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Student Performance in PISA 2018: Nettlesome Questions for Canada

After schools adjust to teaching in a pandemic, educators face longer-term challenges. Across many provinces, especially the six smaller provinces, PISA testing shows declining scores in core subjects, math in particular. As well, wide gaps in achievement exist between advantaged and disadvantaged students, and between Indigenous and non-Indigenous students.

John Richards

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A handwritten signature in black ink that reads 'Daniel Schwanen'.

Daniel Schwanen
Vice President, Research

THE STUDY IN BRIEF

The OECD's Program for International Student Assessment (PISA) has become a universally respected means to assess student outcomes (in reading, mathematics, and science) in national school systems at the upper secondary level. PISA also provides disaggregated results – at the provincial level for Canada.

In each round, starting in 2000 and including the latest in 2018, Canadian schools have performed well above the relevant OECD PISA averages in all three subjects. Since Canada has consistently maintained an enviable overall ranking, there is a danger of complacency. Our schools are good – but there are weaknesses.

Since benchmarking of average international student performance began in the 2000s, average scores among the original OECD countries have been relatively stable over successive rounds. While still well above average, Canadian PISA scores in all three subjects have experienced statistically significant declines. The largest declines have been in mathematics. With the exception of Quebec, declines in mathematics have been statistically significant in all provinces. The largest mathematics decline has been in Manitoba.

Another feature of Canadian results is that average subject levels are consistently lower in the six smaller provinces than in the four large provinces. The most troubling PISA trends are in Manitoba and Saskatchewan, the two provinces with the largest average subject declines from the benchmarking year to 2018.

Two probable explanations for lower scores in the smaller provinces are their inability to realize scale economies accessible by the large provinces and the somewhat lower socio-economic conditions among participating students.

Why is Quebec's mathematics score substantially higher than in the other provinces? One explanation is that Quebec's mathematics curriculum is more rigorous and secondary level math teachers receive more intensive training than in other provinces. A third explanation is that private schools are more prevalent in Quebec than in other provinces. Not all, but much, of the private school superior performance is attributable to family characteristics of students. While Quebec public school scores are below private schools, they are above the national average.

Indigenous/non-Indigenous education outcome gaps are large – albeit the evidence is fragmentary. Six of the 10 provinces agreed to add a voluntary question inviting Indigenous students to self-identify. The agency responsible for administering the Canadian PISA sample decided not to release the Indigenous results, claiming they were “not representative.” Without explanation, it is hard to know what “not representative” means. The decision to withhold results flouts the fundamental rationale for conduct of PISA surveys, namely providing a better empirical foundation for discussion of education policy.

Policy Area: Education, Skills and Labour Market.

Related Topic: Educational Outcomes.

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High-quality K-12 schools and healthcare systems are probably the two most important components of the welfare state. Which leads to the obvious question: what is “high-quality”?

In the context of healthcare, there exist many well-accepted quantifiable outcome measures (such as under-five mortality rates). In the context of schools, evaluation is less precise, but the OECD’s Program for International Student Assessment (PISA) has provided well-accepted comparative measures for school systems at the upper-secondary level, for students age 15. For countries where subnational orders of government manage school systems, PISA provides disaggregated results – which is the case at the provincial level for Canada. (See Box 1.) Two assumptions underlie PISA surveys. The first is that student mastery of upper-secondary-level reading, mathematics, and science is, worldwide, required for meaningful participation in modern industrial society. The second is that low-stake standardized surveys of student learning outcomes are a necessary (but certainly not sufficient) measure of school system performance. To quote the first background volume of the 2018 PISA reports:

Up to the end of the 1990s, OECD comparisons of education outcomes were mainly based on measures of years of schooling, which are not reliable indicators of what people are actually able to do. With ... PISA, we tried to change this. The transformational idea behind PISA lay in testing the skills of students directly, through

a metric that was internationally agreed upon; linking that with data from students, teachers, schools and systems to understand performance differences. (OECD 2019a, 5.)

An unavoidable difficulty in assessing student outcomes is that school quality is not the only relevant factor. The most important factor is often the student’s family.¹ The contribution of family members toward student learning depends on many things: parental education; parental motivation for children to pursue academic studies, which may be influenced by ethnic and religious expectations; and parental income, which affects parental ability to devote time and financial resources to children’s studies (Gang, Zimmermann 2000; Ludeke et al. 2018; Stokes 2008). Peer effects also matter (Richards et al. 2008). In a school where the majority are from families with high education expectations, students perform better than in schools where the majority are from families with low education expectations. Careful multivariate regression can, albeit imperfectly, estimate the relative contribution of school versus family and peer effects.

The criteria for defining good schools include dimensions other than student performance in core subjects. Schools are institutions for transmitting a society’s culture: history, literature, and traditions, and for imparting shared cultural norms necessary

The author thanks Parisa Mahboubi and Daniel Schwanen for encouragement in undertaking this study, an analysis of implications for Canada from the 2018 PISA round. I also thank Barry Anderson, William Robson, Jeremy Kronick, Rosalie Wyonch, Louis Morel, Munir Sheikh and several anonymous reviewers who provided very rigorous and helpful comments. Inevitably, the study is incomplete. Any errors and dubious interpretations are my responsibility.

- 1 The PISA 2018 reports discuss the robust positive relationship between national reading scores and national literacy rate of parents. Parental literacy is measured by the national scores for those in the age 35-54 cohort for the PIACC, an OECD survey of adult core competencies (PISA 2019a, 69).

Box 1: Program for International Student Assessment (PISA)

Since 2000, the Organization for Economic Co-operation and Development (OECD) has organized PISA “rounds” to assess school system performance. Rounds take place every three years, assessing upper secondary students, age 15, in three core subjects: reading, mathematics, and science. In successive rounds, the dominant subject rotates. The latest round, the seventh, was conducted in 2018, with reading as the dominant subject; fewer questions were posed for mathematics and science. In this round, all 37 OECD member countries participated, along with 41 partner jurisdictions (countries and some sub-national jurisdictions). The worldwide sample comprised over 500,000 students. For the Canadian sample of over 22,000, schools were randomly selected in each province, and students were randomly selected within each school. The schools sampled include both provincially managed and non-government schools, but exclude reserve-based schools. Nor is the PISA survey administered in Nunavut or the Territories.

