

SECONDARY SCHOOL CLASS SIZES AND STUDENT PERFORMANCE IN CANADA

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Contents

Executive summary / iii

Introduction / 1

Research and policy context / 2

Data and methodology / 6

Results / 7

Conclusion / 13

References / 16

About the author / 20

Acknowledgments / 20

Publishing information / 21

Supporting the Fraser Institute / 22

Purpose, funding, & independence / 22

About the Fraser Institute / 23

Editorial Advisory Board / 24

Executive summary

Small classes are popular with parents and teachers. They are also expensive. Is the cost worthwhile for governments faced with persistent budget deficits and escalating education costs? Ontario has decided to seek much needed savings by phasing in an increase in secondary school class sizes. Will this negatively impact student achievement as opponents argue? This study draws on aggregate data from the 2015 Programme for International Student Assessment (PISA) to show that provinces with larger reported secondary class sizes than Ontario performed better on standardized measures of student achievement.

Extensive research into the effects of smaller classes has identified relatively small positive benefits in the lower grades and yielded inconclusive results for the higher grades, with some evidence of higher achievement scores in schools with larger secondary classes. This was the pattern found in this study.

Canada has traditionally performed well in the PISA results, and did so again in 2015, placing 10th in math, 7th in science and 3rd in reading among the 72 participating countries. Not all provinces performed equally well, with the largest, wealthiest provinces of Ontario, Quebec, British Columbia, and Alberta outperforming the others. Among these “Big Four” provinces, students in Quebec, British Columbia, and Alberta attained the highest scores in all three subjects.

PISA measures average class size from school principals’ reports. The reported Canadian average secondary school class size of 26.4 was slightly higher than the OECD average of 26.1. There was a large range of class sizes within Canada extending from a low of 22.6 in Saskatchewan to a high of 30.1 in Quebec. Reported class sizes in Ontario (24.8) and British Columbia (25.4) were statistically indistinguishable from four much smaller provinces.

This study finds a positive correlation ($r = 0.758$, $p = 0.011$) between mean subject scores and reported average class sizes: provinces with higher PISA scores tended to have larger classes. The study charts mean scores for reading, science and math against average class sizes in the Big Four provinces. Despite having the lowest scores in each of the three subjects, Ontario also had the smallest classes.

This finding does not mean or imply that increasing class sizes in secondary schools will increase student scores on standardized tests. Many other factors contribute to student outcomes. Still, classroom modifications that research has identified as being effective can cost much less than subsidizing smaller classes. And, as demonstrated by this study, higher scores can be achieved with larger classes.

Introduction

In recent decades, Canadian provinces and US states¹ have adopted policies reducing the numbers of students in public school classrooms. This move has been enthusiastically welcomed by parents and teachers, aggressively promoted by teacher unions, and broadly supported by politicians. Yet smaller classes increase costs. Boards must hire—or retain as enrolments decline—more teachers, incurring substantial and continuing salary, benefit, pension, administrative, and possibly capital costs which ratchet up provincial grants. For all these reasons Chingos (2011) argues that class size reduction is the most expensive school reform.

Faced with stubborn budget deficits and continually rising education costs (MacLeod and Emes, 2019), reversing this policy may appear as an attractive option. Ontario started down this road in March 2019, announcing modest increases in average class sizes for Grades 4–8 and more substantial increases for secondary schools which would add an average of six students to each class (Ontario, 2019a). The response from teacher unions was as combative as it was predictable, the secondary teachers' union most affected vowing to resist what it predicted would be a loss of 5,700 teaching positions (Alphonso, 2019). Since then, Ontario (2019b) has scaled back the change to a mere half-a-student increase for the 2019/20 academic year, but appears committed to phasing in the originally announced increase to an average of 28 students over the following three years.

Will this policy change affect student achievement? This study investigates this key question through an analysis of provincial class size and student performance data from the 2015 Programme for International Student Assessment (PISA). In addition to showing that students in provinces with larger average class sizes performed better on the PISA tests, the study provides a more complete account of class sizes in Canadian secondary schools than has been previously available.

1. The US Federal government initiated the subsequent wave of snowballing class size policies with its 1999 \$1.2 billion class size reduction program which was continued in successive years until folded into the No Child Left Behind Act in 2001 (US Department of Education, 2004). As of 2010, 36 US states had at least one policy limiting class sizes (Zinth, 2010).

