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SOCIAL POLICY

## What Policies Work? Addressing the Concerns Raised by Canada's PISA Results

PART II OF A TWO-PART REPORT

by

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- The latest round of the Program for International Student Assessment (PISA) shows statistically significant declines in mathematics scores for most Canadian provinces, and in science and reading scores for many provinces.
- The PISA background research sheds light on which policies – among many hotly debated approaches – probably do improve student performance.
- Policies that probably do work:
  - Pre-primary (early childhood) education improves outcomes among 15-year-old students – especially among socially disadvantaged students.
  - School autonomy improves outcomes – provided school-level academic results are posted publicly.
  - Paying secondary school teachers well is associated with better outcomes – clearly evident in a Canada/US comparison.
  - Subsidizing a sizeable minority of students to attend private schools probably helps explain Quebec's superior mathematics results – in public as well as private schools.
- Policies that appear not to work:
  - If the national student/teacher ratio is already below 20 (as is true in Canada), lowering it further is unlikely to improve outcomes.
  - Increasing instruction time for mathematics is unlikely, by itself, to improve mathematics scores.

PISA assesses the academic ability of 15-year-old students across three subject areas – reading, mathematics and science. Every three years since 2000, PISA has administered tests in these three subject areas, with a rotating focus. The focus for the latest round, in 2012, was on mathematics,

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with fewer questions posed on the other two. While Canada's outcomes remain well above the OECD average, they have been slipping. Over the last decade, Canada has experienced statistically significant declines in two of the three subject areas, science and mathematics.

In Part I (Richards 2014b), I identified some concerning trends in the Canadian PISA results at a provincial level. Here in Part II, I discuss six education policies analyzed by PISA – three that seem to “work,” one that may be working in the case of Quebec, and two that seem “not to work.”<sup>1</sup>

## A Recap of Canada's PISA Results

The most commonly cited PISA statistics are national scores on each of the three subject areas. The scores are normalized such that, in the base year for a subject area, the average score for OECD member countries is 500 (with a standard deviation of 100). The average OECD member country score for mathematics in 2012 was 494, implying an overall decline relative to the mathematics base year of 2003.

In the 2012 results, the average Canadian mathematics score was 518; the reading score was 523, and science 525. In terms of all participating countries (and cities), Canada ranked 13<sup>th</sup> in mathematics, 9<sup>th</sup> in reading and 10<sup>th</sup> in science. In terms of the OECD-member countries participating, Canada ranked respectively 7<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup>.<sup>2</sup> In summary, Canada is doing reasonably well. But when drilling down into the results, there are signs for concern, as revealed in Table 1. Among them:

- Provincial average 2012 scores display a wide range: in mathematics, from 536 (Quebec) to 479 (PEI), in reading from 535 (BC) to 490 (PEI), in science from 544 (BC) to 490 (PEI). All provinces were consistently above the relevant OECD average, except for PEI (below in all three subjects) and Manitoba (below in two subjects).
- Every province experienced a statistically significant decline in at least one subject between the base year and 2012.
- Two provinces (PEI and Manitoba) experienced statistically significant declines in all three subjects.
- Three provinces (Newfoundland, Quebec and Alberta) experienced statistically significant declines in two subjects.
- Five provinces (Nova Scotia, New Brunswick, Ontario, Saskatchewan and BC) experienced statistically significant declines in one subject.
- Three provincial declines were in excess of 30 points (mathematics in Manitoba and Alberta, reading in Manitoba).

Questions arise from these outcomes. For example, why has Quebec avoided a decline in its composite mathematics score over the last decade while other provinces have seen declines? Why have Alberta and Manitoba experienced exceptionally large declines in mathematics? Perhaps major policy differences between provinces are the explanation.

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1 Most of the PISA research analysis concerns “partial” results, relating education outcomes to one or two explanatory factors, and as such should be treated with caution.

2 While these are the rankings based on the scores, the differences between Canada and some of the jurisdictions immediately above it are not statistically significant.

