table A.1 presents multiple comparisons between Canadian provinces and all other countries and economies that participated in the problem-solving component.

[4] No data were collected in the three territories and in First Nation schools.

Figure 2 **Estimated average scores in problem solving – Canada and the provinces**



Boys in Canada held a small advantage over girls in problem-solving skills

The difference between the sexes in problem solving was small, with boys outscoring girls by five points. Furthermore, this difference was attributed to a single province — Ontario, where boys outscored girls by nine points in problem solving.

For purposes of comparison, in reading, girls outperformed boys in Canada by 35 points, while in mathematics boys scored 10 points higher than girls. In science there was no difference between the two.

Table 1 **Estimated average scores and gender differences in student performance by province**

	Females		Males		Gender difference (Female - Male)	
Canada and provinces	average	standard error	average	standard error	difference	standard error
Canada	523	(2.5)	528	(2.8)	-5	(2.2)*
Newfoundland and Labrador	512	(5.4)	496	(10.6)	16	(8.3)
Prince Edward Island	494	(3.5)	492	(3.3)	2	(4.5)
Nova Scotia	512	(8.0)	512	(5.5)	1	(7.4)
New Brunswick	520	(4.0)	511	(4.7)	9	(6.1)
Quebec	523	(4.7)	526	(5.5)	-4	(4.8)
Ontario	523	(5.2)	533	(6.8)	-9	(4.1)*
Manitoba	503	(5.1)	504	(4.5)	-1	(6.3)
Saskatchewan	520	(3.9)	510	(3.7)	10	(5.1)
Alberta	529	(5.6)	533	(5.1)	-5	(3.7)
British Columbia	530	(5.1)	540	(4.0)	-9	(5.9)
OECD average	**497**	**(0.7)**	**503**	**(0.9)**	**-7**	**(0.8)***

* Statistically significant differences

Overall in Canada, no significant differences were observed between problem-solving skills of students in French- and English-language school systems. However, differences were observed in Ontario and New Brunswick, where students from the English-language systems outperformed their francophone counterparts by 38 and 28 points, respectively.

Table 2 **Estimated average scores and differences in student performance by language of school system, by province**[5]

	Francophone school system		Anglophone school system		Difference between the anglophone and francophone school systems	
Canada and provinces	average	standard error	average	standard error	difference	standard error
Canada	522	(4.5)	527	(3.0)	5	(5.8)
Nova Scotia	524	(6.6)	512	(5.9)	-12	(9.3)
New Brunswick	494	(3.8)	522	(3.9)	28	(5.4)*
Quebec	525	(5.0)	519	(5.0)	-6	(6.8)
Ontario	491	(3.9)	529	(5.9)	38	(6.7)*
Manitoba	494	(6.8)	504	(3.7)	10	(7.7)
Alberta	517	(14.2)	531	(5.1)	14	(15.3)
British Columbia	531	(8.5)	535	(3.5)	4	(9.6)

* Statistically significant differences

Internationally, Canadian 15-year-old students performed relatively well, placing third among OECD countries and eighth among all participating countries/economies. Some significant differences were observed between provinces. For example, the results for British Columbia were comparable to those of the highest-performing countries, while Prince Edward Island scored below the OECD average. A very small gender difference in problem-solving skills was observed. This was in contrast to the gender differences in reading and mathematics as measured by PISA. When it comes to performance by language of the school system, only two provinces saw significant differences, and these were sizable.

What students can do in problem solving

To give concrete meaning to scores, PISA has defined ranges of scores that correspond to specific sets of skills. These are referred to as proficiency levels. For problem solving, six proficiency levels were identified and are defined below.[6]

[5] Due to low target population sizes, estimates for Saskatchewan, Newfoundland and Labrador, and Prince Edward Island were not statistically reliable and therefore not reported.

[6] Adapted from OECD (2014). *PISA 2012 Results: Creative problem solving: Students' skills in tackling real-life problems*. Volume V. Paris: Author, p. 57.

Summary description of the six levels of proficiency in problem solving

Level	Score range	Percentage of students able to perform tasks at this level or above (Canadian / OECD average)	What students can typically do
6	Equal to or higher than 683 points	5.1% / 2.5%	At Level 6, students can develop complete, coherent mental models of diverse problem scenarios, enabling them to solve complex problems efficiently. They can explore a scenario in a highly strategic manner to understand all information pertaining to the problem. The information may be presented in different formats, requiring interpretation and integration of related parts. When confronted with very complex devices, such as home appliances that work in an unusual or unexpected manner, they quickly learn how to control the devices to achieve a goal in an optimal way.
5	618 to less than 683 points	17.5% / 11.4%	At Level 5, students can systematically explore a complex problem scenario to gain an understanding of how relevant information is structured. When faced with unfamiliar, moderately complex devices, such as vending machines or home appliances, they respond quickly to feedback in order to control the device.
4	553 to less than 618 points	40.5% / 31.0%	At Level 4, students can explore a moderately complex problem scenario in a focused way. They grasp the links among the components of the scenario that are required to solve the problem. They can control moderately complex digital devices, such as unfamiliar vending machines or home appliances, but they do not always do so efficiently.
3	488 to less than 553 points	66.3% / 56.6%	At Level 3, students can handle information presented in several different formats. They can explore a problem scenario and infer simple relationships among its components. They can control simple digital devices, but have trouble with more complex devices.
2	423 to less than 488 points	85.3% / 78.6%	At Level 2, students can explore an unfamiliar problem scenario and understand a small part of it. They try, but only partially succeed, to understand and control digital devices with unfamiliar controls, such as home appliances and vending machines.
1	358 to less than 423 points	94.9% / 91.8%	At Level 1, students can explore a problem scenario only in a limited way, but tend to do so only when they have encountered very similar situations before. Based on their observations of familiar scenarios, these students are only able to partially describe the behaviour of a simple, everyday device.