Research and policy context

Proponents of smaller classes argue that fewer students make classrooms easier to manage, allowing for more individualized attention which will increase engagement and improve student achievement. The considerable body of pertinent research shows smaller classes can make a difference, but the effects are smaller and more conditional than often claimed, with many other factors influencing outcomes and complicating analysis.

Tennessee's highly influential Project STAR provided strong but qualified support for the conventional view. From 1985 to 1989, almost 12,000 K–3 students and over 1,000 teachers were randomly assigned to either small (13–17 students) or regular classes (22–25 students).² Those in the small classes did better on a range of achievement and behavioural measures, with disadvantaged students tending to benefit more (Finn and Achilles, 1999; Schanzenbach, 2006). Improvements in test scores were nonetheless small, although larger in the lowest grades,³ suggesting smaller classes may particularly help younger children adapt to classroom norms and routines (Guillemette, 2005).⁴ Subsequent reanalyses found that while all students benefitted from the small classes, higher achievers benefitted more (Konstantopoulos, 2008). Observed gains in student achievement have also been linked to more experienced teachers (Krueger, 1999).

Continuing but reduced positive effects from the STAR project have been reported as the students progressed through school: fewer small class students were retained in grade and they tended to earn higher marks until the effect on test scores faded into statistical insignificance around Grade 8 (Krueger and Whitmore, 2001). Even so, fewer dropped out of high school, more took advanced-level and foreign language courses, and more were in

2. The Chetty et al. (2011) analysis of adult outcomes for 9,939 Project STAR students reported the small classes had 15.1 students on average, the regular classes 22.6 students. Students attended small classes for an average of 2.27 years.

3. Effect sizes (Cohen's D) of 0.187 and 0.189 standard deviation units in Kindergarten and Grade 1, and 0.141 and 0.152 in Grades 2 and 3 (Schanzenbach, 2006: Table 4).

4. This plausible theory implies positive benefits of smaller primary level classes could be reduced as more younger children participate in pre-school, classroom-like experiences.

the top quarter of their classes (Biddle and Berliner, 2002). Longer term trace effects have also been detected, Chetty et al. (2011) reporting improved college attendance, home ownership, and savings, although they were unable to unambiguously identify effects on earnings. Yet despite the influence of Project STAR on subsequent research and policy, scholars have pointed to flaws in design and execution that lead Hanushek (2003) to caution against Project STAR being used to justify class size reduction policies.

More recent studies, including examinations of large-scale class size reduction initiatives in California (Bohrnstedt and Stecher, 2002) and Florida (Chingos, 2010), support Project STAR's core results: relatively substantial reductions in class sizes can provide modest benefits in the primary grades, especially in entry classes. Still, as highlighted in the California results, these gains can be offset by boards being forced to hire more inexperienced teachers and the need to form larger and more split grade classes in higher elementary grades. There is little evidence of positive academic effects from smaller classes in the middle grades, and even less beyond. Neither Hoxby's (2000) rigorous natural experimental treatment of Connecticut data nor Shapson et al.'s (1980) Toronto study found positive effects for smaller classes in Grades 4–8. Uhrain's (2016) recent review of secondary level studies found results to be inconclusive, while Hanushek and Woessmann's (2011) detailed discussion of cross-national econometric analyses of school inputs concluded class size is not “a major driver of student achievement” at the secondary level (p. 138). Indeed, they reported some evidence of higher achievement in larger secondary school classes (p. 131), a relationship also evident in high performing Asian systems in the PISA results (OECD, 2016b: 204).

The systemic difficulty in any attempt to assess the effect of class size is the presence of many other variables affecting classroom dynamics and student outcomes, all of which inevitably interact. Smaller classes can improve learning environments, but the research has shown that not all teachers take advantage of the opportunities created.⁵ Class activities will also be influenced by the availability of learning materials, the presence or absence of disruptive students, more or less supportive school climates, and so forth.

John Hattie's (2005) extensive examination of student achievement research found smaller class sizes to be among the least effective intervention. Hattie's analysis of 164 class size reduction studies found an average effect size of 0.13, essentially mirroring the Project STAR results. He notes the variance across the findings reviewed is small and concludes “the typical effect of reducing class sizes from 25 to 15 is [effect sizes of] about 0.10–0.20” (p. 396). His comparative synthesis of research into other ways of increasing achievement ranked class size 40 out of the 46 different classroom interventions

5. This is particularly clear in the Shapson et al. (1980) Toronto study where very few changes in classroom practices were observed in the smaller experimental classes.