**Table 1: Average 2012 PISA Scores and Change from Subject Base Year to 2012, Canada and Provinces**

	Science		Reading		Mathematics	
	Score	Change 2006-12	Score	Change 2000-12	Score	Change 2003-12
<i>OECD average</i>	501		496		494	
Canada	525	<b>-9</b>	523	-11	518	<b>-14</b>
Newfoundland	514	<b>-11</b>	503	-14	490	<b>-27</b>
Prince Edward Island	490	<b>-18</b>	490	<b>-28</b>	479	<b>-21</b>
Nova Scotia	516	-4	508	-13	497	<b>-18</b>
New Brunswick	507	1	497	-5	502	<b>-10</b>
Quebec	516	<b>-15</b>	520	<b>-16</b>	536	-1
Ontario	527	-10	528	-5	514	<b>-16</b>
Manitoba	503	<b>-21</b>	495	<b>-34</b>	492	<b>-36</b>
Saskatchewan	516	0	505	<b>-25</b>	506	-10
Alberta	539	-11	528	<b>-22</b>	517	<b>-32</b>
British Columbia	544	6	535	-3	522	<b>-16</b>

Note: The bolded changes are statistically significant from 0, at a 5 percent level, based on reported standard errors of the 2012 estimates, the relevant base year for each of science, reading, and mathematics, and a “link error to compare tests over time.”

Sources: Bussière et al. (2001; 2004; 2007), Brochu et al. (2013) and calculations by author.

### Three Policies that Probably Work

*Pre-primary (early childhood) education works – but it should be better targeted toward socially disadvantaged families.*

The PISA data show that pre-primary education has beneficial effects among students a decade later when they reach age 15. This is encouraging inasmuch as other studies show a large benefit in early grades but a fading of benefits in higher grades.<sup>3</sup> However, in Canada and OECD countries overall, those who receive pre-primary education are disproportionately from socially advantaged families.

The average 2012 gap among OECD countries in mathematics scores between students who had more than one year of pre-primary education and those who did not was 51 points (OECD 2014b,46-48). Roughly two-fifths of the performance gap is explicable by the fact that those with pre-primary education enjoyed a large socio-economic advantage over those without. The analogous Canadian performance gap was only 24 points, but again roughly two-fifths of the gap is explicable in terms of family social advantage among those students with pre-primary education.<sup>4</sup>

3 For evidence on the “fading” of benefits in higher grades, see the survey in Richards and Brzozowski (2006).

4 Calculations are available from the author.

While it is encouraging that PISA found a sizeable benefit from pre-primary education, the greatest potential benefit accrues among the socially disadvantaged, whose families can provide fewer education services to their children (Barnett 1995). Fewer than half Canadian students reported attending pre-primary school for more than one year (OECD 2014b, 518), and those who did attend were on average of higher socio-economic status than those who did not.

*Increasing school autonomy improves outcomes – provided school-level academic results are posted publicly.*

Over the last quarter century, many jurisdictions have expanded the autonomy of schools with respect to curriculum design and student assessment. PISA undertook an exercise of dividing schools within systems into a subset with more autonomy over internal allocation of resources and a subset with less autonomy:

*[T]here is a relationship between school autonomy and learning outcomes, but this relationship interacts with the accountability arrangements of school systems. For example ... in systems where a greater share of schools post achievement data publicly, considered here as one form of accountability, there is a positive relationship between school autonomy in resource allocation and student performance ... where schools do not post achievement data publicly, after students' and schools' socio-economic status and demographic profile are taken into account, a student who attends a school with greater autonomy in defining and elaborating curricula and assessment policies tends to perform seven points lower in mathematics than a student who attends a school with less autonomy in these areas (OECD 2014b, 52).*

After taking into account students' and schools' socio-economic status and demographic profile, in school systems where few schools reported academic achievement levels publicly, the less autonomous schools achieved better mathematics scores than the more autonomous. However, as the share of schools in any jurisdiction publicly reporting results rose, the advantage in scores shifted to the more autonomous schools.