Level 2 is deemed to be the minimum proficiency level to function adequately in society. In Canada, 85.3% of 15-year-olds reached at least this level in problem solving. This compares well with the OECD average of 78.6%, but is below other OECD countries such as Korea and Japan (93.1% and 92.9%, respectively). At the other end of the scale, 17.5% of Canadians tested scored at Level 5 or above, compared to the OECD average of 11.4%. While these results are strong, Canada did place significantly lower than certain OECD countries, such as Korea (27.6%) and Japan (22.3%).

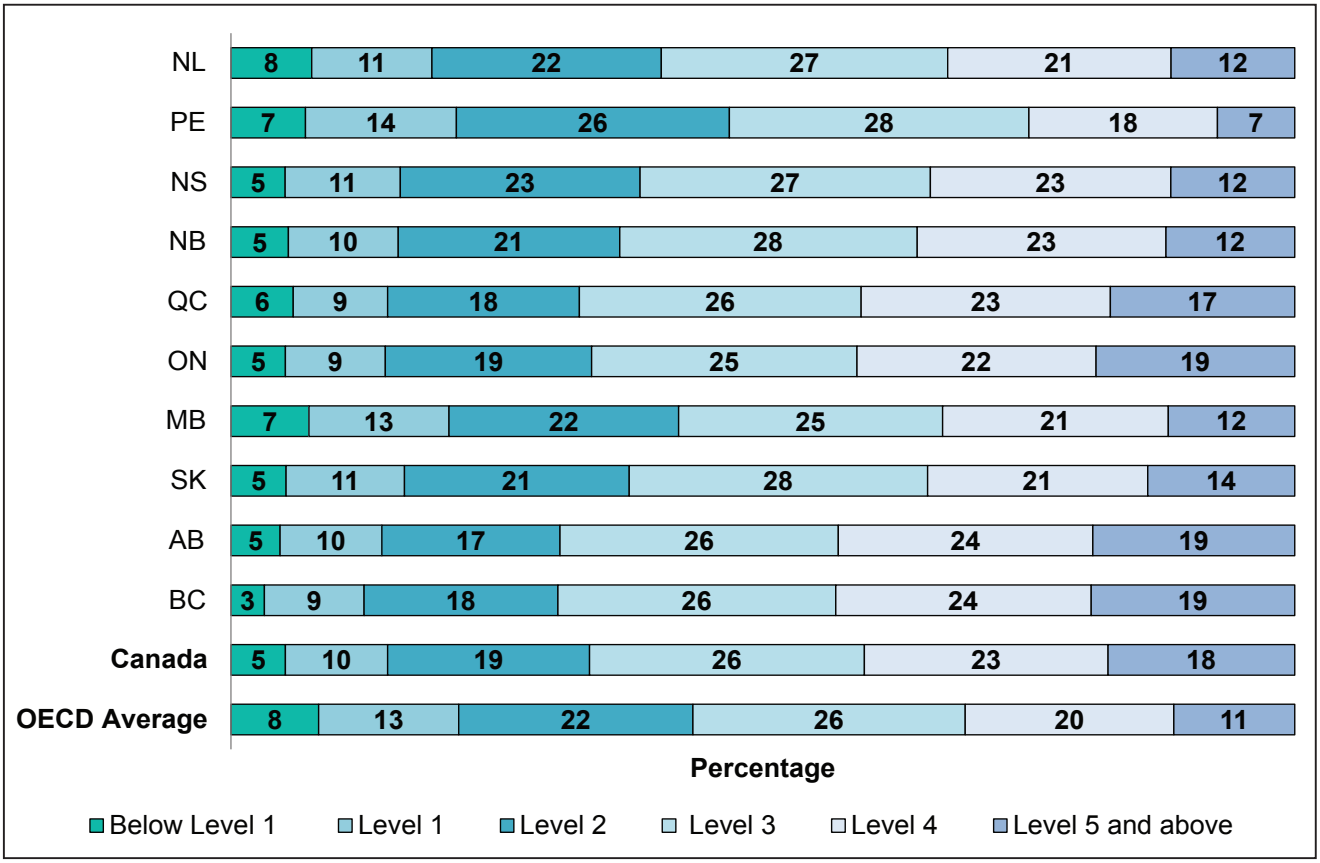
Table 3 **Percentage of students at each proficiency level for provinces, countries, and economies**