considered (table 1). Providing feedback to students and using direct instruction methods each had the highest average effect sizes of 0.81. Other notable influences included general quality of teaching, with an effect size of 0.67, and, in the more modest range, homework and teacher questioning with average effect sizes of 0.35 and 0.17 respectively (table 1).⁶

As Hattie and others point out, the policy implication is not that smaller class sizes make no difference but that they make a smaller difference, for fewer students, at much greater cost than most other ways of seeking classroom improvement. Given the research evidence, the greatest benefits can be expected in the lower, particularly the entry, grades. Governments with the means can thus find some justification for choosing to finance relatively small entry classes, especially as research (e.g., Shapson et al., 1980) and opinion surveys show these are popular with parents and they appear to have valuable socialization effects, particularly for disadvantaged children. Still, few if any governments are likely to fund classes of 15 or so students, which the research suggests is the most desirable size for primary level classes.⁷ There is no convincing research evidence or argument supporting such policies at the secondary level. To the contrary, the larger size, universal enrolment, and course- rather than grade-based curriculum of modern secondary schools encourages a variety of class sizes to best suit different subject and student configurations. This is typically accommodated by setting average class sizes at the board or provincial level, providing flexibility for individual schools to establish classes appropriate to their circumstances.

The policy question thus becomes whether the applicable averages are appropriate under the prevailing circumstances.⁸ There is obviously no easily calculated answer to such an open question: an appropriate policy solution will aim at ensuring schools have sufficient resources to vary class sizes to best meet their instructional needs while guarding against dysfunctionally large classes. Ontario is currently phasing in an increase in its board-wide Grades 9–12 average from 22 to 28 students. This will still be below British Columbia's stipulated average of 30 and Quebec's average of 32 students, but a little above Alberta's recommended target of 27 students. Ontario's planned reduction will produce significant financial savings. But will it negatively affect student

6. Hattie (2008, 2012) has considerably expanded his comparative analysis of classroom interventions in his more recent publications; a 2019 webpage reports effect sizes for 252 different interventions. On this list class size ranks 186 out of the 235 interventions with positive effects (Waack, 2019).

7. Quebec caps Junior Kindergarten at 17 students, Senior Kindergarten at 19 and Grade 1 at 22; Alberta has set a recommended target of 17 students in K–3. Regulations in other provinces except Saskatchewan establish or encourage primary classes in the 20–27 range.

8. These may include various adjustments or further limits specified in provincial regulations and/or provincially or locally negotiated collective agreements.

achievement? As reviewed above, the research record suggests not, but the complex interplay of pertinent variables makes prediction impossible. Some insight can nonetheless be gained by examining relationships between average class sizes and student achievement in other provinces.

Data and methodology

Since 2000, more than half a million 15-year-old students in some 70 countries have participated in the triannual Programme for International Student Assessment (PISA) sponsored by the OECD. Students take an internationally approved two-hour test on reading, mathematics, science, and other domains such as problem-solving and financial literacy. Students, professional staff, and parents are also invited to answer questions on school organization, home qualities, and other aspects.

This study draws on provincial level aggregate data from the 2015 PISA cycle (OECD, 2016a, 2016b). Approximately 20,000 Canadian students in over 700 schools⁹ participated, 87 percent of whom were enrolled in Grade 10.¹⁰ PISA test scores are standardized to a mean of 500 points and standard deviation of 100 for OECD countries.¹¹ Class size averages are derived from school principal responses to a questionnaire item.¹²

9. Both public and private (independent) schools participated, with 6.8 percent of students enrolled in independent schools. But provincial coverage was uneven. Provinces with the highest proportion of private schools were Quebec (17.1 percent), BC (7.9 percent), Manitoba (5.8 percent), and Alberta (2.2 percent). There were no (0 percent) private schools included in the Ontario sample (OECD, 2016b: Table B2.II.22).

10. More than 90 percent of students in BC, Manitoba, Ontario, and Newfoundland & Labrador were enrolled in Grade 10, between 85 and 90 percent in AB, SK, PE, and NB, 78 percent in Nova Scotia and 65 percent in Quebec.

11. The actual mean for OECD countries in the 2015 cycle was 493 (O'Grady et al., 2016: 19).

12. The item wording is: "What is the average size of <test language> classes in <national modal grade for 15-year-olds> in your school? 15 students or fewer, 16–20 students, 21–25 students, 26–30 students, 31–35 students, 36–40 students, 41–45 students, 46–50 students or more than 50 students."