PISA provides some specifically Canadian evidence on the value of posting academic results as a means of assuring school accountability (OECD 2014b, 528). The correlation between the percentage of schools in a province publicly posting school-level academic results and the provincial average mathematics score is high ( $r = 0.59$ ). Posting results may be a good proxy of the intent at a school or provincial level to pursue high mathematics outcomes.

*Paying secondary school teachers generously is associated with better outcomes.*

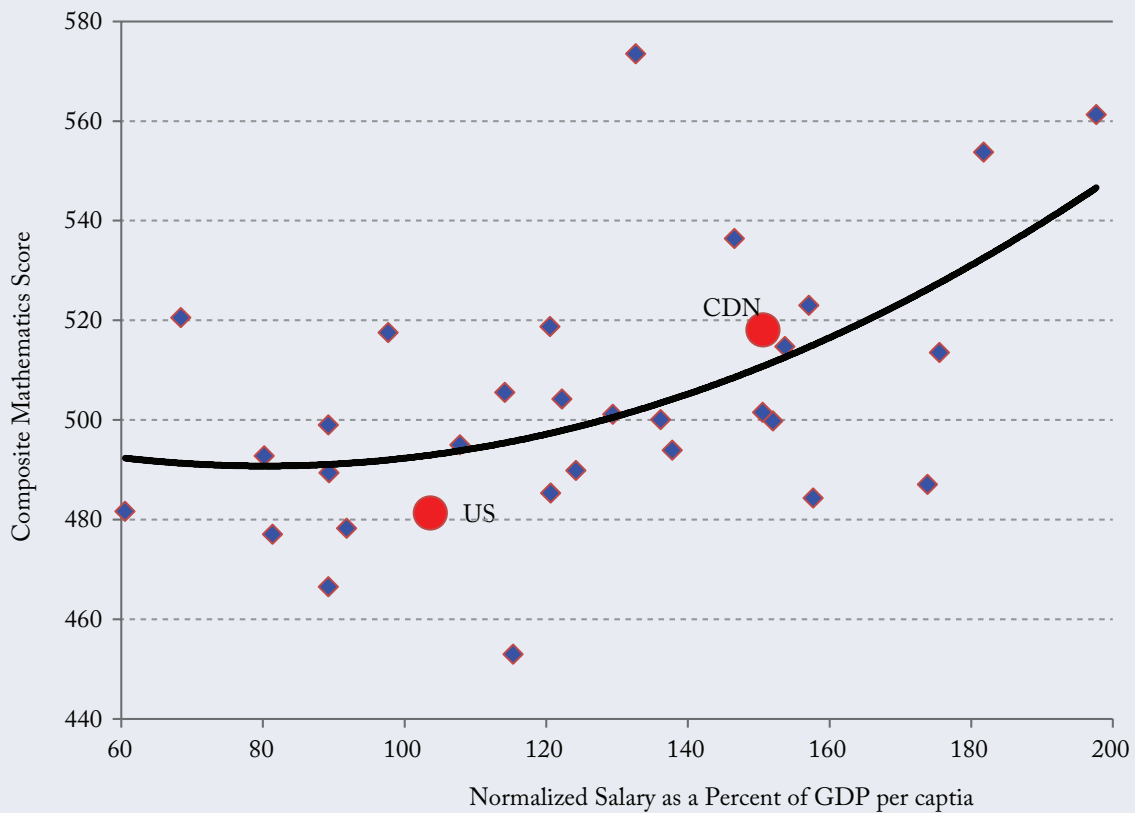
“Paying generously” is ambiguous. To give some precision to this discussion, start with PISA’s procedure for normalizing teacher salaries across countries: average national salaries are expressed as a percent of national per capita GDP. Among high-income countries,<sup>5</sup> there exists a fairly robust positive relationship between average salary at a national level and national PISA performance in mathematics (see Figure 1). The relationship turns positive once the normalized salary exceeds 80 percent. Above 80 percent, the incremental impact of any salary increase rises with average salary. Canadian teachers, with normalized salaries of roughly 150 percent of per capita GDP, are much better paid than their US counterparts. Average salaries place Canada at the 74th percentile of the 32 countries identified, US at the 29th.