Country, economy, and province	Proficiency levels													
	Below Level 1		Level 1		Level 2		Level 3		Level 4		Level 5		Level 6	
	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error
Korea	2.1	(0.3)	4.8	(0.6)	12.9	(0.9)	23.7	(1.0)	28.8	(0.9)	20.0	(1.2)	7.6	(0.9)
Japan	1.8	(0.4)	5.3	(0.6)	14.6	(0.9)	26.9	(1.1)	29.2	(1.0)	16.9	(1.0)	5.3	(0.7)
Macao-China	1.6	(0.2)	6.0	(0.4)	17.5	(0.6)	29.5	(0.8)	28.9	(0.9)	13.8	(0.6)	2.8	(0.3)
Singapore	2.0	(0.2)	6.0	(0.4)	13.8	(0.6)	21.9	(0.7)	27.0	(1.0)	19.7	(0.7)	9.6	(0.4)
Hong Kong-China	3.3	(0.5)	7.1	(0.7)	16.3	(1.0)	27.4	(1.4)	26.5	(1.0)	14.2	(1.1)	5.1	(0.6)
Shanghai-China	3.1	(0.5)	7.5	(0.6)	17.5	(0.8)	27.4	(1.1)	26.2	(1.0)	14.1	(0.9)	4.1	(0.6)
Chinese Taipei	3.4	(0.6)	8.2	(0.6)	17.8	(0.8)	26.3	(1.0)	25.9	(1.0)	14.6	(0.7)	3.8	(0.4)
British Columbia	**3.1**	**(0.7)**	**9.4**	**(1.0)**	**18.2**	**(1.3)**	**26.1**	**(1.4)**	**24.0**	**(1.4)**	**13.8**	**(1.3)**	**5.3**	**(0.7)**
Alberta	**4.6**	**(0.6)**	**9.6**	**(1.0)**	**16.8**	**(1.4)**	**26.2**	**(1.6)**	**23.9**	**(1.6)**	**13.6**	**(1.2)**	**5.3**	**(0.8)**
Finland	4.5	(0.4)	9.9	(0.5)	20.0	(0.9)	27.1	(1.1)	23.5	(0.8)	11.4	(0.6)	3.6	(0.5)
Ontario	**5.1**	**(0.7)**	**9.4**	**(1.0)**	**19.4**	**(1.1)**	**24.9**	**(1.2)**	**22.5**	**(1.3)**	**12.6**	**(1.0)**	**6.0**	**(1.0)**
Quebec	**5.8**	**(0.8)**	**8.9**	**(0.7)**	**18.0**	**(1.0)**	**26.5**	**(1.2)**	**23.4**	**(0.9)**	**12.6**	**(1.1)**	**4.7**	**(0.8)**
Canada	5.1	(0.4)	9.6	(0.4)	19.0	(0.6)	25.8	(0.7)	22.9	(0.6)	12.4	(0.6)	5.1	(0.4)
Estonia	4.0	(0.5)	11.1	(0.8)	21.8	(0.7)	29.2	(1.0)	22.2	(0.8)	9.5	(0.7)	2.2	(0.3)
Australia	5.0	(0.3)	10.5	(0.5)	19.4	(0.5)	25.8	(0.7)	22.6	(0.5)	12.3	(0.5)	4.4	(0.3)
New Brunswick	**5.4**	**(0.7)**	**10.3**	**(1.2)**	**20.8**	**(1.6)**	**28.0**	**(2.4)**	**23.4**	**(1.7)**	**9.3**	**(1.2)**	**2.8**	**(0.6)**
Nova Scotia	**5.1**	**(1.4)**	**10.8**	**(1.6)**	**22.6**	**(3.2)**	**27.3**	**(2.8)**	**22.6**	**(2.4)**	**9.2**	**(1.1)**	**2.5**	**(0.8)**
Saskatchewan	**5.2**	**(0.7)**	**11.1**	**(1.0)**	**21.1**	**(1.6)**	**28.0**	**(1.6)**	**20.7**	**(1.3)**	**10.9**	**(1.1)**	**2.9**	**(0.6)**
United Kingdom	5.5	(0.8)	10.8	(0.8)	20.2	(1.3)	26.5	(0.9)	22.7	(1.1)	10.9	(0.8)	3.3	(0.6)
Italy	5.2	(0.7)	11.2	(1.1)	22.5	(1.0)	28.0	(1.1)	22.3	(1.1)	8.9	(0.9)	1.8	(0.3)
France	6.6	(0.9)	9.8	(0.7)	20.5	(1.0)	28.4	(1.1)	22.6	(0.9)	9.9	(0.7)	2.1	(0.3)
United States	5.7	(0.8)	12.5	(0.9)	22.8	(1.0)	27.0	(1.0)	20.4	(0.9)	8.9	(0.7)	2.7	(0.5)
Czech Republic	6.5	(0.7)	11.9	(0.9)	20.7	(1.0)	27.2	(0.9)	21.8	(0.9)	9.5	(0.7)	2.4	(0.3)
Austria	6.5	(0.9)	11.9	(0.8)	21.8	(1.1)	26.9	(1.2)	21.9	(1.0)	9.0	(0.8)	2.0	(0.4)
Netherlands	7.4	(1.0)	11.2	(1.0)	19.9	(1.2)	26.0	(1.3)	22.0	(1.2)	10.9	(1.0)	2.7	(0.5)