Results

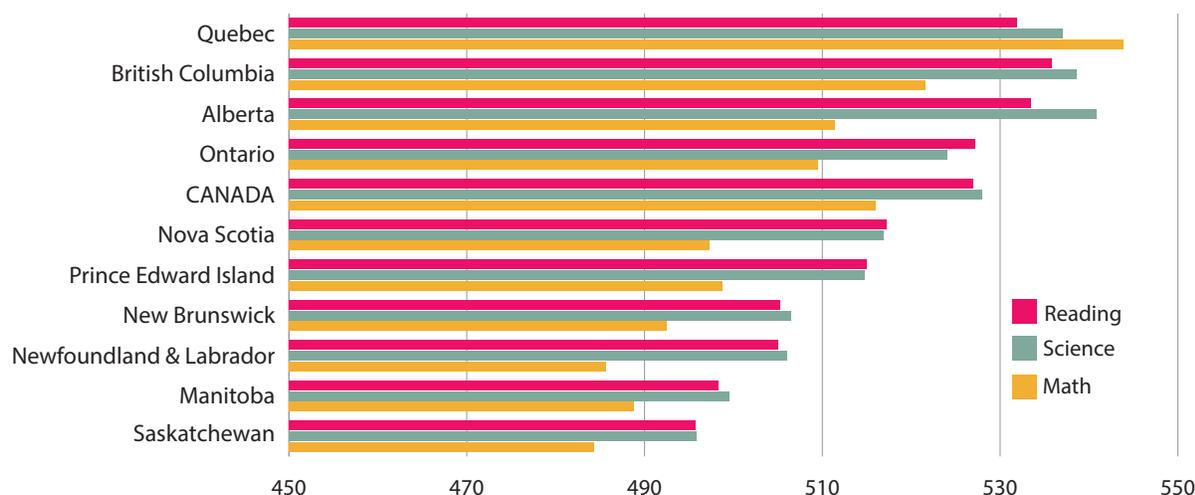
Canada has obtained high PISA scores since the inception of the program in 2000. In the 2015 cycle Canada had the 10th highest score in math, 7th highest score in science, and 3rd highest score in reading from among the 72 participating countries. In each subject domain the Canadian mean scores were significantly higher than the OECD means and were only exceeded by one G7 country in one subject, Japan obtaining a mean score of 538 in math compared to Canada's 528. Only Singapore (535) achieved a higher score than Canada's 527 in reading, which was matched by Hong-Kong.

Figure 1 charts provincial scores for the three subject domains, showing the Canadian means for comparison. Students in British Columbia and Quebec¹³ achieved higher average scores in all three subjects than did Canadian students overall. Alberta exceeded the Canadian average in science and reading. Ontario's mean reading score matched the Canadian average. Students in the remaining provinces scored below the national mean in all three subjects.

Students in all provinces except Quebec attained lower scores in math than in reading or science. Quebec students reversed this pattern by achieving their highest scores in math, followed by science and then reading. British Columbia and Alberta students achieved their highest scores in science, followed by reading, a pattern which matches the Canadian averages. Ontario students obtained their highest scores in reading, followed by science and math.

The four provinces with scores above the Canadian average appearing at the top of figure 1 are also the largest and wealthiest. Between them they accounted for 86.9 percent of total public school enrolment in 2014/15, Ontario enrolling 39.9 percent of all Canadian students, followed by Quebec (23.6 percent), Alberta (12.5 percent) and British Columbia (11.0 percent) (calculated from MacLeod and Emes, 2019: Table 2). Concentrating on secondary school enrolment, these "Big Four" provinces accounted for 84.9 percent of Canadian Grade 9–12 enrolment in 2014/15 (calculated from Statistics Canada, 2019). Grade 12 is not included in the Quebec public school sector,

13. The data released by the OECD warns that "[r]esults for the province of Quebec should be treated with caution due to a possible non-response bias." See O'Grady et al. (2016: 69–70) for details.

Figure 1: Average 2015 PISA scores by subject and province

Source: OECD, 2016a: Tables B2.I.2, B2.I.4, B2.I.10.

