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Variation in Literacy Skills Among Canadian Provinces: Findings from the OECD PISA

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Note of appreciation

Canada owes the success of its statistical system to a long-standing co-operative effort involving Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and good will.

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Introduction

Canada has recently participated in two large international assessments of the literacy skills of its citizens. It was among a group of seven countries that participated in the International Adult Literacy Survey (IALS) in 1994. IALS employed household-based interviews and testing, which in Canada were administered to a representative sample of adults aged 16 to 90. The aim of IALS was to compare the factors that contributed to literacy development among countries of the Organisation for Economic Cooperation and Development (OECD), and therefore the interviews included a series of questions relevant to adults' early linguistic experiences, their experiences in the labour force, their participation in adult education and training, and their personal and family background. The term, "literacy", was used broadly in IALS to describe an individual's ability to "us[e] printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential." (OECD and Statistics Canada, 1995, p. 14). The IALS tests reflected this broad definition: they assessed participants' understanding and ability to use information from a variety of texts in three literacy domains: prose, document, and quantitative.

Canada also participated in the Programme for International Assessment (PISA) in the spring of 2000. PISA is a survey of the reading, mathematics, and science skills of 15-year old youth among member countries of the OECD. The PISA assessments of knowledge and skills are not based on school curriculum common to participating countries, but on the kinds of general literacy skills that youth will need when they enter post-secondary education and the labour market. The first international report, *Knowledge and skills for life: First results from the OECD Programme for International Student Assessment (PISA) 2000,* (OECD, 2001), provided a comparison among countries in student performance in reading, mathematics, and scientific literacy. The last chapter of the report examined how performance in these domains was related to students' family background and features of the schools they attend.

Fifteen-year-old students in Canada fared exceptionally well on this assessment compared with students in other OECD countries. They ranked 2nd in reading, 6th in mathematics, and 5th in science among 27 participating countries. These findings suggest that Canada has improved its international standing over the past decade, and is now among a group of seven or eight top-scoring countries in the world. Findings from the 1999 Third International Mathematics and Science Study (TIMSS) also placed Canada among top-scoring countries in mathematics and science (Robitaille & Taylor, 2003), and showed that its standing had improved from a 1995 assessment based on the same tests.

Despite its success in international terms, the 1994 IALS results indicated that there is a disproportionate number of Canadian youth scoring at the low end of the literacy scales (Sloat & Willms, 2000; Statistics Canada & HRDC, 1996). Also, the Canadian

report on PISA, *Measuring up: The performance of Canada's youth in reading, mathematics, and science*, found that there was significant variation among the ten Canadian provinces in their literacy skills. Not all provinces attained scores among the top group of countries. Earlier work by Willms (1999a) based on the IALS also indicated large variation among Canadian provinces in the literacy skills of youth aged 16 to 25. The PISA results pertaining to provincial variation were also consistent with findings derived from curriculum-specific tests used in Canada's National Longitudinal Study of Children and Youth (Willms, 1996), and in the TIMSS (Frempong & Willms, 2002).

This study examines in greater detail the variation among Canadian provinces in the literacy skills of 15-year old youth using data from the PISA. It has four aims: (1) to locate the performance of Canadian provinces in an international context, with attention to the magnitude of the differences; (2) to describe the relationship between students' literacy skills and their family backgrounds, with a focus on socioeconomic gradients in performance; (3) to describe the variation in student performance among schools and provinces, and estimate the relationships between school performance and the socioeconomic context of schools; and (4) to examine the relationship of school performance with various factors related to school policy and practice. The next two sections of the report describe the methods and findings addressing each of these aims. The last section summarizes the results and discusses their implications in the context of other research.

PISA Results for Canada and the Provinces

Interpreting PISA Scores

The scores on the reading, mathematics, and science assessments for PISA were scaled to have a mean of 500 and a standard deviation of 100 for students from all OECD countries participating in the study. As a way to interpret the magnitude of one-point on the PISA scale in substantive terms, consider two hypothetical students who had scores on the reading test of 500 and 515, respectively. The student with a score of 500 would be near the 50th percentile among all OECD students, while the student with the 15-point advantage would be at about the 56th percentile.

Expressing scores in standard deviation units, or as effect sizes, permits one to gauge the magnitude of an effect in terms of particular educational interventions, such as the effects associated with reducing class size, increasing educational expenditures on classroom materials, or adopting certain teaching practices (Hattie, 1992). It is also technically correct in scientific terms. However, effect sizes are not always easily interpreted by policy audiences, who want to know what a 15-point advantage is in real-life terms. We can interpret the magnitude of PISA scores by "looking back" and asking how much schooling is associated with, say, a 15-point difference in scores. We can also consider the magnitude in terms of the kinds of skills associated with different levels of PISA scores. Finally, we can "look forward" and ask, "What does a 15-point difference mean in terms of later life outcomes, such as wages or access to post-secondary education?" Each of these approaches has its strengths and limitations.

Looking back. One way to interpret the magnitude of a 15-point difference is to equate it to "years of schooling", or "days of schooling". On most achievement tests at the secondary level, the difference between students from one grade to the next is about one-half to two standard deviations. It is not possible to estimate the effect of one additional grade of schooling with PISA, because the sampling strategy was age-based – the sample was 15-year old students in each country. However, a grade effect can be estimated by considering students in those countries where 15 year-old youth span two grades, by virtue of the cut-off date used for entry to primary school. It was possible in 12 of the OECD countries[1] to identify youth who were in either a lower grade or an upper grade, based on their birth date. For example, in a number of countries, the majority of youth who were born between January and August, 1984, were in grade 10 at the time of the PISA assessment, while the majority of those born between September and December, 1984, were in grade 9. Therefore, an estimate of the "grade effect" on PISA results in these countries can be obtained by comparing the results of the youth in these two grades, and excluding those who had not reached grade 9 or 10 on schedule, in most cases because they had been retained a grade. The analysis revealed that on average, across the 12 countries, the average grade effect was 34.3 points (standard error = 3.5). The average school year for PISA students was 950 hours, or about 172 days based on a 5.5 hour school day. With this metric, then, one PISA point is "worth" about 5 school days. A 15-point gap then is equivalent to about 75 days of schooling at grade 9 or 10.

However, PISA is not simply an assessment of what youth have learned during their previous year at school, or even during their secondary school career. It is an assessment of the *cumulative* learning and skill development that has occurred since birth. Therefore, the average PISA scores for a country may reflect the quality of care and stimulation provided to children during infancy and the pre-school years, and the opportunities children have to learn both in school and at home during the elementary and secondary school years. Therefore, we must think of the 15-point learning gap as a difference that has accumulated from birth.

Thinking about the magnitude of PISA scores in this way is useful in that it emphasizes the fact that differences among schools, provinces, or countries in their reading performance are the result of several factors that contribute to children's development from birth. It also offers a somewhat hopeful message, as it suggests that it is possible to bridge a wide gap in achievement with a comprehensive approach that emphasizes interventions at all ages from birth to adolescence. However, one should not interpret PISA scores in the "days of schooling" metric too literally. For example, adding five days of schooling per year at each grade from grade 1 to grade 10 would not necessarily increase a country's PISA scores by 10 points. The effect of such an intervention would depend of course on what was actually taught and learned in those extra five days. Also, children's growth in their learning does not occur in a linear fashion. For example, vocabulary growth during the second year of life is rapid and exponential (Hart & Risley, 1995; Huttenlocher *et al.*, 1991), while growth in reading skills tends to be more rapid during the elementary years, than during secondary school. Also, one should not lose sight of the fact that learning occurs both in and out of school.