For the first round, in 2000, scoring assessments led to benchmarking of reading results, with a mean of 500 and standard deviation of 100. For the second round, in 2003, a similar benchmarking was undertaken for mathematics, and in 2006 for science. To enable consistent scoring in subsequent rounds, some questions have been maintained from one round to the next.

for civil society to function. These additional dimensions are complements to – not substitutes for – reading, mathematics, and science.²

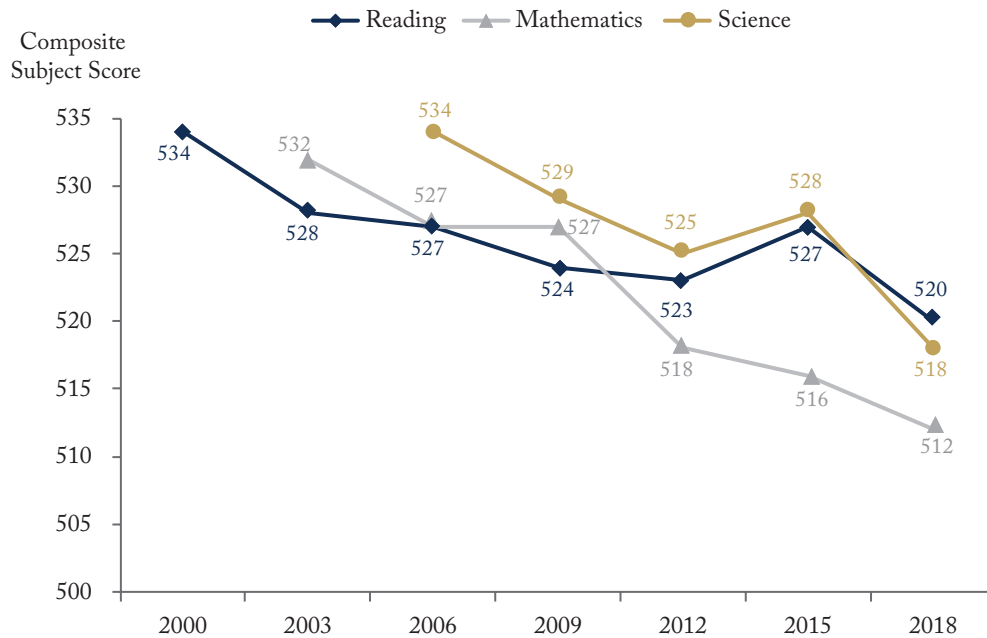
Overall, in all three subjects, Canadian schools have performed well above the relevant OECD averages in each round of the PISA surveys, starting in 2000. In the 2018 round, out of 78 participating jurisdictions, Canada ranked 6th in reading, 12th in mathematics, and 8th in science.³ Since Canada has consistently maintained an enviable overall ranking, there is a danger of complacency. Our system is good – but it has weaknesses.

Since benchmarking of average international student performance (set at 500 for each subject) began in the 2000s, average OECD scores among the original OECD countries have been relatively

stable over successive rounds. While Canada’s PISA rankings remain well above average, Canadian scores in all three subjects have experienced statistically significant declines since benchmarking of the relevant subject (See Figure 1 and Table 1). Provinces are responsible for managing public schools in Canada. Hence, it is important to review results at the provincial as well as the national level. Notably, I compare the impact on PISA reading scores due to variation in the socio-economic conditions of families of participating students – both at the level of selected national scores and, within Canada, provincial scores.

My motivation in writing this Commentary is to persuade Canadians to take a greater interest in our provincial education systems – and in international

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- 2 In addition to reading, mathematics and science, PISA assesses other aspects of learning, with examples including financial literacy (since PISA 2015), collaborative problem solving (PISA 2015), global competence (PISA 2018), and creative thinking (PISA 2021). A discussion of secondary results is, however, beyond the scope of this study.
 - 3 The rankings cited include all 78 participants in the 2018 round. If the ranking is restricted to the 37 OECD member countries, in reading Canada ranked 2nd (exceeded only by Estonia), in mathematics 7th (exceeded by Japan, Korea, Estonia, Netherlands, Poland, and Switzerland), in science 5th (behind Estonia, Japan, Finland, and Korea). Some differences in ranking are small and not statistically significant.

Figure 1: Composite Canadian Scores in Reading, Mathematics, and Science, Benchmark Year to 2018

Note: Reading, mathematics, and science results were initially benchmarked at an average score of 500 and standard error of 100 for the overall PISA survey. Benchmarking for reading, mathematics, and science took place respectively in the 2000, 2003, and 2006 rounds.

Source: O'Grady et al. (2019b).

comparisons. The first section reviews provincial outcomes. Across Canada, many provincial outcomes are “well above” the relevant OECD averages. This is not the case among the six smaller provinces. Of the three subjects, mathematics scores are overall the weakest. In mathematics, Quebec is a positive outlier. I offer tentative explanations for its exceptionalism. The second section discusses equity of outcomes, in terms of socio-economic family conditions and, briefly, in terms of Indigenous/non-Indigenous outcome gaps.

PROVINCIAL PISA RESULTS

By construction, national scores provide no information on the relative performance of provincial school systems. For the three subjects, Table 1 provides a snapshot of provincial performance. It shows 2018 average provincial scores and two calculations of difference: from the

benchmark year for each subject to 2018, and the recent change from the 2015 to 2018 round. The provinces are ranked by 2018 reading scores. What are the key conclusions to draw?