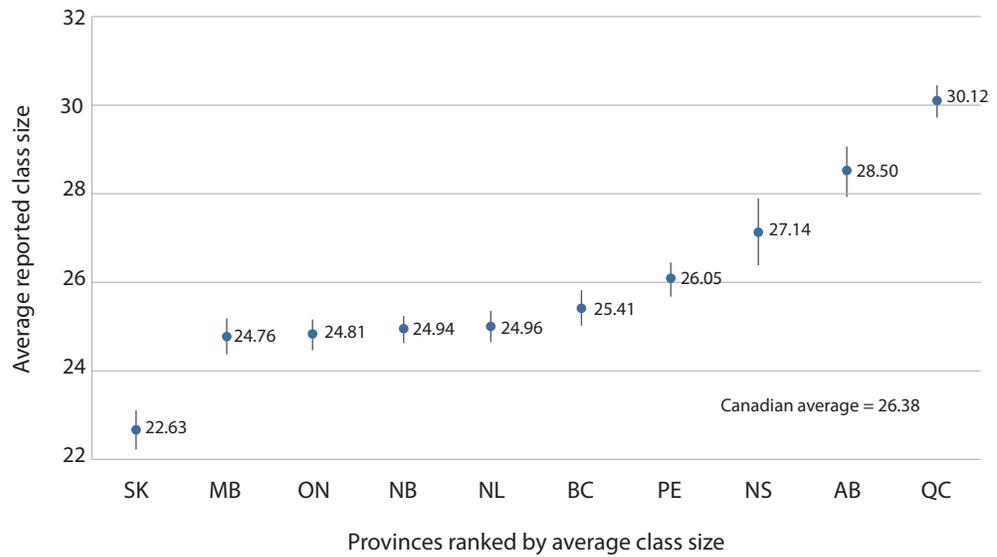
Note: Results for Quebec should be treated with caution due to a possible non-response bias. See O'Grady et al. (2016: 69-70) for details.

which reduces the number and relative proportion of Quebec secondary level students. This inverts the relationship between secondary enrolment and PISA scores for the Big Four provinces, with lowest-scoring Ontario enrolling 45.2 percent of Grade 9–12 students, Alberta 13.9 percent, British Columbia 13.1 percent, and Quebec 12.7 percent.

There is also an inverse relationship between 2015 PISA scores and per-pupil expenditures. Saskatchewan and Manitoba, the two provinces with the highest 2014/15 per pupil expenditures of \$15,040 and \$14,498 as reported by MacLeod and Emes (2019: Table 3), had the lowest PISA scores. Conversely, Quebec and British Columbia, the best performing provinces in figure 1, had the lowest per-pupil expenditures of \$11,049 and \$11,216 respectively. Alberta (\$13,197) and Ontario (\$13,276), the two other high scoring provinces, each spent more per pupil than Quebec and British Columbia, and more per pupil than Prince Edward Island (\$12,610), Newfoundland and Labrador (\$13,174), and Nova Scotia (\$13,179), each of these last three performing below the Canadian average.

As shown in the broader PISA results (OECD, 2012) and discussed at length in a recent Fraser Institute study (Krieg, 2019), the amount of money relatively wealthy jurisdictions spend on schools does not, by itself, directly improve student achievement. What matters is how the money is spent, class size being one policy pertinent variable.

Figure 2 charts provincial class size averages as reported by principals of the secondary schools participating in PISA 2015. Provinces are ranked along the horizontal axis by increasing class size, ranging from Saskatchewan

Figure 2: Ranked average secondary school class size by province

Source: OECD, 2016b: Table B2.II.44.

Note: Results for Quebec should be treated with caution due to a possible non-response bias. See O'Grady et al. (2016: 69-70) for details.

on the extreme left with the smallest reported secondary school class size of 22.63 to Quebec with the largest class size of 30.12. Provinces are ranked to separate data points and avoid crowding among similar values. The bars extending from the plotted values map one standard error above and below the data point, providing a visual indicator of the margin of error associated with sampling and measurement. Overlapping bars indicate a 95 percent chance that the true population means for the plotted values lie within the range mapped by the error bars, implying a lack of statistical significance. Error bars that do not overlap do not necessarily imply a statistically significant difference unless they are a substantial distance apart.

Using these visual indicators, Saskatchewan stands out in figure 2 as having uniquely small secondary school classes. Ontario's reported secondary school class average of 24.81 is the third smallest and below the national average of 26.38. As shown in the chart, Ontario's average secondary school class size is statistically indistinguishable from the average class sizes in Manitoba, New Brunswick, Newfoundland and Labrador, British Columbia, and Prince Edward Island secondary schools.¹⁴ In clear contrast, secondary school principals in Alberta and Quebec reported class sizes substantially and significantly

14. A t-test confirmed no statistically significant difference between the reported secondary school class sizes for Ontario and British Columbia $t(209) = 1.02, p = 0.472$.

larger than the Canadian average.¹⁵ Nova Scotia occupies an intermediary position in figure 2, but no statistically significant difference was found between the provincial and Canadian average class sizes.¹⁶

By way of comparison, Finland (19.07) and Belgium (19.73) had the lowest reported mean class sizes among OECD countries in the 2015 PISA data; Mexico (39.08) and Turkey (47.15) had the largest, with Turkey appearing as an outlier in the distribution. Among G7 countries, France (29.26) and Japan (36.1) had the largest average class sizes; the United Kingdom (24.35) and Italy (23.32) had the smallest. When compared to the provincial data, Quebec class sizes are larger than the national averages for all G7 countries except Japan, while mean class sizes in Saskatchewan high schools are smaller than all G7 national averages.