Newfoundland and Labrador	**7.6**	**(2.1)**	**11.3**	**(1.6)**	**21.6**	**(1.5)**	**26.9**	**(1.7)**	**21.0**	**(1.6)**	**9.3**	**(1.1)**	**2.3**	**(0.6)**
Germany	7.5	(0.8)	11.8	(0.9)	20.3	(0.9)	25.6	(1.0)	22.0	(1.0)	10.1	(1.0)	2.7	(0.4)
Ireland	7.0	(0.8)	13.3	(0.9)	23.8	(0.8)	27.8	(0.9)	18.8	(0.8)	7.3	(0.6)	2.1	(0.3)
Denmark	7.3	(0.7)	13.1	(0.7)	24.1	(0.8)	27.8	(0.9)	19.0	(1.1)	7.2	(0.7)	1.6	(0.3)
Manitoba	**7.3**	**(1.0)**	**13.2**	**(1.2)**	**21.6**	**(1.1)**	**24.8**	**(1.6)**	**21.2**	**(1.4)**	**9.2**	**(1.2)**	**2.7**	**(0.5)**
Portugal	6.5	(0.6)	14.1	(1.0)	25.5	(0.9)	28.1	(1.0)	18.4	(0.9)	6.2	(0.6)	1.2	(0.3)
Belgium	9.2	(0.6)	11.6	(0.6)	18.3	(0.7)	24.5	(0.6)	22.0	(0.7)	11.4	(0.7)	3.0	(0.3)
Prince Edward Island	**7.0**	**(0.7)**	**14.2**	**(1.2)**	**25.7**	**(1.5)**	**28.2**	**(2.1)**	**17.7**	**(1.2)**	**5.6**	**(0.9)**	**1.6**	**(0.5)**
Norway	8.1	(0.7)	13.2	(0.7)	21.5	(0.9)	24.7	(0.8)	19.4	(0.8)	9.7	(0.7)	3.4	(0.4)
Russian Federation	6.8	(0.7)	15.4	(1.1)	27.0	(0.9)	27.9	(1.2)	15.7	(0.9)	5.9	(0.7)	1.4	(0.3)
Sweden	8.8	(0.7)	14.6	(0.8)	23.9	(0.9)	26.3	(0.8)	17.6	(0.7)	7.0	(0.5)	1.8	(0.3)
Poland	10.0	(1.1)	15.7	(1.0)	25.7	(0.9)	26.0	(1.0)	15.7	(1.0)	5.8	(0.7)	1.1	(0.2)
Slovak Republic	10.7	(1.1)	15.4	(1.1)	24.3	(1.0)	25.6	(1.3)	16.2	(1.2)	6.3	(0.6)	1.6	(0.5)
Spain	13.1	(1.2)	15.3	(0.8)	23.6	(0.9)	24.2	(1.0)	15.9	(0.8)	6.2	(0.6)	1.6	(0.3)
Slovenia	11.4	(0.6)	17.1	(1.0)	25.4	(1.2)	23.7	(0.8)	15.8	(0.8)	5.8	(0.5)	0.9	(0.2)
Serbia	10.3	(1.0)	18.3	(0.8)	26.7	(1.4)	25.8	(1.1)	14.3	(0.8)	4.1	(0.4)	0.6	(0.2)
Croatia	12.0	(1.0)	20.2	(1.0)	26.8	(1.2)	22.9	(1.1)	13.2	(1.1)	4.0	(0.6)	0.8	(0.2)
Hungary	17.2	(1.3)	17.8	(0.9)	23.9	(1.2)	22.4	(0.9)	13.0	(1.0)	4.6	(0.7)	1.0	(0.2)
Turkey	11.0	(1.1)	24.8	(1.3)	31.4	(1.4)	21.2	(1.2)	9.4	(1.1)	2.0	(0.5)	0.2	(0.1)
Chile	15.1	(1.3)	23.1	(1.1)	28.6	(1.0)	22.2	(1.0)	8.8	(0.7)	1.9	(0.3)	0.2	(0.1)
Israel	21.9	(1.4)	17.0	(0.9)	20.1	(0.8)	18.5	(0.9)	13.7	(0.9)	6.7	(0.8)	2.1	(0.4)
Brazil	23.5	(1.6)	25.5	(1.4)	26.1	(1.3)	16.8	(1.4)	6.3	(0.8)	1.4	(0.3)	0.4	(0.1)
Malaysia	22.7	(1.5)	27.8	(1.2)	27.8	(1.2)	15.7	(0.9)	5.2	(0.6)	0.8	(0.2)	0.1	(0.0)
United Arab Emirates	30.3	(1.2)	24.6	(0.8)	22.0	(0.7)	14.2	(0.6)	6.4	(0.4)	2.1	(0.2)	0.4	(0.1)
Bulgaria	33.3	(1.9)	23.3	(1.1)	22.1	(1.0)	14.1	(0.8)	5.6	(0.7)	1.4	(0.3)	0.2	(0.1)
Montenegro	30.0	(0.8)	26.8	(0.8)	23.9	(1.0)	13.8	(0.7)	4.6	(0.4)	0.7	(0.2)	0.1	(0.1)
Uruguay	32.4	(1.6)	25.6	(1.0)	22.4	(1.0)	13.2	(0.7)	5.3	(0.5)	1.1	(0.2)	0.1	(0.1)
Colombia	33.2	(1.7)	28.3	(1.1)	22.2	(0.9)	11.3	(0.8)	3.9	(0.5)	0.9	(0.2)	0.2	(0.1)
OECD average	**8.2**	**(0.2)**	**13.2**	**(0.2)**	**22.0**	**(0.2)**	**25.6**	**(0.2)**	**19.6**	**(0.2)**	**8.9**	**(0.1)**	**2.5**	**(0.1)**