PISA Levels. The PISA scores were also categorized into six levels, from Below Level 1 to Level 5. Students at a given level are expected to answer at least one-half of the items at that level correctly. The range of scores at each level are as follows: level 5 – above 625; level 4 – from 553 to 625; level 3 – from 481 to 552; level 2 – from 408 to 480; level 1 – from 335 to 407; and Below Level 1 – below 335. The kinds of items associated with each level are described in the first international report (OECD, 2001). This is useful also, as it calls for educators to consider the kinds of skills required to answer items at each level. For example, one might consider the kinds of skills students need to acquire to move from level 2 to level 3.

This approach also has its weaknesses. The main problem is that the "levels" in PISA are determined on empirical grounds, and do not necessarily represent a qualitative shift in skills. There is a progression of reading skills from the early elementary years to secondary school. Many students fall "off track" in the first few years because they do not adequately acquire the basic reading skills (e.g., phonemic awareness), while others fall "off track" later in their reading development because they fail to acquire some of the skills associated with higher-order comprehension (Spear-Swerling & Sternberg, 1996). What we need is a clearer understanding of how particular kinds of skill acquisition relates to PISA levels, and at what stage of schooling most students are falling off track.

Looking Forward. Although the tests developed for PISA are not identical to those used in IALS, they are similar in many respects (Kirsch *et al*., 2002). Thus, one can use the IALS data to achieve some purchase on the relationships we expect to observe between PISA results and post-secondary outcomes, when follow-up data for the 2000 cohort become available. Table 1 shows the odds-ratios for attending some form of post-secondary education (PSE) associated with IALS test results and respondents' family backgrounds. In this analysis, for the sample of youth aged 19 to 25, a logistic regression analysis was performed, regressing attendance in a post-secondary institution on the prose literacy levels[2] (see Inset 1). The model also included a variable denoting whether a respondent's quantitative literacy level was below, the same as, or above his or her prose literacy level. The model also included controls for the respondent's age and sex, and whether either of the respondent's parents had completed university.

Five levels of reading literacy

Programme for International Student Assessment

Reading achievement was divided into five levels. Essentially, these levels represent the most difficult test items that a student could answer. Therefore, a student at one level could be assumed to be able to answer questions at all lower levels. To help in interpretation, these levels were linked to specific score ranges on the original scale. Because the five levels are complex to describe, an example from each level is given for the *reading retrieving scale*. Tasks of similar complexity were required for each level of the other reading scales.

Level 1 (score from 335 to 407): Students were shown a notice from a personnel department about a service that would help with job mobility. They were asked to find a single explicitly stated piece of information—how to find out more about the service—which was signalled by a heading in the text that matched the term used in the question.

Level 2 (score from 408 to 480): Students were required to state how to check that a bicycle seat was in the right position, by finding two pieces of connected information in an assembly manual. The placement of the relevant information was clearly stated in the question.

Level 3 (score from 481 to 552): Looking at a complex international airline timetable, with prominent competing information, students had to find a single piece of information that satisfied three conditions—time, destination and connecting city. For information about one of the conditions, the reader had to refer to a separate list of abbreviations.

Level 4 (score from 553 to 626) : Presented with a relatively long, dense extract from a play, students had to use information embedded in a stage direction in order to mark the positions of two actors on a diagram of the stage.

Level 5 (score above 626): Students were given a complex and unfamiliar set of instructions about how to make telephone calls from a hotel room, and a letter with the phone number of a friend in a different country. They were required to find and organise in correct sequence four pieces of information and to draw inferences to work out exactly how to dial the number.

Performance below level 1: Students performing below Level 1 (total reading score below 335) are not able to routinely show the most basic type of knowledge and skills that PISA seeks to measure. Such students have serious difficulties in using reading literacy as a tool to advance their knowledge and skills in other areas. Placement at this level does not mean that these students have no literacy skills. Most of these students are able to correctly complete some of the PISA items. Their pattern of responses to the assessment is such that they would be expected to solve less than half of the tasks from a test composed of only level 1 items.

International Adult Literacy Survey (1994)

Measuring literacy: More than one gauge

Literacy cannot be narrowly defined as a single skill that enables people to deal with all types of text. People in industrialized countries face many different kinds of written material every day, and they require different skills to understand and use the information. To reflect this complexity, IALS developed three categories of literacy:

1. **Prose literacy**: the ability to understand and use information from texts such as editorials, news stories, poems and fiction.
2. **Document literacy**: the ability to locate and use information from documents such as job applications, payroll forms, transportation schedules, maps, tables and graphs.
3. **Quantitative literacy**: the ability to perform arithmetic functions such as balancing a chequebook, calculating a tip, or completing an order form.

The specific literacy tasks designed for IALS were scaled by difficulty from 0 to 500 points. This range was subsequently divided into five broad literacy levels.

Level 1 indicates very low literacy skills, where the individual may, for example, have difficulty identifying the correct amount of medicine to give to a child from the information found on the package.

Level 2 respondents can deal only with material that is simple, clearly laid out and in which the tasks involved are not too complex. This is a significant category, because it identifies people who may have adapted their lower literacy skills to everyday life, but would have difficulty learning new job skills requiring a higher level of literacy.

Level 3 is considered as the minimum desirable threshold in many countries but some occupations require higher skills.

Levels 4 and 5 show increasingly higher literacy skills requiring the ability to integrate several sources of information or solve more complex problems. It appears to be a necessary requirement for some jobs.

The odds-ratio associated with age is 1.41. This indicates that youth in the age range 19-25 are more likely to have completed at least the first stage of PSE if they are older. The odds increase by a factor of 1.41 for each increase in age of 1 year. Many Canadian youth take a year or two away from full-time studies after secondary school before continuing with their studies, and thus we would expect that the likelihood of enrolment in PSE would increase with age.

The odds of females pursuing PSE were about twice that of males. These results are consistent with other findings from Statistics Canada, which indicate that in 1994/95, the college enrolment rates were 15% for females and 12% for males, while university enrolment rates were 21% for females, and 14% for males (Oderkirk, 2002). (This would yield an unadjusted odds-ratio of about 1.60, whereas the results here yielded an estimate of 1.35 when adjustment was made only for age). The odds of a youth enrolling in PSE is nearly double (odds ratio is 1.98) if at least one of the parents had completed a university degree.

Table 1

Effects on PSE attendance associated with youth's age, sex, parental education, and literacy scores

International Adult Literacy Study, 1994

	Coefficient	Standard error	Odds ratio
Age of respondent (years)	0.345	0.051	**1.41**
Respondent is female	0.684	0.188	**1.98**
At least one parent completed university	0.681	0.191	**1.98**
Prose Literacy Score at Levels 1 or 2	-2.275	0.282	**0.10**
Prose literacy Score at Level 3	-0.698	0.218	**0.50**
Respondent's quantitative literacy score is high relative to his or her prose literacy score	0.660	0.147	**1.93**

The results reveal very strong effects associated with literacy skills. In this analysis, the reference category was youth who had attained Levels 4 and 5 prose literacy. The odds of attending PSE for youth who were at Level 2 or lower were about 10% that of youth with Levels 4 and 5 skills. Similarly, the odds of attending PSE for youth at Level 3 were about one-half that of youth with Level 4 and 5 skills.