Despite the relatively higher cost of smaller class sizes, Saskatchewan, as noted earlier, had the highest per-pupil expenditure in 2014/15; Quebec, with the smallest average class size, the lowest. Various economies and diseconomies of scale associated with population density and system structure are likely at work here, making superficial comparisons difficult. Per-pupil spending in the seven provinces with class sizes clustered around the Canadian average ranged from a low of \$11,216 in British Columbia to a high of \$14,498 in Manitoba, with Ontario's \$13,276 falling in the middle of the range. Alberta stands out with the second largest class size and the second lowest per-pupil expenditure of \$13,197 (MacLeod and Emes, 2019: Table 3).

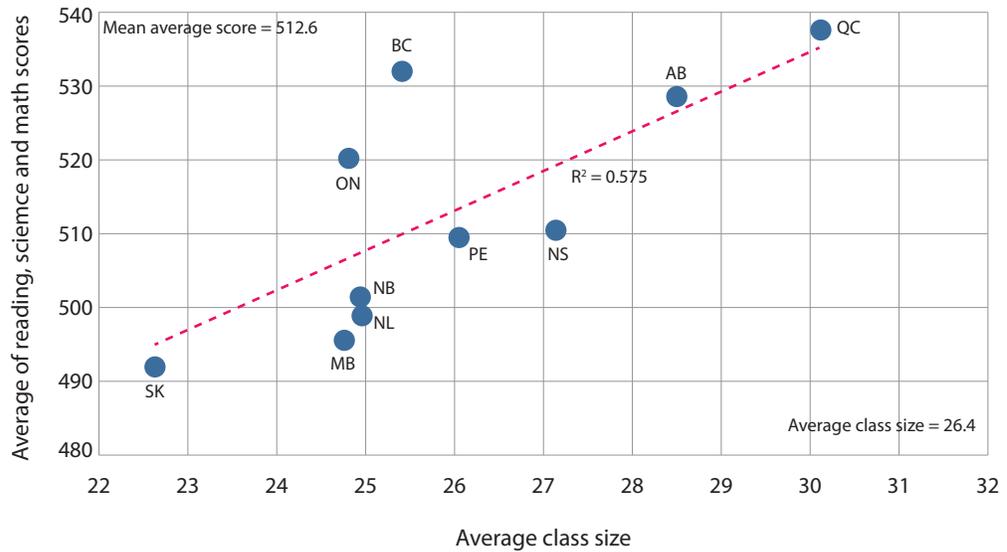
Figure 3 plots mean PISA test scores against class sizes. The PISA scores plotted on the vertical axis are means of the reading, science, and math scores. The horizontal axis plots provincial class sizes by actual values rather than the ranks used in figure 2.

All of the Big Four provinces have average subject scores above the mean, consistent with figure 1. Two of these provinces, Alberta and Quebec, also have average class sizes significantly larger than the Canadian mean. In contrast, Ontario and British Columbia have high achievement scores with class sizes below the national average, a pattern matching conventional expectations. The smaller six provinces all have scores below the mean, with class sizes ranging from a low of 22.6 in Saskatchewan to a high of 27.1 in Nova Scotia.

The dotted trend line in figure 3 is the best fit linear regression model for the data. The positive slope shows a direct correlation ($r = 0.758$, $p = 0.011$)

15. Statistically significant differences between the national and provincial averages and between the Alberta and Quebec class sizes were confirmed by t-tests: Canada ($M = 26.4$, $SD = 5.59$) v. Alberta ($M = 28.5$, $SD = 5.21$) $t(804) = 3.174$, $p = 0.002$; v. Quebec ($M = 30.12$, $SD = 3.61$) $t(817) = 6.278$, $p < 0.001$.