Note: Countries, economies, and provinces have been sorted by the total percentage of students who attained Level 2 or higher.

At the provincial level, the proportions of students reaching at least Level 2 varied from 78.8% in Prince Edward Island to 87.5% in British Columbia. At Level 5 or above, percentages ranged from 7.3% in Prince Edward Island to 19.1% in British Columbia.

Figure 3 **Distribution of students by proficiency level on the problem-solving scale, Canada, provinces, and OECD**



In Canada as a whole, slightly more than 85% of boys and girls attained at least Level 2 in problem solving. At the provincial level, British Columbia had the highest rate of boys (88.1%) and girls (86.9%) attaining this degree of proficiency. Newfoundland and Labrador reported the lowest proportion of boys at this level (77.9%), while Manitoba and Prince Edward Island both reported the lowest proportion for girls, at 79.1%.

Table 4 **Percentage of students at each proficiency level by gender, Canada and OECD**

		Proficiency levels													
		Below Level 1		Level 1		Level 2		Level 3		Level 4		Level 5		Level 6	
	Gender	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error
Canada	**Males**	**5.3**	**(0.6)**	**9.6**	**(0.5)**	**18.1**	**(0.7)**	**25.1**	**(0.8)**	**23.0**	**(0.7)**	**13.1**	**(0.7)**	**5.9**	**(0.6)**
	Females	**4.9**	**(0.4)**	**9.7**	**(0.6)**	**19.9**	**(1.0)**	**26.6**	**(1.0)**	**22.8**	**(0.8)**	**11.8**	**(0.7)**	**4.3**	**(0.4)**
Newfoundland and Labrador	Males	9.9	(2.8)	12.2	(1.8)	19.8	(1.9)	25.5	(2.6)	21.5	(2.4)	9.0	(1.4)	2.1	(0.8)
	Females	5.3	(2.1)	10.4	(2.1)	23.3	(2.0)	28.3	(2.1)	20.6	(2.0)	9.7	(1.5)	2.5	(0.9)
Prince Edward Island	Males	7.6	(1.2)	13.8	(1.6)	24.9	(2.5)	29.1	(3.2)	17.3	(2.2)	6.0	(1.0)	1.2	(0.5)
	Females	6.4	(1.0)	14.6	(1.7)	26.4	(1.9)	27.2	(2.5)	18.1	(1.7)	5.2	(1.4)	2.0	(0.7)
Nova Scotia	Males	6.5	(2.1)	10.6	(1.8)	21.0	(3.2)	27.4	(3.8)	21.7	(2.6)	10.2	(1.8)	2.6	(1.2)
	Females	3.6	(1.4)	11.1	(2.7)	24.2	(4.4)	27.2	(2.4)	23.5	(4.0)	8.1	(1.3)	2.3	(1.0)
New Brunswick	Males	6.4	(1.3)	11.0	(1.6)	21.8	(2.1)	26.9	(3.3)	21.6	(1.9)	9.3	(2.1)	3.0	(0.8)
	Females	4.4	(0.9)	9.6	(1.4)	19.8	(2.1)	29.1	(2.6)	25.2	(2.5)	9.4	(1.7)	2.5	(1.0)
Quebec	Males	6.5	(1.2)	9.3	(1.0)	16.0	(1.4)	25.4	(1.4)	24.2	(1.3)	13.2	(1.4)	5.4	(1.0)
	Females	5.2	(0.8)	8.5	(0.9)	20.1	(1.6)	27.5	(1.5)	22.7	(1.3)	11.9	(1.2)	4.1	(0.8)
Ontario	Males	5.0	(1.1)	9.2	(1.3)	18.9	(1.7)	23.6	(1.4)	22.3	(1.6)	13.7	(1.3)	7.3	(1.3)
	Females	5.2	(0.9)	9.6	(1.3)	19.9	(1.7)	26.2	(1.7)	22.6	(1.6)	11.7	(1.3)	4.8	(0.9)
Manitoba	Males	7.4	(1.4)	12.7	(1.6)	21.7	(2.4)	24.5	(2.6)	21.6	(1.9)	9.2	(1.6)	2.9	(0.7)
	Females	7.2	(1.4)	13.7	(1.8)	21.5	(1.8)	25.2	(2.3)	20.8	(2.0)	9.1	(1.1)	2.5	(0.6)
Saskatchewan	Males	6.2	(1.2)	11.7	(1.6)	21.4	(2.1)	27.2	(2.2)	21.0	(1.8)	10.1	(1.2)	2.5	(0.7)
	Females	4.1	(1.0)	10.5	(1.4)	20.8	(1.9)	29.0	(2.1)	20.5	(1.8)	11.8	(1.6)	3.3	(0.8)
Alberta	Males	4.5	(0.8)	9.2	(1.3)	15.9	(1.5)	26.3	(2.0)	25.0	(2.1)	13.4	(1.5)	5.7	(1.1)
	Females	4.7	(0.8)	9.9	(1.3)	17.7	(2.0)	26.0	(2.7)	22.8	(2.3)	13.9	(1.5)	4.9	(1.0)
British Columbia	Males	2.9	(0.7)	9.1	(1.1)	17.5	(1.5)	26.3	(1.9)	23.1	(1.7)	14.7	(1.9)	6.5	(1.1)
	Females	3.4	(1.0)	9.7	(1.6)	18.9	(1.8)	25.9	(2.3)	25.0	(2.5)	12.9	(1.5)	4.2	(0.9)
OECD average	**Males**	**8.7**	**(0.2)**	**12.8**	**(0.2)**	**20.7**	**(0.2)**	**24.5**	**(0.2)**	**20.2**	**(0.2)**	**10.0**	**(0.2)**	**3.1**	**(0.1)**
	Females	**7.8**	**(0.2)**	**13.5**	**(0.2)**	**23.3**	**(0.3)**	**26.8**	**(0.3)**	**19.0**	**(0.2)**	**7.7**	**(0.2)**	**1.8**	**(0.1)**