There is also a substantial premium associated with strong quantitative skills. If a youth had quantitative literacy skills at least one level above his or her prose literacy skills, the odds of attending PSE increased by a factor of 1.93.

These results pertain to the experiences of young people who were aged 19 to 25 in 1994. The relationships will probably differ for the PISA cohort of 2000, as they will be affected by changes in tuition rates, and several other factors affecting PSE. However, they do provide compelling evidence that the kinds of literacy skills measured in PISA are strongly related to attendance at PSE. Other research suggests that they are also related to employment opportunities and wages upon entry to the labour market (Raudenbush & Kasim, 1998).

Inset 1

Logistic Regression

When an outcome variable is dichotomous, such as whether or not a child repeated a grade at school, or in this case, whether a youth attended post-secondary education, a variant of multiple regression called logistic regression is appropriate. The analyst is interested in the *probability* or *likelihood* of a child or youth having the particular trait, or experiencing the event at a particular time, and how various individual-level characteristics, such as age, sex, or family income, affect that probability. The regression coefficients from a logistic regression can be easily transformed to *odds ratios*, which can be easily interpreted for policy purposes.

The *odds* of an event occurring is the likelihood of the event *occurring* divided by the likelihood of the event not occurring. For example, if an event has a 75 per cent chance of occurring, then the odds of it occurring are [0.75/(1-0.75)], which is 3.0. An event with an odds ratio of 1.0 has an equal chance of occurring or not occurring. An odds ratio is simply the ratio of the odds for two different sets of circumstances. For example, one

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could assess the odds of an event occurring for girls and for boys, and calculate the ratio of the odds. Odds ratios are interpreted in a fashion similar to multiple regression coefficients: they denote the ratio of the odds of an event occurring after a one-unit change in the independent variable, compared to what it was previously, given all other independent variables in the model are held constant.

For the logistic regression results presented in Table 1, the outcome variable is whether or not a student attended some form of post-secondary education. The independent variables are age of the respondent (in years), the respondent's sex (coded 1 for females, 0 for males), whether at least one of the respondent's parents had attended university (coded 1 for yes, 0 for no), the level of Prose literacy scores attained by the respondent (Level 4 is used as a reference category), and whether the respondent had a quantitative literacy score that was at least one level above his or her Prose score. To interpret these results, consider for example the results pertaining to the sex of the respondent. The odds ratio is 1.81. This indicates that the likelihood of a youth who was female attending post-secondary is about 1.81 time that of males. The predictors for a logistic regression can also include continuous variables; for example, in this model we have the age of the respondent. The odds-ratio indicates the increase in odds associated with a one point (in this case, a one-year) increase in the independent variable. Norusis/SPSS Inc. (1992) provides a simple introduction to logistic regression.

Canadian Reading Performance in an International Context

The average score for Canadian students on the PISA reading test was 534. This was 12 points below that of Finland, the highest-scoring country. Canada's score in mathematics was 533, which was very close, and not significantly different from the mean scores of Australia, Finland, and New Zealand. Only Korea and Japan scored significantly higher, with scores of 547 and 557 respectively. Canada's score in science – 529 – did not differ significantly from the UK (532), but was significantly lower than that of Finland, Japan, and Korea, with scores of 538, 550, and 552 respectively.

In 2000, the PISA tests for reading performance were much more extensive than the mathematics or science tests. In 2003, the emphasis will be on mathematics, with reading and science as minor domains, and in 2006 the emphasis will be on science, with reading and mathematics as minor domains. In 2009, the cycle will begin again, with the emphasis on reading performance. If Canada were to improve its reading scores by 15 points, and assuming other countries' scores were about the same, Canada would be the highest scoring country in the world. Canada would need to improve its scores by about 25 points in mathematics and science to be the highest-scoring country in those domains.

Figure 1 shows the mean reading performance for each of the ten provinces, compared with a number of other countries. The figure also shows for each province the standard errors of the mean scores, which indicate the accuracy of the estimates. For example, if one imagines that the PISA study had been repeated a number of times with the same sample sizes for each province, then in about two-thirds of the cases, the estimates of the means would have fallen within the range indicated by

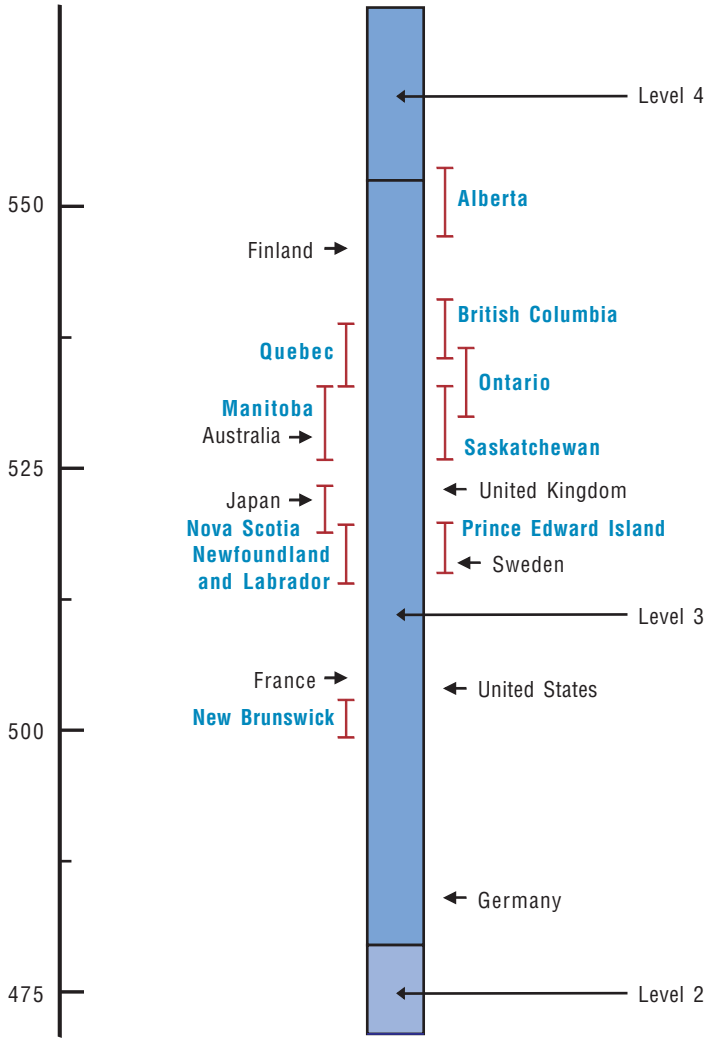
the error bars in Figure 1. The first column of Table 2 also provides the mean scores and their standard errors. The PISA sample design in Canada entailed an over-sampling of students in smaller provinces in order to obtain reasonably accurate estimates at the provincial level. Therefore, the standard errors are fairly small and relatively consistent across the ten provinces.[3]

Provinces clearly vary in their reading performance, ranging from 501 in New Brunswick to 550 in Alberta. The average scores for the three largest provinces, Ontario, Quebec, and British Columbia, were 533, 536, and 538 respectively. Their scores were close to the Canadian average of 534, and because almost three-quarters (73.5%) of all 15-year old students live in these three provinces, their reading performance anchors the Canadian average. The mean scores for Manitoba and Saskatchewan – both at 529 – were also not significantly below the Canadian average. Alberta's average reading performance, 550, was clearly above the Canadian average of 534, while the mean scores for the four Atlantic provinces were clearly below the Canadian average. New Brunswick had the lowest score, at 501, which is comparable to the OECD international average, set at 500.