Relative Decline in PISA Scores for the Smaller Provinces

It is useful to categorize the provinces into three groups:

- *Group A – Ontario, Quebec, British Columbia, Alberta:* The four large provinces (with population over four million) are home to 86 percent of Canada's population. For all subjects, they have the four highest 2018 scores.
- *Group B – Nova Scotia, Newfoundland, Prince Edward Island:* While outcomes are weaker than provinces in Group A, average results in this group are higher than provinces in Group C, and have been more stable than in Group C.

Table 1: Canadian PISA 2018 Performance, Score and Changes, by Province

	Reading			Mathematics			Science		
	Score	Change		Score	Change		Score	Change	
	2018	2000-18	2015-18	2018	2003-18	2015-18	2018	2006-18	2015-18
<i>OECD (see note)</i>	493	-7	-4	494	-5	2	489	-6	-2
Canada	520	-14	-7	512	-20	-4	518	-16	-10
GROUP A									
Alberta	532	-19	-2	511	-38	-1	534	-17	-7
Ontario	524	-10	-3	513	-17	3	519	-18	-5
British Columbia	519	-19	-16	504	-34	-17	517	-22	-22
Quebec	519	-16	-12	532	-4	-11	522	-9	-15
GROUP B									
Nova Scotia	516	-6	-2	494	-21	-3	508	-12	-9
Newfoundland and Labrador	512	-5	7	488	-28	3	506	-19	0
Prince Edward Island	503	-15	-12	487	-14	-12	502	-7	-13
GROUP C									
Saskatchewan	499	-30	4	485	-31	1	501	-16	5
Manitoba	494	-35	-4	482	-47	-7	489	-34	-10
New Brunswick	489	-12	-16	491	-20	-2	492	-14	-14
Group averages (weighted)									
Group A	523	-14	-7	516	-19	-4	521	-16	-10
Group B	513	-7	0	492	-22	-2	507	-14	-6
Group C	495	-27	-4	485	-35	-3	494	-22	-6

Note: Bolded differences are statistically significant at 5% one-tail. The OECD average scores and changes are calculated from the sample of OECD member countries participating in all rounds from 2000 to 2018. Due to addition, since benchmarking, of several OECD member countries with weaker outcomes, the OECD 2018 average scores published (reading 487, mathematics 489, science 489) are below those cited above.

Source: Author's calculations from OECD (2019b) and previous round PISA reports and ESDC's calculations using data from PISA 2000, 2003, 2006, 2015 and 2018.

- *Group C – Saskatchewan, Manitoba, New Brunswick:* With one exception, the highest subject score among these three provinces is below the minimum comparable score in Group B. Furthermore, all but one of the benchmark-to-2018 declines in this group are statistically significant.⁴

On all three subjects, the Group A provinces score sufficiently high that their differences from the OECD averages are statistically significant.⁵

Among the six smaller provinces, this is not the case. In reading, five of the six Group B and C scores are statistically above the OECD average. The exception, New Brunswick, scores below the OECD average but the difference is not statistically significant. In mathematics, five of the six Group B and C scores are within a range where deviations from the OECD average are not statistically significant. Here, Manitoba is the exception, with a score significantly below the OECD average. In science, four Group B and C scores are statistically above the OECD average. Two, Manitoba and New Brunswick, score within a range that is not statistically significant in terms of difference from the OECD average. To summarize: among the 18 Group B and C scores, nine are statistically above the OECD average; eight are, in terms of statistical significance, at the OECD average; one score is significantly below average.

Description is not explanation ...

Perhaps the explanation for weak scores among Group B and C provinces is that four are “have not” provinces qualifying for equalization payments.⁶ Since their own-source revenues fall below the benchmark level, they might be expected

to spend less on education than the others, which in turn could be a partial explanation. This is not a persuasive argument. Average per student spending (unweighted by population) among the four Group A provinces in 2014/15 was \$12,600, lowest among the three groups. Among Group B provinces, two receive equalization, and average spending was \$13,100. Among Group C provinces, again two receive equalization, and average spending was \$14,600 (Statistics Canada 2018). At an international level, cumulative per student spending has a positive impact on national PISA scores, but the relationship displays a declining impact on outcomes from incremental spending. Canadian cumulative spending per student (from ages 6 to 15) is close to the OECD average (US\$89,000 in purchasing power parity), a level at which incremental spending on the typical student is unlikely to yield large benefits (OECD 2019a, 65-66).

A more persuasive explanation is that significant scale economies exist, permitting Group A provinces to achieve superior student outcomes despite spending less per student. At the secondary level, the cost per student of delivering comparable education quality in large cities is much less than in small towns and rural areas. All of Canada's cities with a population over one million are in a Group A province.⁷ Provincial school systems acknowledge scale economies via more generous per student funding formulas in rural schools. Nonetheless, the scope of course offerings in rural schools is usually less than in urban centres.⁸

4 At 10 percent significance level, the ninth decline, science in New Brunswick, is also statistically significant.

5 The source of results summarized in this paragraph is O'Grady et al. (2019, Tables 1.3, 3.4, 3.5).

6 Five provinces currently receive equalization payments: Quebec, Prince Edward Island, Nova Scotia, New Brunswick, and Manitoba (Canada 2019a).

7 Six Census metropolitan areas (Toronto, Montreal, Vancouver, Calgary, Ottawa-Gatineau, Edmonton) have a population above one million. They account for half the population of the Group A provinces.