16. Nova Scotia ($M = 27.14$, $SD = 5.67$) v. Canada ($M = 26.4$, $SD = 5.59$) $t(778) = 0.974$, $p = 0.341$.

Figure 3: Average subject scores by class size

Source: Subject means calculated from OECD, 2016a: Tables B2.I.2, B2.I.4, B2.I.10. Class sizes from OECD, 2016b: Table B2.II.44.

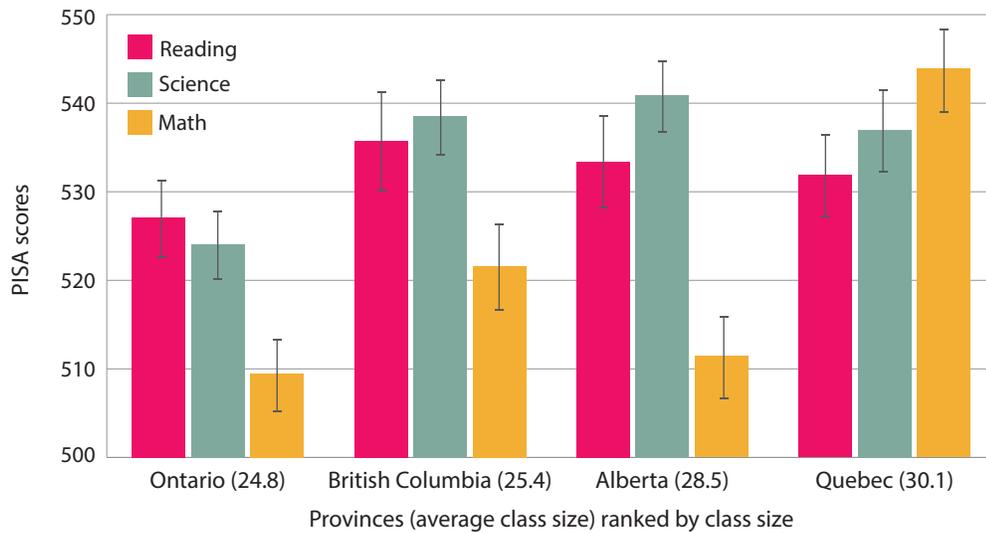
Note: Results for Quebec should be treated with caution due to a possible non-response bias. See O'Grady et al. (2016: 69-70) for details.

between mean subject scores and class sizes at the provincial level, with larger average class sizes being associated with higher subject scores. Specifically, the slope of the regression line in the statistical model predicts an estimated increase of 5.73 in the subject score for each additional student in a class, with a standard error of 1.74. Such a positive relationship is contrary to conventional expectations, but has been previously reported for secondary schools as noted earlier.

Nevertheless, the 0.575 R^2 coefficient of determination shows there is a substantial proportion of the variation in the subject scores that is not accounted for by variation in average class size. This difference is shown by the distance between the subject scores predicted by the trend line and the actual scores as plotted. These residual values are notably large for Ontario and British Columbia, the data points for which are plotted further away from the trend line than for any other province, although Manitoba and Nova Scotia also have large residual values.¹⁷ This reflects the influence of factors on subject scores other than variation in class size.

Figure 4 focusses on the Big Four provinces of Ontario, Quebec, British Columbia, and Alberta by plotting student scores for the three tested subject domains against average class sizes ranked along the horizontal axis. Ontario clearly had both the poorest performance in all three subjects and the

¹⁷ The actual residual values are 22.4 for BC, 14.0 for Ontario, -10.3 for Manitoba, and -9.1 for Nova Scotia.

Figure 4: Provincial subject scores by ranked class sizes

Source: OECD, 2016a: Tables B2.I.2, B2.I.4, B2.I.10; OECD, 2016b: Table B2.II.44.

Note: Results for Quebec should be treated with caution due to a possible non-response bias. See O'Grady et al. (2016: 69-70) for details.

smallest reported average class size. Alberta, British Columbia, and Quebec all attained higher PISA scores than Ontario in each of the tested subjects even though they had larger classes. Across the four provinces the reading scores fall within a range of nine points, with no statistically significant differences. The science scores are spread across a wider range of 17 points, with a much closer spread of four points between the three highest scoring provinces, the differences between the Ontario score and those for each of the other three provinces being statistically significant beyond the 95 percent probability level (O'Grady et al., 2016: Table B.3.1). Math scores for Ontario and Alberta cluster close together with both falling below the Canadian average of 516. Quebec's math score exceeds second place British Columbia by a substantial 22 points and Alberta and Ontario math scores by 33 and 35 points respectively, with the differences between Quebec and British Columbia and the lower scores for Alberta and Ontario being statistically significant beyond the 95 percent confidence level (O'Grady et al., 2016: Table B.2.2).