In substantive terms, New Brunswick's mean performance is about 33 points below the Canadian average, and the mean reading scores for Newfoundland and Labrador (517), Prince Edward Island (517), and Nova Scotia (521) were on average about 16 points below the Canadian mean. To place the size of this gap in context, recall that the grade effect on average across 12 OECD countries was about 34 points.

Figure 1

Provincial reading scores in an international context



Socioeconomic Gradients

A socioeconomic *gradient* describes *the relationship between a social outcome and socioeconomic status for individuals in a specific community* (Willms, 2002b). In this study, the social outcome is students' reading performance. In formal terms, socioeconomic status (SES) refers to the relative position of a family or individual on an hierarchical social structure, based on their access to, or control over, wealth, prestige, and power (Mueller & Parcel, 1981). The measure of socioeconomic status used in PISA describes students' economic, social, and cultural background. It was derived from data describing levels of parental education and occupation of the students' parents, and material and cultural possessions in the home.

The socioeconomic gradient for Canada (red line), and for all OECD countries combined (blue line) is shown in Figure 2.[4] The small black dots are students' scores on the PISA reading test plotted against family socioeconomic status,

for a representative sample of 2000 Canadian students. The vertical axis has two scales: the left-hand scale is the continuous scale for the reading scores, which is scaled to have a mean of 500 and a standard deviation of 100 for all students in participating OECD countries. The right-hand axis depicts reading levels, defined by the OECD, which range from Below Level 1 to 5. The horizontal axis is family socioeconomic status, which is scaled to have a mean of zero and a standard deviation of 1 for all students in OECD countries. Thus, approximately two-thirds of all OECD students fall between -1 and +1 on this scale. The gradient lines are drawn from the 5th to the 95th percentile of the SES scores for a particular population, in this case for all Canadian students and all OECD students. The white circles on the gradient line depict the 5th, 25th, 50^{th,} 75th, and 95th percentiles of SES. Therefore, the gradient line also conveys information about the distribution of SES within Canada and the OECD.

Socioeconomic gradients comprise three components: their level, their slope, and the strength of the outcome-SES relationship.

The *level* of the gradient is defined as the expected score on the outcome measure for a student with average SES. The level of a gradient for a country (or a province or school) is an indicator of its average performance, after taking account of students' socioeconomic status.

The *slope* of the gradient indicates the extent of inequality attributable to SES. Steeper gradients indicate a greater impact of SES on student performance – that is, more inequality – while gradual gradients indicate a lower impact of SES – that is, less inequality.

The *strength* of the gradient refers to how much individual scores vary above and below the gradient line. If the relationship is strong, then a considerable amount of the variation in the outcome measure is associated with SES, whereas a weak relationship indicates that relatively little of the variation is associated with SES. The most common measure of the strength of the relationship is a statistic called R-squared, which in this context would pertain to the proportion of variance in reading performance explained by SES.

Figure 2

Socioeconomic gradients for Canada and OECD countries

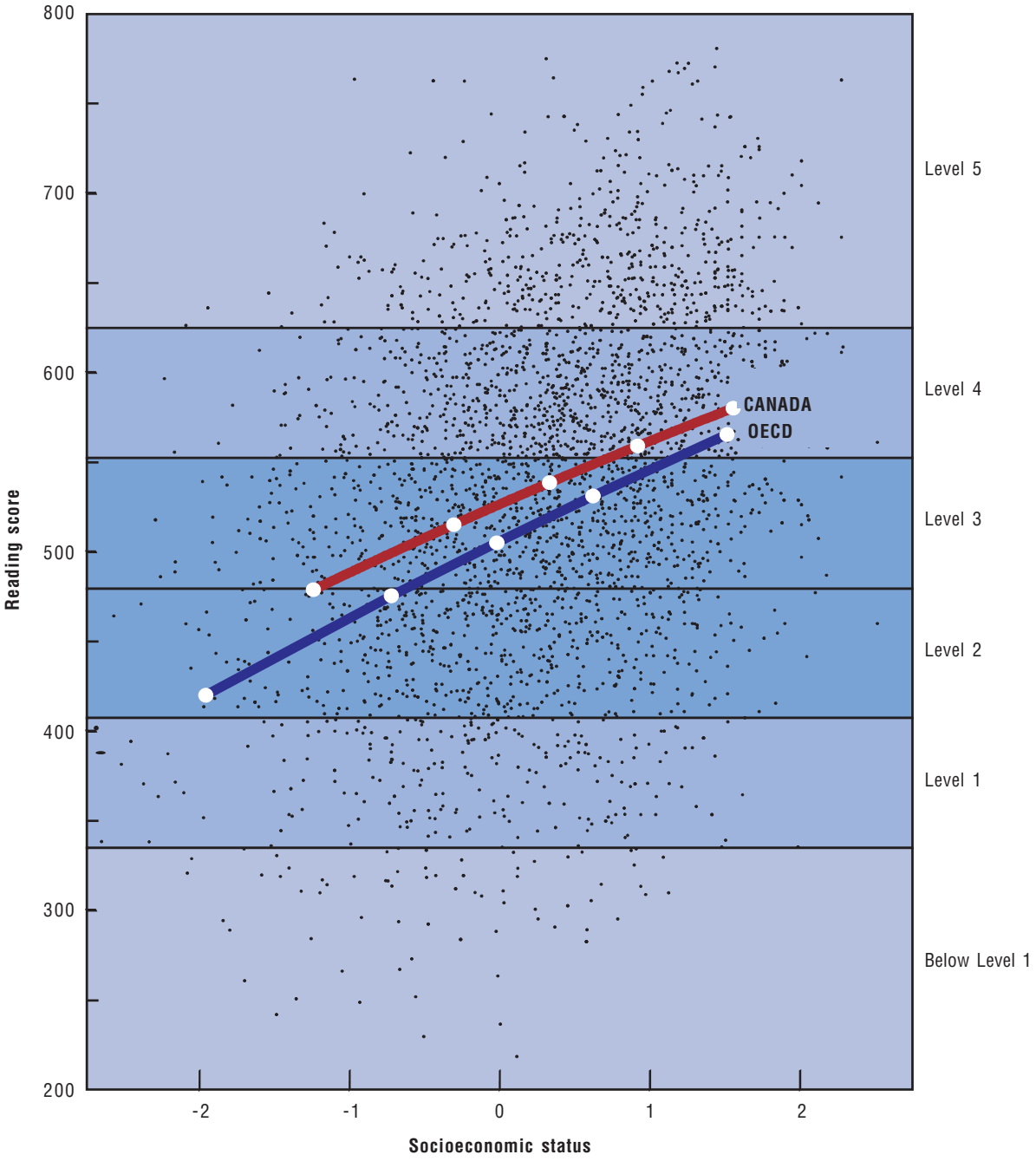


Figure 2 makes several important points concerning reading performance among Canadian students. First, the socioeconomic background of Canadian students is higher than the OECD average. The median SES score for Canada is 0.29, which is one-quarter of a standard deviation above the OECD median of 0.04. Also, the range of SES scores is smaller than the range for all OECD countries.