8 For an informal discussion of scale economies in financing secondary schools, see Anderson and Richards (2016).

A third potential explanation is differing socio-economic conditions across provinces. PISA generates an index of the socio-economic status of a student's family, using evidence provided by the participating student. (See Box 2 on the index of economic, social, and cultural status (ESCS)). Regression analysis (admittedly very crude given 10 observations) employs two variables: provincial average ESCS scores and an index variable identifying the four Group A provinces best able to realize scale economies. The results provide tentative evidence that both variables matter.⁹

Mathematics

Mathematics is the subject in which Canada's decline from the benchmark year to 2018 is most pronounced. In all provinces except Quebec and Prince Edward Island, the decline has been statistically significant.¹⁰

Writing for the C.D. Howe Institute, Anna Stokke (2015) makes two arguments. She concludes that many provincial curricula have adopted "discovery based" mathematics instruction, a teaching strategy that invites students to discover independently solutions to problems and discourages direct teaching by instructors. It is an inefficient strategy, she argues, that generates weak results at the early primary level, a disadvantage that many students carry into the secondary level. It encourages teachers to ignore the role of early grade memorization (such as multiplication tables) and of simple algorithms (such as the carry-over rule for subtraction), and minimizes pencil and paper practice in learning basic arithmetic operations. Recent revisions to the Ontario elementary mathematics curriculum are an attempt to address

the problems Stokke raises (Ontario 2020). Second, she emphasizes the importance of instructors' subject knowledge. It is here that Quebec outperforms the other provinces.

Paul Bennett's (2018) explanation of superior Quebec performance is that secondary-level mathematics teachers are required to take more rigorous university mathematics training than is the case in other provinces. Also, Quebec students enter secondary school in Grade 7, as opposed to Grade 9 in many of the other provinces. The combination of better-trained secondary math teachers and more years of secondary-level instruction is, Bennett concludes, the basic explanation for Quebec's superior performance. The trade-off, he acknowledges, is lower secondary completion rates:

Immersed in a French educational milieu, the Quebec mathematics curriculum has been, and continues to be, more driven by mastery of subject knowledge, didactic pedagogy and a more focused, less fragmented approach to student intellectual development. Socio-historical and cultural factors weigh heavily in explaining why Quebec continues to set the pace in mathematics achievement. A challenging curriculum produces higher math scores, but it also means living with lower graduation rates. (Bennett 2018.)

According to the 2016 Census, the share of young non-Indigenous adult Canadians (ages 20-24) with at least secondary certification is 92 percent. At 87 percent, the comparable Quebec statistic is five points lower (Richards, Mahboubi 2018).

Eric Hanushek (2018) and his colleagues have generalized the argument that teachers' knowledge of subject is an important independent factor in explaining national PISA scores. From the Program for the International Assessment of

9 For more detail see results in Box 2.

10 As in Quebec, the decline in mathematics scores in Prince Edward Island between 2003 and 2018 is not statistically significant. However, in the case of PEI, this is largely due to the fact that the standard errors surrounding its provincial estimates are large owing to its small population.

Box 2: PISA Index of Economic, Social and Cultural Status (ESCS)*

PISA makes extensive use of a socio-economic-cultural index (ESCS) in attempting to distinguish the relative importance of school and non-school factors. The socio-economic status of a participating student's family is estimated from several features of the student's family: parents' education, parents' occupations, number of home possessions that can be taken as proxies for material wealth, and the number of books and other educational resources available in the home. The ESCS index of economic, social and cultural status is a composite score derived from these indicators via principal component analysis. It is constructed to be internationally comparable.

Students are considered socio-economically advantaged if they are among the 25 percent of students with the highest values on the ESCS index in their country or economy, as socio-economically disadvantaged if their values on the ESCS index are among the bottom 25 percent, and as average if in the middle 50 percent. Following the same logic, schools are classified as socio-economically advantaged, disadvantaged or average within each country or economy based on the schools' students mean values on the ESCS index.

On average across OECD countries, parents of socio-economically advantaged students are highly educated: a large majority have attained tertiary education and work in a skilled, white-collar occupation. By contrast, the parents of socio-economically disadvantaged students have much lower educational attainment. Few disadvantaged students have a parent working in a skilled occupation. One of the home possessions that most clearly distinguishes students of different socio-economic profiles is the quantity of books at home.

A consistent finding is that socio-economic status is related to performance at the system, school and student levels. These associations partly reflect the advantages in resources that relatively high socio-economic status confers. However, other characteristics are associated with socio-economic status but have not been measured by the ESCS index. For example, at the system level, high socio-economic status is often related to greater wealth and higher spending on education. At the school level, school socio-economic status (i.e., peer effects) matter. School level performance tends to be positively correlated with a range of community characteristics that can boost student performance, such as a safe environment, or the availability of public libraries and museums. At the individual level, socio-economic status can be related to parents' attitudes towards education, in general, and to their involvement in their child's education, in particular.

Each of the simple regressions in the table below indicates the strength of the association between a province's mean subject score and two variables, an indicator of provinces in Group A and mean provincial ESCS. In the "reading" regression, the Group A indicator is not significant; the provincial ESCS score is highly significant. In the "mathematics" regression, the Group A indicator is highly significant; the ESCS index is not significant. In the "science" regression, the Group A indicator is significant (at a low level of significance); the ESCS is significant (at a higher level of significance).

* Much of this box has been adapted from the description of the ESCS in Volume I of the 2015 round.

Dependent Variables	Reading	Mathematics	Science
Independent variables			
Group A indicator (1: Group A; 0: Group B or C)	5.4	29.2***	11.0*
Mean provincial ESCS score	108.6***	-14.2	84.5**
Intercept	470.9	491.9	475.4
Adjusted R ²	0.80	0.71	0.83

Notes: Legend: one-tail significance – * 10%, ** 5%, *** 1%.

Source: OECD (2019b, Tables II.B2.1, II.B2.2, II.B2.43, II.B2.44).