The link between salaries and outcomes is not simple. Many factors can therefore be invoked to explain the 37-point advantage of Canadian students relative to their US counterparts in mathematics proficiency. The ability

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5 There is no significant relationship between salary and performance among PISA participants with per capita GDP below PPP\$20,000, where PPP, purchasing power parity, adjusts for price differences of goods across countries to make salaries comparable.

Figure 1: National Composite Mathematics Score, by Normalized Salary of Secondary School Teachers, 2012



Note: The figure includes all high-income PISA countries (per capita GDP above \$20,000 purchasing power adjusted) with available data, excluding Qatar.

Source: OECD (2014b,42).

of Canadian provinces to pay teachers generously is just one of them. Design of the mathematics curriculum is probably important. Education authorities must also take seriously their discretion to hire mathematics teachers who both understand core mathematics and can teach well. This implies a responsibility to evaluate teacher performance and not succumb to the hiring and firing rigidities characteristic of many US states.<sup>6</sup>

<sup>6</sup> For an estimation in the US context of the costs of providing tenure to exceptionally weak teachers, see Hanushek (2011). The measure of costs is forgone future earnings of students taught by weak teachers, relative to earnings of students taught by teachers of average skill and competence, controlling for other factors.

## A Controversial Policy that Seems to Work in Quebec

*Subsidizing families to send children to private schools may help explain Quebec's overall superior PISA mathematics outcomes.*

Private schools have a role – in introducing new teaching techniques, in providing a competitive benchmark for public schools, and providing an alternative for parents and students determined to obtain a good education in the context of an under-performing neighbourhood public school.

The average mathematics performance of students in Canadian private schools exceeds that in public schools by a substantial margin, 54 points (= 568 – 514). This is well above the overall private/public margin among OECD countries (28 points). However, there is also a substantial difference in average family socio-economic status, according to the PISA index, between private- and public-school students in Canada. Adjusting for this reduces the margin to 38 points.<sup>7</sup> PISA also adjusts for school-based factors (such as positive peer effects in a school whose student body has an above-average socio-economic status). After adjustment for family and school factors, there remains a more modest, but statistically significant, 25-point margin of private- over public-school performance.”

In Canada, 8 percent of PISA-assessed students were in private schools, 92 percent in public schools. The results most suggestive of the impact of private schools are in Quebec, the province that, by a large margin, has the highest share of private-school students.<sup>8</sup> Most Quebec private-school students sampled are in schools defined by PISA as “government-dependent” (inasmuch as they receive substantial public funding) as opposed to “government-independent.” The average private-school mathematical performance was 62 points above that of public schools in the province (= 584 – 522). The difference in the average socio-economic status between students in Quebec public and private schools explains 22 points of the difference. PISA also adjusted for school-based factors. Allowing for this further reduces the unexplained margin, by 31 points.

In sum, social advantage of students’ families and school-based factors explain most of the private/public performance gap; the unexplained margin of 9 points (= 62 – 22 – 31) is statistically insignificant. However, this decomposition misses a second argument. The prevalence of competition between public and private schools may be part of the explanation for the fact that Quebec public schools realized a mathematics score (522) above the national average and that, among provinces, Quebec’s 2012 mathematics performance was the highest.

While private schools have a role, there are reasons to continue placing the primary emphasis on maintaining and strengthening the public sector. Were large numbers of socially advantaged families to abandon the public system, there would be a loss of parental oversight of that system, which would probably lead to greater disparity between more and less advantaged students. The United States arguably suffers from this dynamic. Another reason to question expansion of the private system is the potential to retard integration of immigrants. A century ago, at a time of rapid immigration, the public-school system played a major role in both Canada and US in integrating new immigrants. At present, Canada is again experiencing large-scale immigration, and integration of new immigrants is a political and economic priority. Many private schools form on a religious or ethnic basis, which raises concerns over private schools’ contribution to intergenerational integration of ethnic minorities. An

7 Calculations are available from the author. Data in this and the subsequent paragraph are drawn from OECD (2014b, 389-90, 524-26).