Second, Canadian students scored above the OECD average at all levels of SES, but this "advantage" is slightly greater for low SES students than for high SES students. This suggests that Canada does comparatively well in developing the literacy of youth from less advantaged backgrounds.

Third, despite Canada's relative success with less advantaged students, there is a large performance gap between students from low and high SES backgrounds. A typical student at the 5th percentile scored approximately 479, while a typical student at the 95th percentile scored approximately 580 – a difference of about 100 points.

Fourth, the figure shows that there is a wide range in reading scores at all levels of SES. There are many students from low SES backgrounds with very high scores, and *vice-versa*. What is particularly striking is that youth scoring at Levels 2 and 3 are found at all levels of SES. Recall that the results presented in Table 1 suggest that attaining Level 4 literacy skills is a critical threshold predicting whether a young person will pursue a post-secondary education.

Figure 3 displays the gradients for each of the ten provinces, and Table 2 sets out the gradient specifications. The first column of Table 2 presents the mean levels of performance and their standard errors. These are consistent with the results presented in Figure 1. The second, third, and fourth columns of Table 2 present the gradient specifications. The last column indicates the amount of data that was lost due to missing data on the measure of socioeconomic status.

One of the findings of this analysis that warrants attention is that some, but not all, of the variation among provinces in their reading performance is attributable to students' socioeconomic status. The third column of Table 2 provides the SES-adjusted means. These are the expected scores of a hypothetical student who had an OECD average SES. In 6 of the 10 provinces the adjustment affects the mean score by only a small amount, at most by four points. In Nova Scotia, Ontario, Alberta, and British Columbia, the adjusted score is lower, with the reduction ranging from 6 points for Nova Scotia to 15 points for Alberta. Nevertheless, even after adjusting for SES, there is substantial variation among provinces in their reading performance – from 503 in New Brunswick to 539 in Quebec. This is more than one-third of a standard deviation.

The slopes of the socioeconomic gradients also vary significantly among provinces. For example, Newfoundland and Labrador and Alberta have relatively steep slopes, at 44.2 and 42.1, respectively, which are significantly above the overall Canadian gradient. In contrast, the slope of Saskatchewan's gradient, 28.2, is relatively gradual, indicating fewer inequalities in performance among students with advantaged and less advantaged backgrounds.

Table 2

Unadjusted means and socioeconomic gradients

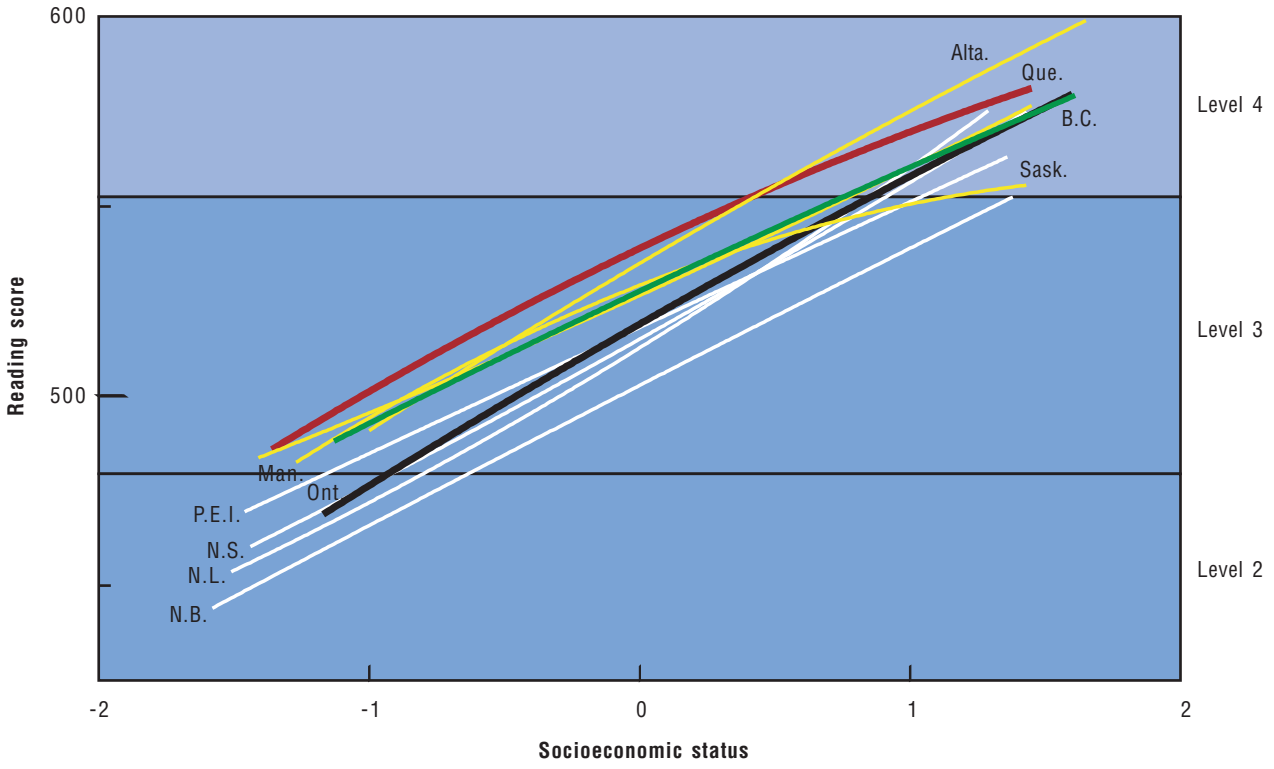
Province	Mean score	(SE)	Gradient specifications: SES – adjusted mean	(SE)	SES slope	(SE)	R^2 (%)	Missing SES (%)
Newfoundland and Labrador	**517**	(2.8)	**513**	(3.5)	**44.2**	(3.0)	**15.2**	3.6
Prince Edward Island	**517**	(2.4)	**518**	(2.9)	**33.2**	(2.5)	**9.0**	3.9
Nova Scotia	**521**	(2.3)	**515**	(2.7)	**40.0**	(2.9)	**13.2**	4.1
New Brunswick	**501**	(1.8)	**503**	(2.0)	**36.6**	(2.4)	**12.1**	3.1
Quebec	**536**	(3.0)	**539**	(2.7)	**34.2**	(1.8)	**11.6**	1.8
Ontario	**533**	(3.3)	**519**	(3.4)	**40.8**	(3.3)	**12.4**	3.3
Manitoba	**529**	(3.5)	**526**	(3.2)	**32.4**	(3.2)	**8.9**	3.5
Saskatchewan	**529**	(2.7)	**529**	(2.9)	**28.2**	(2.4)	**6.5**	3.3
Alberta	**550**	(3.3)	**535**	(3.3)	**42.1**	(2.7)	**13.0**	3.9
British Columbia	**538**	(2.9)	**528**	(3.1)	**33.8**	(2.5)	**9.1**	4.5
Canada	**534**	(1.6)	**527**	(1.5)	**36.7**	(1.3)	**11.3**	3.4

The proportion of the variance in reading performance also varies significantly among provinces: in Saskatchewan, Manitoba, and Prince Edward Island, less than 10 percent of the variation is attributable to SES, while in Newfoundland and Labrador, more than 15% of the variation is attributable to SES.