Adult Competencies (PIAAC), another OECD data source, they estimated the median national cognitive level of teachers in mathematics and reading in 31 countries (Canada among them). From the 2012 PISA results, they identified the reading and mathematics scores for national samples of secondary students in each country, plus characteristics of the students' families and schools. A one standard deviation increase in teachers' cognitive level in mathematics had three times the incremental impact on student PISA mathematics scores as an equivalent increase in parents' cognitive level in mathematics.¹¹

In addition to a more rigorous curriculum and better-trained teachers, a third explanation is the relative importance of private schools in Quebec. The private school share is above 20 percent, more than double the national rate of 8 percent. In Quebec private schools, the average PISA 2018 mathematics score was 579, in public schools 519. Much of this gap is attributable to the above-average socio-economic status of families that select private schools. Nonetheless, despite loss of positive peer effect in public schools due to the choice of a private school by many higher status families, the public school score is above the Canadian average of 512.¹² The other province with a private school share of students well above the national average is BC.

Recent PISA Declines (2015-2018)

The second set of differences, between the PISA rounds in 2015 and 2018, are for most provinces small and not statistically significant. However, Quebec experienced a statistically significant decline in science. New Brunswick, already in 2015 below national levels in all three subjects, experienced a significant decline in reading.

The major observation here is that British Columbia can no longer rest on its laurels as one of the best-performing provinces. From the 2015 round, in which it scored above the Canadian average on all three subjects, it experienced statistically significant declines in all three. British Columbia's 2018 scores were close to the respective national averages in reading and science, but well below average in mathematics.

I offer no satisfactory explanation for the five significant declines. A partial explanation in the case of BC may be the underlying strategy of curriculum design that seeks to minimize any memorization: "The redesigned curricula are described as concept-based and competency-driven. They place more emphasis on the deeper understanding of concepts and the application of processes than on the memorization of isolated facts and information" (BC 2020). Drawing conclusions from summary statements is problematic. Slightly more explicit is the new BC primary grade mathematics curriculum, which explicitly states there is to be no memorization of simple arithmetic algorithms. It may be time for BC to do as in Ontario and reintroduce traditional teaching strategies in mastery of basic arithmetic.

EQUITY

Socio-economic Equity

A nation in which virtually all upper-secondary students can read, use mathematics, and understand science at a reasonably high level is likely to be more prosperous and enjoy more social trust than a nation with the same average PISA scores but more polarized results in terms of socio-economic conditions. An implicit goal of Canadian education

11 A similar result arose in terms of impact on PISA reading results from teachers' incremental cognitive level in reading relative to parents' incremental cognitive reading level.

12 These statistics are based on ESDC calculations with PISA 2018 data.

policy is not only achieving high average scores, but also minimizing the expected decline in outcomes among students as socio-economic conditions decline from top to bottom scores.

One strategy to realize socio-economic equity is pre-school education, in particular targeting low-income and marginalized communities. Quebec among provinces has devoted the most revenue to this strategy. Another strategy is programs, such as Pathways to Education, that provide intense tutoring and mentoring among secondary-school students living in low-income neighbourhoods that historically have displayed low secondary completion rates. Rigorous evaluation of Pathways has demonstrated its success (Oreopoulos et al. 2015; Canada 2019). Strategies intended to raise outcomes among students from low socio-economic status families are public money well spent, but they are not cheap. For example, the incremental annual cost per student enrolled in Pathways is approximately \$5,000, nearly half the average provincial per student spending in urban schools.

There exist many measures of equity in education outcomes. The measure favoured by PISA is the following. After ranking students by the PISA socio-economic-cultural index (ESCS), equity is measured by the difference between the average score among the top quarter and average score among the bottom quarter. The smaller the difference the more egalitarian the system.

To illustrate this measure of equity at the national level, Figures 2 and 3 illustrate reading performance among the G-7 countries, by quarter-specific averages of national samples. Relative to the other G-7 members, Canada's performance is impressive. It enjoys the highest average reading

score and lowest top-to-bottom ESCS quarter difference. As noted above, Canada's overall reading score among OECD member countries is exceeded only by Estonia. So too, its top-to-bottom quarter difference is second lowest (value in parentheses): Canada (68), Estonia (61).¹³ Considering G-7 countries, one might conclude that countries can have their cake and eat it too. Unfortunately, based on all OECD-plus participating jurisdictions, a trade-off exists: average reading score and top-to-bottom quarter differences are positively correlated – albeit the correlation is low, implying a loose relation between higher average performance and higher differences.¹⁴

Figure 3 presents the same evidence on G-7 quarter-specific averages as does Figure 2, here in terms of deviations from the relevant G-7 quarter average score. Canada's positive deviation from the G-7 bottom-quarter average is the largest (+26.8), twice the second largest (UK at +12.0).¹⁵ The three countries with the largest top-bottom quarter differences (Germany, France, and United States) have bottom quarter averages at or below the bottom-quarter G-7 average, and top-quarter averages above the relevant G-7 average. Italy is an outlier. It displays a relatively low top-to-bottom difference due to weak relative performance in all four quarters, more so in the top than bottom quarter.