At the high end of skills, more boys than girls reached Level 5 or above (19.0% versus 16.1%). This compared well with the OECD averages of 13.1% and 9.5%, respectively. A higher proportion of boys in British Columbia and Ontario reached Level 5 or above (around 21%), while a higher proportion of girls reached this level in Alberta (18.8%). Prince Edward Island had the smallest proportions of 15-year-olds reaching the highest skill levels for both boys and girls (7.3% and 7.2%, respectively).

Fewer francophone-school-system students reached the minimum skill level

A slightly lower proportion (84.6%) of 15-year-old students from francophone school systems reached at least skill Level 2 than did their peers from the anglophone systems (85.5%). Similarly, 16.7% of students from francophone systems reached at least Level 5, compared to 17.8% of students in anglophone systems.

Table 5 **Percentage of students at each proficiency level by language of the school system, Canada and the provinces**

		Proficiency levels													
	Language of the school system	Below Level 1		Level 1		Level 2		Level 3		Level 4		Level 5		Level 6	
		%	standard error	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error	%	standard error
Canada	**Anglophone**	**4.8**	**(0.4)**	**9.7**	**(0.6)**	**19.2**	**(0.7)**	**25.6**	**(0.8)**	**22.9**	**(0.8)**	**12.5**	**(0.6)**	**5.2**	**(0.5)**
	Francophone	**6.1**	**(0.8)**	**9.3**	**(0.7)**	**18.3**	**(1.0)**	**26.5**	**(1.2)**	**23.1**	**(0.9)**	**12.1**	**(1.0)**	**4.6**	**(0.8)**
Nova Scotia	Anglophone	5.2	(1.4)	10.9	(1.7)	22.6	(3.3)	27.2	(2.8)	22.6	(2.5)	9.1	(1.1)	2.5	(0.8)
	Francophone	2.7	(1.8)	9.1	(2.3)	21.0	(3.6)	30.8	(4.5)	23.2	(4.2)	11.2	(2.8)	2.1	(1.2)
New Brunswick	Anglophone	5.1	(0.9)	8.8	(1.5)	19.7	(1.8)	27.8	(3.1)	25.0	(2.4)	10.4	(1.6)	3.3	(0.7)
	Francophone	6.3	(1.0)	14.8	(1.2)	24.3	(2.3)	28.4	(1.9)	18.8	(1.6)	6.3	(1.1)	1.2	(0.5)
Quebec	Anglophone	6.4	(1.5)	9.0	(0.9)	20.2	(1.2)	25.4	(1.6)	22.7	(1.8)	12.6	(1.1)	3.7	(0.5)
	Francophone	5.8	(0.9)	8.9	(0.8)	17.8	(1.1)	26.6	(1.3)	23.5	(1.0)	12.6	(1.2)	4.9	(0.9)
Ontario	Anglophone	4.9	(0.8)	9.3	(1.0)	19.3	(1.1)	24.9	(1.2)	22.6	(1.3)	12.8	(1.1)	6.2	(1.0)
	Francophone	10.2	(1.1)	13.6	(1.3)	22.8	(1.3)	24.8	(1.7)	18.4	(1.6)	7.8	(1.0)	2.4	(0.6)
Manitoba	Anglophone	7.3	(1.0)	13.1	(1.2)	21.5	(1.1)	24.9	(1.6)	21.3	(1.4)	9.2	(1.2)	2.7	(0.5)
	Francophone	9.0	(2.6)	15.5	(3.4)	24.2	(3.3)	23.1	(4.3)	14.9	(2.5)	10.8	(2.3)	2.6	(1.5)
Alberta	Anglophone	4.6	(0.7)	9.5	(1.0)	16.8	(1.5)	26.2	(1.6)	23.9	(1.6)	13.6	(1.2)	5.3	(0.8)
	Francophone	7.8	(2.9)	12.4	(3.5)	14.4	(3.1)	25.2	(4.4)	24.5	(4.3)	11.7	(4.5)	4.2	(2.5)
British Columbia	Anglophone	3.1	(0.7)	9.4	(1.0)	18.2	(1.3)	26.1	(1.4)	24.0	(1.4)	13.8	(1.3)	5.3	(0.7)
	Francophone	4.9	(2.6)	7.8	(3.5)	18.0	(5.4)	25.2	(5.0)	28.2	(5.7)	12.2	(3.9)	3.7	(2.0)

At the provincial level, the proportions of students performing below Level 2 from the francophone systems ranged from 24.5% in Manitoba to 11.8% in Nova Scotia. For the anglophone systems, the figures ranged from 20.4% in Manitoba to 12.5% in British Columbia.