In two of the provinces, Quebec and Saskatchewan, the relationship between reading performance and SES was significantly non-linear: the slope is steeper at the lower end of the SES range than at the high end. This is referred to as the "hypothesis of diminishing returns" (Willms, 2002). This result is apparent in Figure 3, and is most pronounced for Saskatchewan. In Saskatchewan, the reading performance of youth from relatively affluent families is only slightly higher, on average, than youth from families of average socioeconomic status.

Figure 3

Socioeconomic gradients for Canadian provinces



Reading Performance and Family Background

The measure of socioeconomic status provides a useful summary of the relationship between reading performance and family background. However, a more detailed analysis of the relationship between performance and family background can further our understanding of the factors affecting performance in each province. Table 3 presents the results of a regression analysis of reading performance on gender and several factors describing the students' family structure and socioeconomic background.

The first column indicates the adjusted mean scores for each province and for Canada, after controlling for the factors in the model. One way to consider the impact of these factors is to imagine a group of 1000 students in each province who were representative of all students in the OECD countries that participated in PISA. This group would comprise:

501 males and 499 females;

150 students from single-parent families; and

66 students born outside the country.

On average, the group of 1000 students would have:

1.89 brothers and sisters;

parents with an occupational index score of 4.88;

parents with 12.4 years of education;

a family with a score of 0.0 on the indices of educational and cultural possessions in the home.

The first column of Table 3 then is an estimate of how well this OECD representative group of students would have performed in each province. The estimates range from 497 in New Brunswick to 534 in Alberta. These results also show clearly that there is significant variation among provinces in their reading performance.

The second column of Table 3 indicates the magnitude of the difference between females and males in their reading performance. On average, across Canada, females scored 30 points higher than males in their reading performance. This is a large difference – equivalent to almost one year of schooling for 15 year-olds. Also, females scored higher than males in every province, although the gender differences were larger in some provinces than in others. The gender differences were largest in Newfoundland and Labrador and New Brunswick, at about 40 points, and smallest in British Columbia and Ontario, at about 27 points.

Students who are living in single-parent families on average have lower scores than those living in two-parent families. The effect is not statistically significant at the national level, or in any of the provinces, except Saskatchewan. In Saskatchewan, students from single-parent families scored about 12 points lower. Note that these estimates are the effects associated with single-parent families, after taking account of the other variables in the model. On average, there is a performance gap of about 10 points in reading performance between students from single- versus two-parent families. However, the majority of single-parent families in Canada have relatively low incomes and on average the lone parent has a lower level of education. For the students sampled in PISA, the average SES score is 35% of a standard deviation lower for single-parent families compared with two-parent families. These finding indicate that the performance gap in PISA associated with students living in single-parent families can be accounted for by differences in their SES.

On average the performance gap between students born outside of Canada and those born in the country is about 28 points, after accounting for family structure and socioeconomic status. The estimates of the performance gap are not very accurate for the four Atlantic provinces, because of the relatively small number of foreign-born residents in these provinces. The gap appears to be especially large in Manitoba and Quebec, while in Ontario, Alberta, and British Columbia, the performance gap is close to the national average. Research based on the IALS data for Canada and the United States (Willms, 1999a), and based on PISA data for Switzerland (Willms, in press) shows that the literacy gap for foreign-born residents decreases sharply during the first ten years that foreign-born residents are in the country.

Table 3

Relationship between reading performance and gender and family background

	Adjusted mean	Female	Single parent	Number of siblings	Foreign-born	Parent occupation	Parent education	Home educational resources	Cultural possessions
N.L.	**503.01**	**39.18**	3.17	-2.81	**-87.77**	5.91	**5.32**	**8.27**	**13.07**
	(2.93)	(4.54)	(6.81)	(2.03)	(31.11)	(8.69)	(1.21)	(2.54)	(2.33)
P.E.I.	**512.19**	**31.52**	-3.95	-2.64	8.76	**14.68**	**4.09**	**6.60**	**13.80**
	(3.24)	(4.46)	(6.30)	(1.88)	(14.10)	(7.56)	(1.29)	(2.42)	(2.62)
N.S.	**510.81**	**29.26**	-.49	**-2.76**	-15.05	**23.62**	**3.42**	3.02	**17.30**
	(3.55)	(4.13)	(6.55)	(1.40)	(12.27)	(7.33)	(1.10)	(2.14)	(2.10)
N.B.	**496.73**	**40.27**	-9.21	**-3.43**	-13.98	**19.23**	**5.04**	**3.86**	**15.02**
	(2.08)	(3.60)	(5.26)	(1.37)	(14.72)	(6.25)	(0.91)	(1.79)	(1.92)
Que	**526.77**	**32.47**	0.42	**-5.44**	**-46.14**	4.09	**6.00**	**8.75**	**7.87**
	(2.89)	(2.90)	(4.43)	(1.54)	(8.19)	(4.81)	(0.73)	(1.62)	(1.44)
Ont.	**517.36**	**27.42**	.26	**-3.89**	**-21.55**	**15.15**	**4.22**	**8.11**	**13.08**
	(3.38)	(3.21)	(4.26)	(1.70)	(5.42)	(6.74)	(0.94)	(2.49)	(2.02)
Man.	**525.20**	**32.43**	-9.67	**-5.37**	**-39.43**	3.03	**2.82**	3.23	**14.98**
	(3.18)	(3.61)	(6.10)	(1.68)	(10.47)	(8.51)	(1.11)	(2.39)	(2.25)
Sask.	**522.18**	**35.54**	**-11.71**	**-5.04**	-26.91	1.44	5.26	3.77	11.96
	(4.35)	(3.59)	(5.84)	(1.44)	(13.76)	(7.14)	(1.27)	(1.88)	(2.15)
Alta.	**534.78**	**31.96**	-6.46	**-5.86**	**-20.66**	**13.49**	**4.28**	**9.80**	**15.13**
	(3.21)	(4.02)	(5.43)	(1.49)	(7.57)	(6.84)	(1.15)	(2.34)	(1.91)
B.C.	**527.96**	**27.41**	-8.44	**-4.48**	**-29.14**	**15.66**	**3.63**	**7.07**	**12.48**
	(2.79)	(4.33)	(4.86)	(1.78)	(5.51)	(6.96)	(0.93)	(2.36)	(2.06)
Canada	**522.58**	**30.00**	**-2.16**	**-4.61**	**-27.82**	**11.79**	**4.57**	**7.89**	**11.78**
	(1.57)	(1.54)	(2.08)	(0.87)	(3.71)	(2.91)	(0.43)	(0.97)	(0.87)

Note: Results in bold text are statistically significant at $p < 0.05$.

Predictably, the effect associated with parents' occupational status[5] is large and statistically significant for Canada and most provinces. The results indicate that a one-point increase on this index (which ranges from 1.6 to 9.0 in Canada) is associated with an increase in reading performance of almost 12 points. The effect of occupational status is statistically significant in six provinces; the exceptions are Newfoundland and Labrador, Quebec, Manitoba, and Saskatchewan.