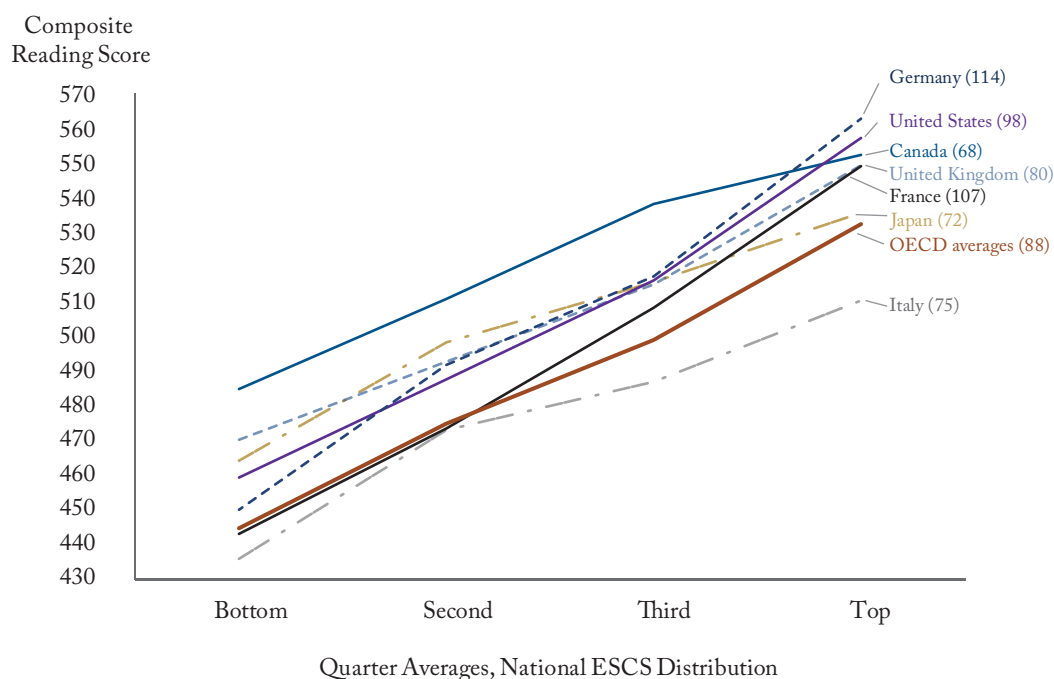
Figure 4 illustrates top-to-bottom quarter differences at the provincial level. As in Table 1, the provinces are ranked by their average PISA 2018 reading score. With a few exceptions, the Group A provinces occupy the highest rankings among both the top- and bottom-quarter results. The three lowest top- and bottom-quarter averages are all in Group C provinces.

13 While Estonia's top-to-bottom difference is lower than Canada's, the difference in differences is not statistically significant.

14 Among the G-7 countries, the correlation between national composite reading score and social gradient is negative (-0.21). Among the 77 participating jurisdictions with published data however, the correlation between average composite reading score and social gradient as defined is positive (0.17).

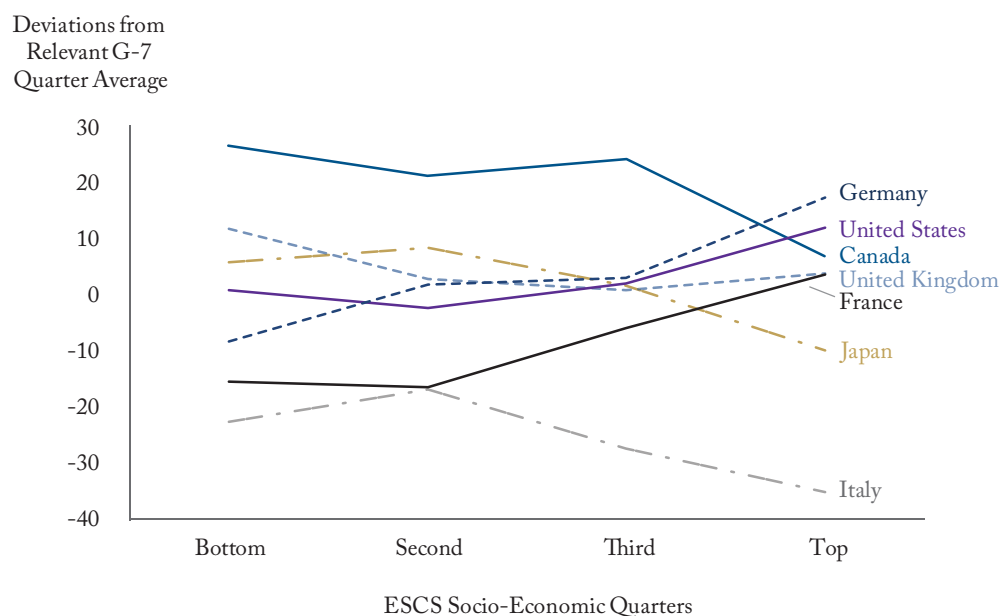
15 Among all countries participating in PISA 2018, Canada ranked 5th in terms of bottom-quarter reading score.

Figure 2: PISA 2018 Quarter-Specific Average Reading Scores, by Socio-Economic Quarters, G-7 Countries and OECD



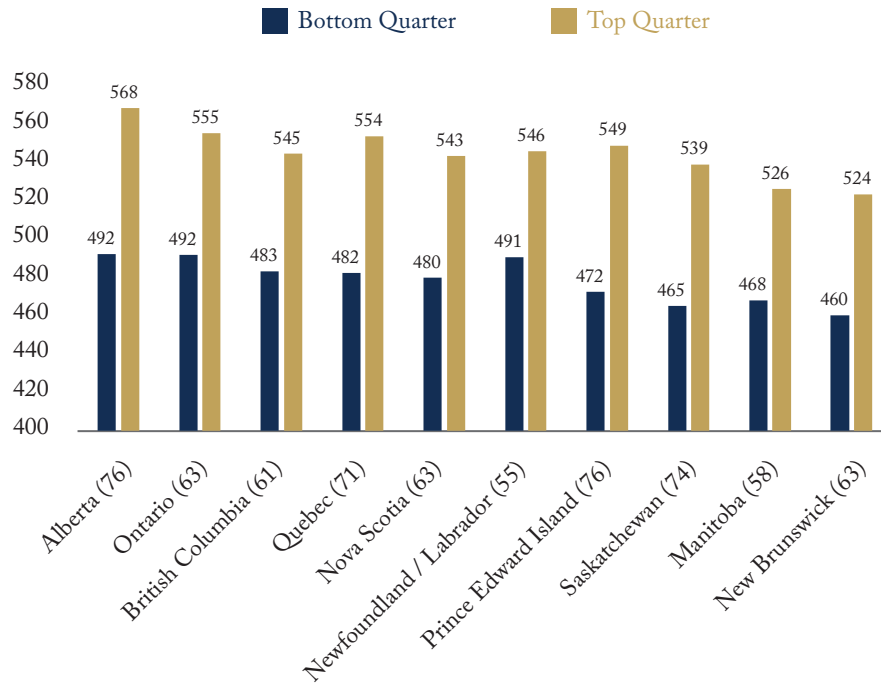
Note: Top-to-bottom quarter differences are in parentheses in labels for Figures 2 and 3. Figure 2 is constructed using the respective national ESCS distributions. Hence, in terms of the absolute ESCS index values, the ESCS quarter-specific average scores vary among countries. Using the absolute ESCS index values would result in modest adjustments to calculated national social gradients.