Conclusion

Despite its apparent simplicity, class size is a complex variable in the calculus of education policy. The research literature shows that smaller classes in the lower, particularly entry grades, can have positive effects, although these are less than usually assumed and most clearly associated with classes smaller than the target of 20 students often advocated in debate. At the secondary level research has found no clear relationship between smaller classes and higher student achievement, with some evidence pointing to higher achievement in larger classes. Such a relationship was the central finding of this study: as shown in figure 3, student achievement was higher in Canadian provinces with larger reported average secondary school classes.

This does not mean that increasing secondary school class sizes will automatically boost student achievement. As shown in figure 3, Prince Edward Island and Nova Scotia both had larger classes than Ontario and British Columbia, but had lower scores. A host of other factors play their part in the complex interactions contributing to student achievement, many of which, as shown by Hattie's (2005, 2012) research touched on earlier, have been shown to have a stronger effect on student achievement than does class size alone. What can be taken from this study is that class size by itself does not appear to be a limiting factor on secondary level student achievement in Canada. Given this, Ontario's plan to phase in a higher average class size of 28 in Grade 9–12 is not likely to depress student performance. When this increase is fully phased in, Ontario secondary schools will still have smaller average class sizes than provinces with statistically higher 2015 PISA scores. Concerns that larger class sizes in Ontario secondary schools will necessarily result in lower student achievement find no support in this analysis of the most pertinent research data currently available.

While there can be no guarantee that student achievement in Ontario will increase with larger secondary school classes, this is possible. If that were to come to pass, the improvement would most likely be attributable to either changes independent of the larger classes or to related changes made possible by the larger classes, rather than to the larger classes alone. Instructional innovations are examples of independent changes; greater flexibility in setting individual class sizes to better suit subject and student are an example

of related effects. By definition, improvements from changes of the first kind will be independent of changes in class size and could occur in any or all of the three provinces already outperforming Ontario. Even if Ontario's scores were to improve with increased class sizes this would not necessarily reduce the performance gaps with the other Big Four provinces.

Requiring schools to maintain relatively small class sizes is expensive. Any consideration of the costs must necessarily balance policy goals. In this case, is the goal to control class sizes or improve student achievement? If smaller classes are associated with improved performance the two are easily conflated. Yet given the findings in the research literature and the results of this study, a commitment to maintaining smaller classes in secondary schools may well impede student achievement. Governments may have what appear to be good reasons for keeping class sizes low, such as minimizing the possibility of teacher strikes. But when there is an educational cost to doing this as well as a financial cost, the policy calculus changes.

In this context, the central question raised by this study is not whether the financial cost of a small class policy can be justified, but whether improved educational outcomes could be gained by investing the money spent to maintain smaller class averages on other initiatives. The Hattie (2005, 2012) analyses discussed earlier identify many potentially better investments, the most powerful of which fall under the general heading of improved teacher quality. An OECD (2012) discussion of PISA findings draws a similar conclusion, noting that "high-performing countries tend to prioritise investment in teachers over smaller classes" (p. 3).

Given this, variation in teacher quality may be a contributing factor to the variation in provincial level student achievement reported in this study. This requires investigation, but no appropriate comparative measures of initial and in-service training are readily available. A related, potentially more powerful and more easily adjusted factor is the relative flexibility of schools to assign teachers to best serve the educational needs of students. Provincial regulations and local collective agreements differentially limit the ability of school leaders to assign teachers to classes best suited to their strengths. Ontario appears to have a particularly restrictive web of requirements limiting principal discretion in this respect, which may well be contributing to the province's low scores. As discussed by Alger (2014), the outdated approach to teacher salary schedules and lack of performance-related incentive systems to reward outstanding teachers may also be limiting student achievement. In these respects, Ontario's (2019b) plan to cushion the impact of larger classes through a \$1.6 billion Teacher Job Protection program intended to "help maintain teaching positions, so that staffing reductions can be managed through teacher retirements and voluntary leaves" may forfeit potential gains by postponing savings and retaining less effective teachers.

Alternative ways of seeking improved student achievement need study and serious consideration as innovations that could be funded with savings realized from allowing class sizes to increase. Still, when considering how best to improve student achievement in public schools, policies that allow individual schools to form classes, set class sizes, and assign teachers to best pursue educational goals and serve student needs as informed by local knowledge and professional judgments appear inherently preferable to a reliance on centrally imposed regulation.

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