The effect of parental education is more consistent across the ten provinces, ranging from about 3 to 6 points for each additional year of education of the students' parents.

The measures of home educational resources and cultural possessions are also significantly related to reading performance. For these measures, a one-standard deviation increase is associated with increases in reading performance for Canada of 8 and 12 points, respectively. The effects of these two factors are quite similar across the ten provinces.

Overall, these results indicate that provinces vary in their reading performance, even after account is taken of students' family background. They also show that the effects associated with SES, and with particular aspects of family background, vary among the provinces. The next section examines variation among schools within each province, and examines whether certain structural and social processes of schooling are related to school performance.

Schools Make a Difference

School Profiles

Figure 2 above shows the socioeconomic gradient for Canada, which describes the student-level relationship between reading performance and students' socioeconomic status. In PISA, schools were sampled in the first stage of the sample design, and then 15-year old students were sampled within schools. Therefore it is possible to describe the relationship between the average reading performance and the average socioeconomic status for each school. This relationship provides a "profile" of school performance that is useful for policy and planning purposes. More detailed analyses that incorporate an extensive set of student-level covariates are used to estimate the potential effects of various family and school-level variables.

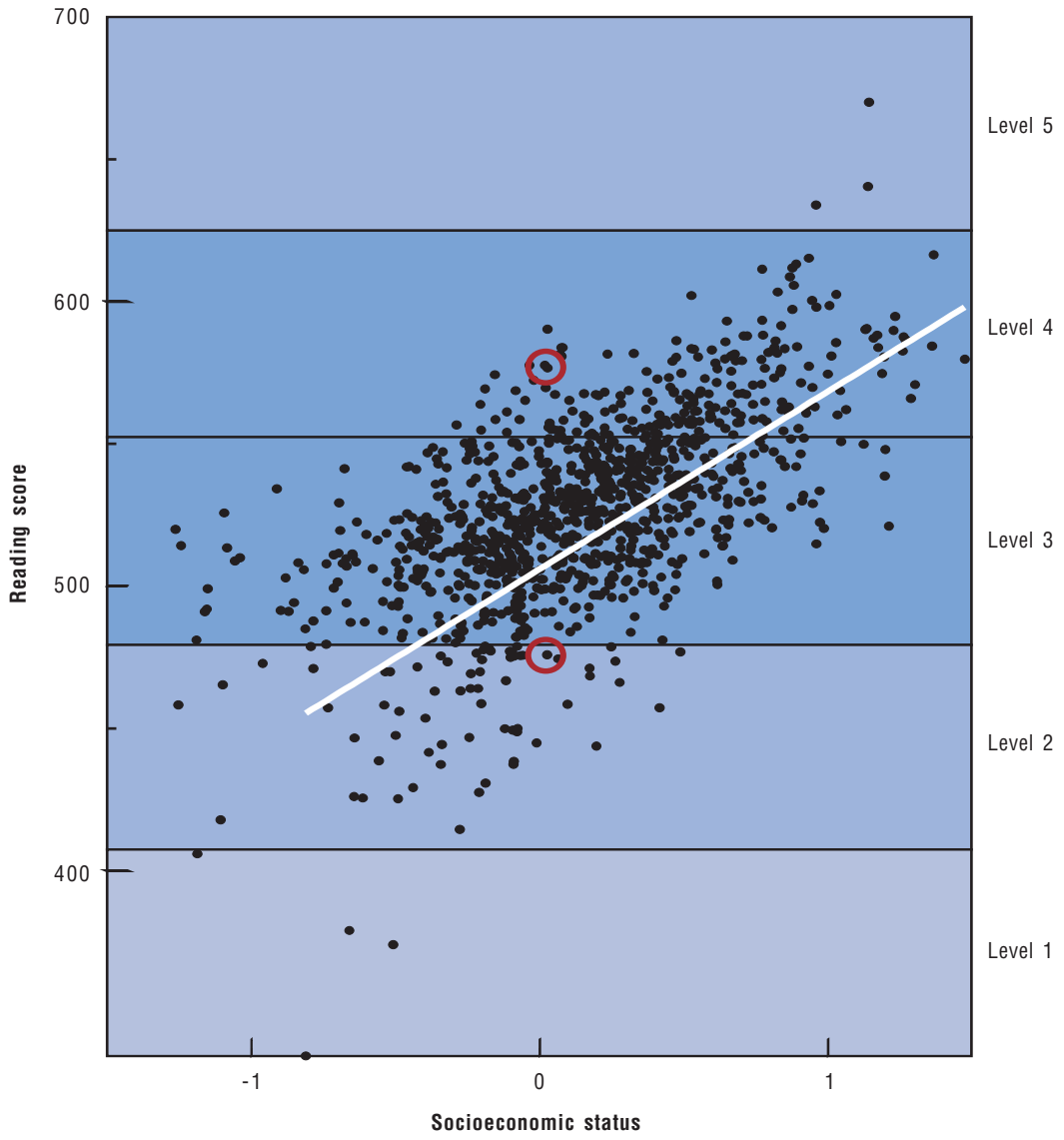
Figure 4 is a "profile" of reading performance for Canadian schools. It shows the relationship between school mean reading performance and school mean socioeconomic status for the 1117 schools that participated in PISA.[6] Each dot on the graph represents a school. The solid black line depicts the between-school regression relationship. Schools that lie above this line have relatively high performance, while those below the line have relatively low performance, given the socioeconomic intake of their students. Raudenbush and Willms (1995) provide a detailed description of the multilevel statistical models used in the estimation of "school effects" or "added value". They refer to this type of estimate as a Type B school effect, which is relevant to those concerned with school quality.

Consider, for example, the two schools circled in red. The average socioeconomic status of the students attending both schools is close to zero; that is, the family background of the students attending both schools, on average, is close to the OECD average. However, one school has an average reading score of about 575, while the other has an average score of about 475. Therefore, even though these two schools have similar intakes in terms of student socioeconomic status, they differ in their reading performance by about 100 points.

An important finding of this analysis is that there is a similar range between the highest and lowest performing schools at every level of socioeconomic status. Also, the highest-performing schools among those with low average levels of SES (e.g., with mean SES between -1.0 and -0.5) have average levels of reading performance at or above the Canadian average of 534. These high-performing low-SES schools also have reading levels that are similar to the lowest-performing schools among those with high socioeconomic intakes (e.g., with mean SES between 0.5 and 1.0).