At the high end of proficiency, the proportion of students from francophone systems varied from 7.5% in New Brunswick to 17.4% in Quebec. For anglophone systems, the figures ranged from 11.6% in Nova Scotia to 19.1% in British Columbia.

Compared to the OECD average, fewer Canadian students are at the lowest proficiency levels in problem solving and more are at the highest. However, when compared to certain countries, Canada lags behind in these measures. Significant provincial differences were also observed. Consistently, eastern provinces and Manitoba saw more of their students at or below the minimum required levels of skill and fewer at the highest levels, compared to western provinces.

There were small differences in favour of boys, and somewhat larger differences favouring students from anglophone school systems over those from francophone systems.

A look at performance and equity in problem solving

This section analyzes three variables related to equity and student achievement in problem solving in PISA: the difference between high- and low-achieving students; the impact of socioeconomic factors on these differences; and the difference in achievement between students with an immigrant background and those born in Canada.

The gap between low and high performers

The gap between the average score of students in the 90th percentile (high achievers) and those in the 10th percentile (low achievers) is a measure of equity in an education system.[7] In the domain of problem solving, this gap was 251 points in Canada, similar to the average of 245 points for OECD countries.

Of note is the fact that four high-achieving jurisdictions (Japan, Korea, Macao-China, and Hong Kong-China) showed relatively small gaps, indicating that equity in education does not have to come at the cost of high achievement.

Within Canada, lower-achieving provinces tended to have smaller gaps. In Prince Edward Island, New Brunswick, and Nova Scotia, for example, the differences between high and low performers were 228, 232, and 233 points, respectively. In Ontario, Alberta, and Quebec, where student performance largely mirrored the Canadian average, the gaps were 257, 252, and 251 points, respectively. Significantly, however, British Columbia deviated from this trend. It recorded the highest average performance in problem solving, together with some of the highest scores among both high and low achievers; yet it also showed a comparatively low gap of 244 points between the two groups. (See Appendix A, Table A.2).

Socioeconomic factors

Another measure of equity is the impact of the socioeconomic environment on student achievement. Unsurprisingly, the index of economic, social, and cultural status (ESCS) relates positively to performance in problem solving, as it does in the other domains assessed by PISA. On average, the ESCS index explains 10.6% of the variation in problem solving among OECD countries, with Canada registering the smallest effect at 4.0%.

The PISA *index of economic, social, and cultural status* (ESCS) was constructed from the following variables, as reported in the Student Questionnaire: the highest occupational status of parents, the highest educational level of parents, and an index of possessions found in the home.

These figures should be understood in the context of overall socioeconomic status. The mean ESCS index of OECD countries is 0.01 (with a higher index signifying a higher average socioeconomic status), while Canada's ESCS index is 0.41 — one of the highest in the OECD.

At the provincial level, the ESCS index varies from a high of 0.51 in Alberta to a low of 0.26 in Manitoba. The variance in achievement in problem solving explained by ESCS ranged between 3% and 6%, except in Prince Edward Island (8%) and Newfoundland and Labrador (13%). (See Appendix A, Table A.3).

Immigration status

PISA also measured the performance of students by immigration status. Just over 70% of 15-year-olds who participated in PISA in Canada are categorized as non-immigrants, 17% as second-generation immigrants (born in Canada but with at least one parent who is foreign-born), and 13% as first-generation immigrants (not born in Canada). Among all 44 participating countries and economies in the problem-solving component of PISA, only three included more first-generation immigrants than Canada: Macao-China, United Arab Emirates, and Hong-Kong China.

Across OECD, non-immigrants scored 30 points higher than second-generation students and 47 points higher

[7] Brochu, P., Deussing, M-A., Houme, K., & Chuy, M. (2013). *Measuring up: Canadian results of the OECD PISA study. The performance of Canada's Youth in mathematics, reading and science. 2012 First results for Canadians aged 15*. Toronto: Council of Ministers of Education, Canada.

than first-generation students. In Canada, however, these differences were only 13 and 11 points, respectively.

At the provincial level, there was little difference in problem solving between the three groups of students for those provinces with a proportion of immigrants high enough to report. Native-born students performed better than students with an immigrant background (first- or second-generation) in Manitoba, Ontario, and Quebec, whereas first-generation students achieved higher scores than the native-born in British Columbia. (See Appendix A, Table A.4).

How problem solving is related to the other subject areas

It is important to note that problem solving is not a specific school subject: the cognitive processes it employs are demanded across all subject areas. As such, the relationship between problem solving and the other areas assessed by PISA (mathematics, science, and reading) is of interest, because it provides insights into how students apply what they know outside of subject-bound assessments. Increasingly, school curricula require students to go beyond the mastery of a repertoire of facts and procedures to handle unfamiliar situations with unpredictable outcomes. PISA's assessment of problem solving reflects this requirement by measuring the ability to use curricular knowledge to meet real-life challenges and develop problem-solving competence.