Figure 3: Deviation of Quarter-Specific Average National Reading Scores from Quarter-Specific G-7 Average, 2018



Sources: Author's calculations for Figures 2 and 3 from OECD (2019b, Figure II.2.3).

Figure 4: Average Reading Scores, Provincial ESCS Index Bottom and Top Quarters, 2018



Note: The numbers in parentheses in the axis labels are the provincial top-to-bottom-quarter differences.

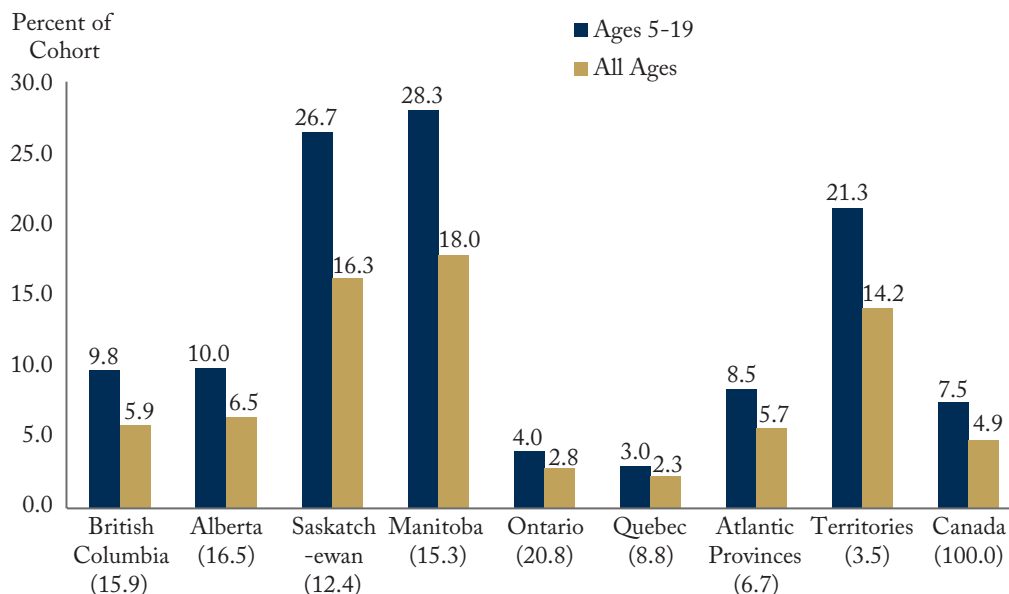
Source: OECD (2019b, Table II.B2.4).

The average top-to-bottom quarter difference among Group A provinces (68) is larger than the average among Group B and C provinces (65). But not by much. In general, as the provincial ESCS index declines, the children of families in all provinces experience similar reading score declines. At the top quarter, all 10 provinces are far above the OECD average reading score. At the bottom quarter, Group A and B provinces are within the range of average OECD reading scores; Group C provinces are below average OECD scores.

Indigenous education outcomes

The gap in PISA Canadian reading scores between top- and bottom-quarters, ranked by the ESCS index, is 68, more than 0.5 standard deviation. The gap between non-Indigenous and Indigenous PISA scores is probably of similar magnitude. Unfortunately, we have no access to Indigenous PISA results from the 2018 round. More on that below. The Pan-Canadian Assessment Program of students age 13 employs a grading system similar to that for PISA. (As with PISA, the average for

Figure 5: Indigenous Population Share, Canada and Provinces, All Ages and School Age Cohort (ages 5 – 19), 2016



Note: Statistics in parentheses in horizontal axis labels indicate the jurisdiction's share of all K-12 Indigenous students.

Source: Statistics Canada (2017).

reading performance was set at 500, with standard deviation of 100.) The 2016 PCAP survey reported the following reading performance among students, by identity: non-Indigenous 512, Métis 489, Inuit 481, First Nation 456 (O'Grady et al. 2019, 27). The non-Indigenous/First Nation difference is 56, also more than 0.5 standard deviation.¹⁶

It is worth emphasizing Census data on the Indigenous share of the K-12 student population. Nationally, the Indigenous share of the school-age cohort (ages 5-19) is 7.5 percent. As can be seen in Figure 5, the share is much higher in the West than

in the East. One in seven of the school-age cohort in the four western provinces is Indigenous, and over one in four in Manitoba and Saskatchewan.

In search of better information on Indigenous education outcomes, the education ministries of six provinces – the four western provinces plus Prince Edward Island and Newfoundland/Labrador – agreed to add a voluntary Indigenous identifier question to the Canadian 2018 PISA questionnaire. The agency responsible for Canada's contribution to PISA is the Council of Ministers of Education, Canada (CMEC). Unlike Australia

¹⁶ The Indigenous/non-Indigenous outcome gap is associated with multiple factors: school quality, socio-economic conditions of Indigenous families, peer effects, and probably discrimination. As illustration, colleagues and I analyzed the outcome gap in 360 British Columbia schools, based on primary-level student assessment scores generated by the Foundation Skills Assessment (Richards et al. 2008).

and New Zealand, two other Commonwealth countries with sizeable Indigenous populations, CMEC has decided not to publish the Indigenous results and, instead, to make data available to the provincial ministries only for internal use. The data are supposedly not representative of the Indigenous populations within each participating province.¹⁷

Since evidence on outcomes among Indigenous students is fragmentary, it is hard to determine whether the data are non-representative. Perhaps, the Canadian PISA results are not representative due to voluntary self-identification. However, a similar source of bias exists with the Australia and New Zealand PISA results (see Box 3.) These countries also use voluntary identifier questions. There is a reasonable *a priori* argument that, with voluntary identification, those with weak school outcomes are less likely to identify than those with strong results, and hence the Indigenous results may embody an upward bias. On the other hand, perhaps the conclusion that the PISA results are deemed not representative is due to large deviations of PISA results from results of PCAP surveys of students age 13. Finally, if the results are sufficiently non-representative to prevent public disclosure, why share them with provincial education ministries?