8 Private-school students reside disproportionately in Quebec (21.0 percent of provincial students). In BC they comprise 10.8 percent. In the eight other provinces, the private-school share is 5 percent or lower (OECD 2014b, 524).

inability of the school system to integrate second- and third-generation immigrants living in large diaspora has become a serious political problem in many European countries (Collier 2014).

## Two Policies that Probably Don't Work

*Once the national student/teacher ratio is below 20, lowering it further is unlikely to generate better outcomes.*

Figure 2 illustrates national mathematics scores plotted against average national student/teacher ratios for all PISA countries with available data.<sup>9</sup> (Note that the student/teacher ratio is typically smaller than the size of typical classes in a school.<sup>10</sup>) The negatively sloped trendline indicates some value from lower ratios. But if we eliminate the six outliers with ratios above 20 (all are relatively low-income partner countries), the relationship between student/teacher ratio and math scores for the remaining 58 essentially disappears.

Relative to the average student/teacher ratio of 13.0 among the 58 jurisdictions, Canada has an above-average ratio (15.6). But there is no good evidence from PISA to suggest that lowering it be a high priority. One might consider the ratio in private schools to be optimal, yet private schools are not opting for a lower ratio – there is no significant difference between the two (16.6 private versus 15.5 public).<sup>11</sup>

*Increasing time devoted to teaching mathematics does not seem to generate better outcomes.*

PISA summarizes their conclusion as follows:

*after accounting for the socio-economic status and demographic profile of students and schools and various other school characteristics, ... across all countries that participated in PISA 2012 there is no clear pattern between a system's overall mathematics performance and whether students in that system spend more time in regular mathematics classes or not. Since learning outcomes are the product of both the quantity and the quality of instruction time, this suggests that cross-system differences in the quality of instruction time blur the relationship between the quantity of instruction time and student performance. (OECD 2014b, 43.)*

Among Canadian provinces, the average time devoted to regular mathematics instruction ranged from 257 minutes per week in Newfoundland to 364 in Alberta (OECD 2014b, 508), with a negligible correlation ( $r = 0.05$ ) between average instruction time and mathematics performance.

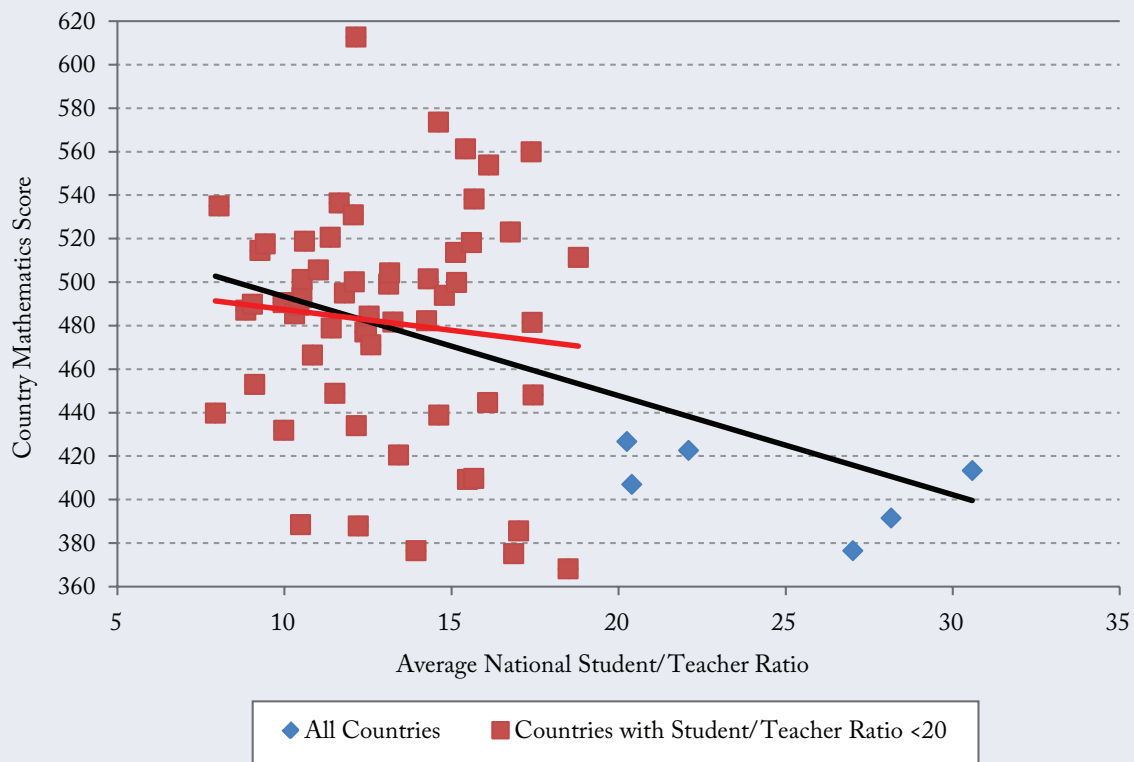
As the PISA research report suggests, “quality of instruction” probably matters more than quantity. This implies that education authorities should be concerned with the mathematics knowledge among teachers and with curriculum design. Currently in Canada a lively debate is underway about appropriate curriculum for teaching mathematics in primary grades (Anderson 2014). The “traditionalists” advocate that primary school instruction stress the learning, by rote if necessary, of basic algorithms for addition, subtraction,