Looking at the correlation between problem solving and mathematics, science, and reading offers the possibility of understanding how achievement in these areas can influence performance in problem solving.

For OECD countries, the correlation between scores in problem solving and mathematics was 0.81, followed by reading (0.78) and science (0.75). It is perhaps not surprising that the strongest correlation was with mathematics, because the problem-solving questions were more likely to demand skills that were more closely related to mathematics than was the case with the other two domains.[8] Although these correlations are fairly high, they are lower than those between the three core areas, as shown in Table 6.

Table 6 **Correlation between problem solving and the other subject areas (international and Canada)**

OECD				
	Problem solving	Mathematics	Science	Reading
Problem solving		0.81	0.75	0.78
Mathematics			0.90	0.85
Science				0.88
Reading				

Canada				
	Problem solving	Mathematics	Science	Reading
Problem solving		0.76	0.75	0.71
Mathematics			0.87	0.82
Science				0.87
Reading				

In Canada, the correlations were slightly lower: 0.76 for mathematics, 0.75 for science, and 0.71 for reading. While these correlations are still fairly high, they are far from being absolute determinants of performance: students who do well in problem solving will not automatically do well in mathematics, science, or reading. That being said, as noted in the international PISA report, Canada is among the few high-performing countries where student performance in problem solving provides a good indication of their expected performance in mathematics, science, and reading when compared to students in other countries.[9]

[8] OECD (2014). *PISA 2012 Results: Creative problem solving: Students' skills in tackling real-life problems*. Volume V. Paris: Author. 250 pages.
[9] Ibid., p. 69.

Summary and conclusions

In 2003, PISA included a problem-solving assessment in addition to its assessments of the core domains of mathematics, science and reading. In 2012, the ability to assess the skills and competencies of 15-year-olds in problem solving was significantly enhanced by the implementation of a computer-based assessment. This allowed for the comparison of problem-solving skills of students in 44 participating countries and economies using questions that required students to use knowledge from all of the core domains and find solutions to problems that did not have obvious solutions.

The PISA 2012 results show that Canadian youth are well equipped to apply their skills and competencies to solve challenging problems. Canada is one of the top-performing countries, being surpassed by only seven of the 44 participating countries and economies. Across Canada, there was marked variation in skills at the jurisdictional level. British Columbia was the only province to perform significantly higher than the Canadian average. All other provinces, except Prince Edward Island, performed at or above the OECD average.

Compared with the mathematics and reading domains as measured by PISA, problem-solving results were much more gender-neutral. In Canada, boys outperformed girls by only five score points compared to seven score points across OECD countries. When comparing students by the language of the school system, there were no significant differences between problem-solving skills in the francophone and anglophone school systems at the pan-Canadian level, though a number of differences were observed between these two school systems at the provincial level.

In Canada, the vast majority of students (over 85%) reached the baseline Level 2 proficiency in problem solving, while almost 18% reached the highest proficiency level (Level 5 or above), thus performing above the OECD average of 79% and 11%, respectively. Notable provincial differences were also observed. For instance, fewer students in the eastern provinces and Manitoba scored at either the baseline or the highest levels in comparison with western provinces. There were also marked differences between the performance of students in the francophone and anglophone school systems, with fewer students in the former performing at the highest skill levels.

While student achievement is an important indicator in determining the performance of Canadian students in a global context, equity in education is also important for determining how Canadian school systems are faring internationally. PISA's assessment of problem-solving skills offered another window through which to investigate equity in education systems by examining the impact of socioeconomic factors and immigrant background on proficiency in problem solving. Generally, the impact of socioeconomic environment and immigrant background on students' problem-solving performance is much lower in Canada than in most other participating countries.

When examining performance equity, the difference between high achievers (90th percentile) and low achievers (10th percentile) in Canada was no different on average from that of other participating countries and economies. In Canada, lower-achieving provinces tended to have smaller gaps between high and low achievers, thus suggesting more equity in their education systems. However, the small achievement gap in some of the highest-performing countries suggests that performance equity does not have to come at the cost of high achievement. In other words, to increase equity in education, emphasis should be placed on closing the gap between high and low achievers by striving to increase the achievement of all students, paying particular attention to low achievers throughout education systems in Canada. This in turn has the potential of increasing the overall performance of Canadian students.

The ability to solve problems requires the capacity to build on and use a variety of skills and competencies. Students' ability to apply the skills and competencies they learn in mathematics, science, and reading to solve problems outside the realm of these subjects is a crucial component in assessing what students can do with what they know. Assessing such ability also sheds light on how students will use what they know outside the classroom in an increasingly globalized labour market when they are faced with problems that require solutions that are not straightforward.

In this rapidly changing world, Canadian students are well prepared for the many situations they face for which no routine solution has been acquired at school. The ability to handle such situations is associated with greater opportunities for employment[10] and full participation in society, and the PISA 2012 assessment of problem solving confirms that education systems need to continue instilling knowledge and skills that go beyond the core subject areas.

Funding for PISA was provided by Employment and Social Development Canada (ESDC) and the provinces through CMEC. This publication was prepared jointly by ESDC and CMEC.

[10] OECD. (2013). *OECD Skills Outlook 2013. First results from the Survey of Adults Skills*. Paris: Author.