The decision not to release Indigenous results invites speculation that rationales other than sample bias lie behind the decision. There is a strong tradition in France not to identify any official statistics in terms of ethnicity, on grounds that those with racial bias will exploit weak outcomes to disparage ethnic minorities. Probably, this ideological opposition figured in Quebec's refusal to pose an Indigenous identifier question in the Quebec sample – and it may have been important among the three other provinces that refused to add the identifier.

Against the argument of misuse of data is the old maxim, “if you don't know where you are,

you are unlikely to get where you want to go.” Or, “better to have imperfect empirical evidence plus interpretation than intuitive hunches alone.” The decision to withhold results flouts one of the fundamental rationales for conduct of PISA surveys, namely the desire to provide a better empirical foundation for public discussion of education policy. By careful preparatory work in design of PISA, it has been feasible to analyze trends from one round to another and undertake international comparisons of K-12 school systems. PISA has also contributed to assessing the role of socio-economic factors relative to school-related factors. These features of PISA can potentially contribute not only to knowledge about Indigenous education among Canadian provinces, but also contribute to comparison of Indigenous results in other countries such as Australia and New Zealand.

CONCLUSION

The Canadian K-12 system ranks high in international comparison – but it has weaknesses. The first is the growing gap between results in the four large provinces and the six smaller provinces (recall average changes from benchmark year to 2018 between Group A and, on the other hand, Group B and C provinces).

Since scale economies are a factor in explaining gaps in provincial performance, there is a strong case for Group B and C provinces partnering with other provinces in order to realize scale economies. They could share curricula reforms and encourage their university education faculties to develop complementary specialties. (Sharing curricula reforms does not mean copying the curricula of other provinces displaying weak results.)

Indigenous/non-Indigenous education outcome gaps are large – albeit the evidence is fragmentary. Provinces should be undertaking ambitious

17 The rationale for not divulging Indigenous results is expressed in a personal email from the CMEC.

Box 3: PISA 2018 Australia and New Zealand Results

In Australia, 5 percent of the national PISA sample identified as Indigenous (Thomson et al. 2019). In New Zealand, fully a third identified as Indigenous: Maori, Indigenous to New Zealand (21 percent); Indigenous to other Pacific islands (13 percent) (May et al. 2019). As expected, the summary snapshots of average performance on the three subjects show large gaps between Indigenous and non-Indigenous average results on the three PISA subjects. (See Table B3.1.) The Indigenous/non-Indigenous gaps are smallest in the case of Maori.

Both reports include trends over time, by identity group and by level of subject performance, since the initial round in 2000. Both provide Indigenous/non-Indigenous descriptive results on urban vs. rural distributions and socio-economic distributions based on the ESCS index. New Zealand's report includes additional education-related questions (such as Indigenous education expectations, satisfaction with teachers and school, home use of an Indigenous language).

The New Zealand report introduces discussion of Indigenous results with an appropriate foreword indicating the potential contribution of PISA evidence on Indigenous education results to better education and socio-economic outcomes:

In the historical context of Aotearoa [Maori word for two islands] New Zealand, where Maori were colonized and long subjugated, our education system plays a central role in helping remedy the lingering social and economic inequities while reflecting the country's unique bicultural heritage.

The ultimate test of an education system is whether it leads to the attainment of excellent outcomes. Higher literacy, numeracy, and scientific thinking are linked to improved outcomes including better health and higher standards of living. The cumulative knowledge, skills and relationships built at school empower school leavers to participate in and contribute to our communities and wider society...

Included alongside the Maori achievement data is a modest selection of additional indicators from PISA. This is a first attempt at using PISA indicators of value to Maori to pull together a wider view of how Maori students are doing at school: their classroom experiences, their language use at home, their aspirations for future learning and their relationships for learning and wellbeing. (May et al. 2019, 36).

Table B3.1: PISA 2018 Average Competence Level, Australia and New Zealand, by Self-Identified Indigenous and Non-Indigenous Ethnic Identification

	Australia		New Zealand		
	Indigenous	Non-Indigenous	Maori	Pacific	National Average
Reading	431	507	463	442	506
Mathematics	426	495	451	433	494
Science	432	507	465	438	508

Sources: Thomson (2019); May (2019).

programs to improve Indigenous outcomes, in provincial schools. Two-thirds of those identifying in the Census as First Nation live off-reserve, as do all Métis. Combined, four-fifths of Indigenous families live off-reserve, and their children attend provincial schools (Richards 2018). Given these location realities, the provinces should be taking the lead in closing the Indigenous/non-Indigenous gaps in core subjects. First Nations should be undertaking similar outcomes on reserve schools. This undertaking need not discourage native educators from developing culturally relevant instruction. Effective teaching of Indigenous students does however require adaptation of teaching pedagogies (Waubageshig 2016).

While Canada performs well among G-7 countries in terms of student outcomes among the bottom-quarter of students ranked by ESCS

(recall Figure 3), the Canadian top-to-bottom outcome differences are nonetheless large. Targeted programs addressing bottom-quarter students, such as Pathways and early child education, overlap with programs addressing Indigenous students. These programs can yield benefits. However, provinces must accept the consequences, education budget increases.

Finally, the subject in which Canada's relative international performance is weakest, and the decline has been largest, is mathematics. Quebec's superior mathematics performance suggests that other provinces place more emphasis on mathematics in teacher training, and adopt mathematics curricula similar to those of Quebec.

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