9 The scatterplot includes 64 observations, including partner countries that are not OECD members and the four East Asian cities.

10 PISA 2012 asked school principals to report the number of all teachers and students in their schools. One reason for the gap between the student/teacher ratio and size of typical class is “special needs” students. Such students are typically taught in regular classes supplemented by teachers working with very small classes of these students. The larger the proportion of “special needs” students in a school the larger will be the expected difference between the two ratios.

11 Data in this paragraph are derived from a web-only table (Table IV.3.36) linked to OECD (2014b).

Figure 2: PISA Mathematics Scores, by Average National Student/Teacher Ratios



Source: OECD (2014b, 321).

multiplication, and division. Their opponents advocate teaching based on student “discovery” of strategies to solve mathematics problems.

One province that is undergoing a redesign to its mathematics curriculum in terms of student “discovery” is Alberta. This has been a controversial innovation, and has catalyzed considerable parental opposition (Staples 2014). Between 2003 and 2012 its average mathematics score fell from 549 to 517, from highest-ranked province to the national average. At a minimum, Alberta education authorities should be undertaking rigorous evaluation for links between curriculum based on “discovery” and test scores.

## Conclusion

By regularly testing the academic performance among large random samples of students in all jurisdictions of interest, and capturing information about the socio-economic and cultural status of the students’ families and characteristics of their schools, PISA researchers can subsequently analyze policy factors that appear to explain differences in student outcomes. This strategy has its limitations. The researchers must define the factors of interest beforehand, and they may mis-specify what really matters. But if the likely alternative is policy based on policy fads and very little evidence, comparative assessment projects such as PISA are valuable tools.



What information can policymakers glean from PISA 2012?

- In Canada and other countries, those students who had, a decade earlier, received early-childhood education had better student outcomes at the upper secondary level. This was true after adjusting for student socio-economic status.
- Those students who received early childhood education enjoy an above-average socio-economic status, whereas the incremental benefit of pre-primary education is larger among the socially disadvantaged.
- School autonomy over in-school resource allocation seems to generate modest benefits in student outcomes, provided school academic achievements are publicly posted.
- Paying Canadian secondary teachers generously relative to their US counterparts is probably among the reasons for Canada's superior PISA performance.
- PISA supplies some evidence to the effect that publicly subsidized private schools are part of the explanation for Quebec's superior mathematics performance.
- On the other hand, PISA offers no evidence to support reducing Canada's average student/teacher ratio or relying on increased mathematics teaching time as means to improve results.

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