Figure 4

School profile for Canadian schools

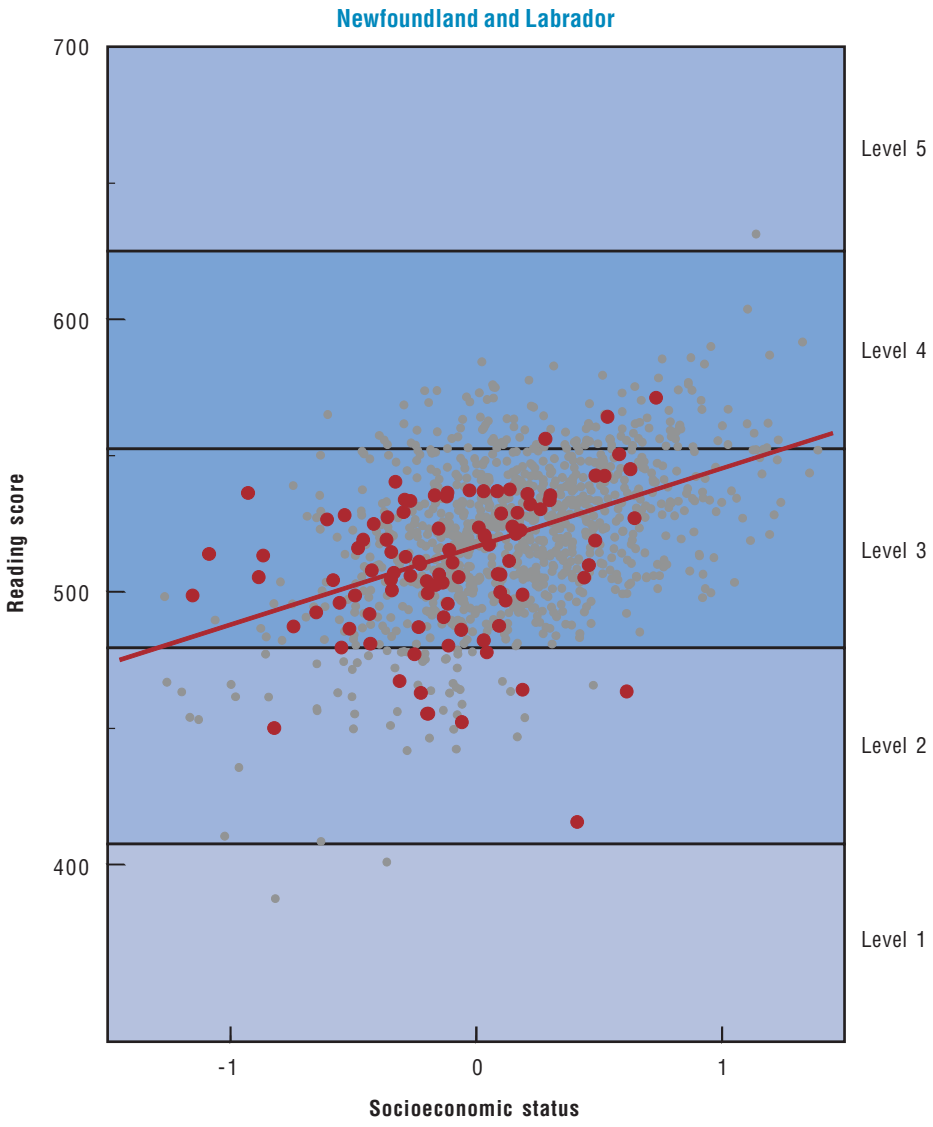


The figure also shows that there is a wide range in the socioeconomic intake of Canadian schools. The average level of socioeconomic status in Canada is 0.27 on the OECD index. Nearly twenty percent of all Canadian schools have a mean socioeconomic status that is more than one-half of a standard deviation below the Canadian average; that is, below -0.23. This is similar to the average SES of schools in Greece, Latvia, and Spain. About 8.5% of Canadian schools have mean SES scores below -0.48, or 75% of a standard deviation below the Canadian average. These schools are comparable in their intake to the average school in Russian Federation, and below that of Portugal and Poland.

Figures 5a to 5j show the school profiles for each province. The schools for each province are coloured red, while all other schools are shown in gray for comparison.

Figure 5a

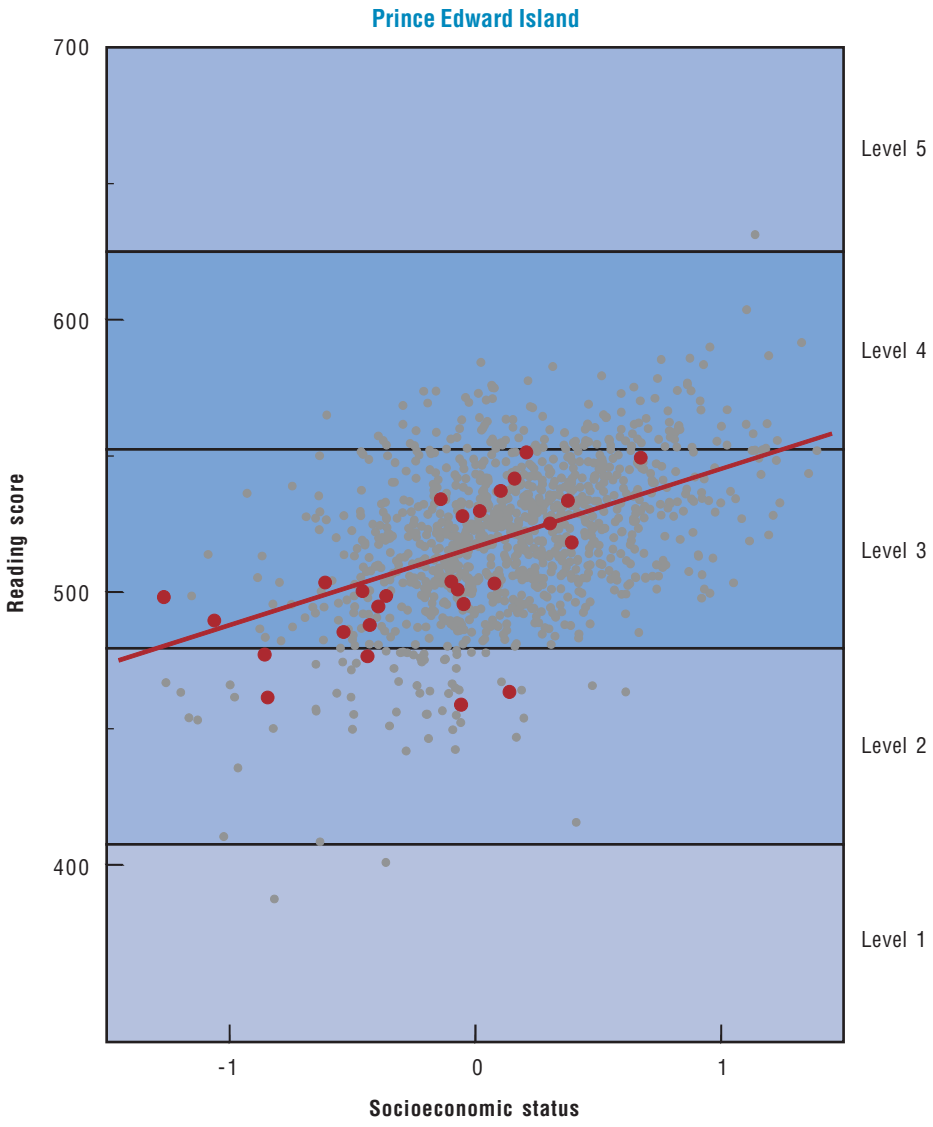
School profile for Newfoundland and Labrador



Newfoundland and Labrador's schools exhibit a wide range of performance, with some schools scoring slightly above the Canadian regression line, and some scoring well below the line. Among those schools serving students in the middle range of SES, there were not any schools among the very high-performing schools. Also, Newfoundland and Labrador's profile is characterized by some schools that are very low-performing compared with other Canadian schools of similar SES intake, as well as some very low SES schools (e.g., with an SES below -0.5).

Figure 5b

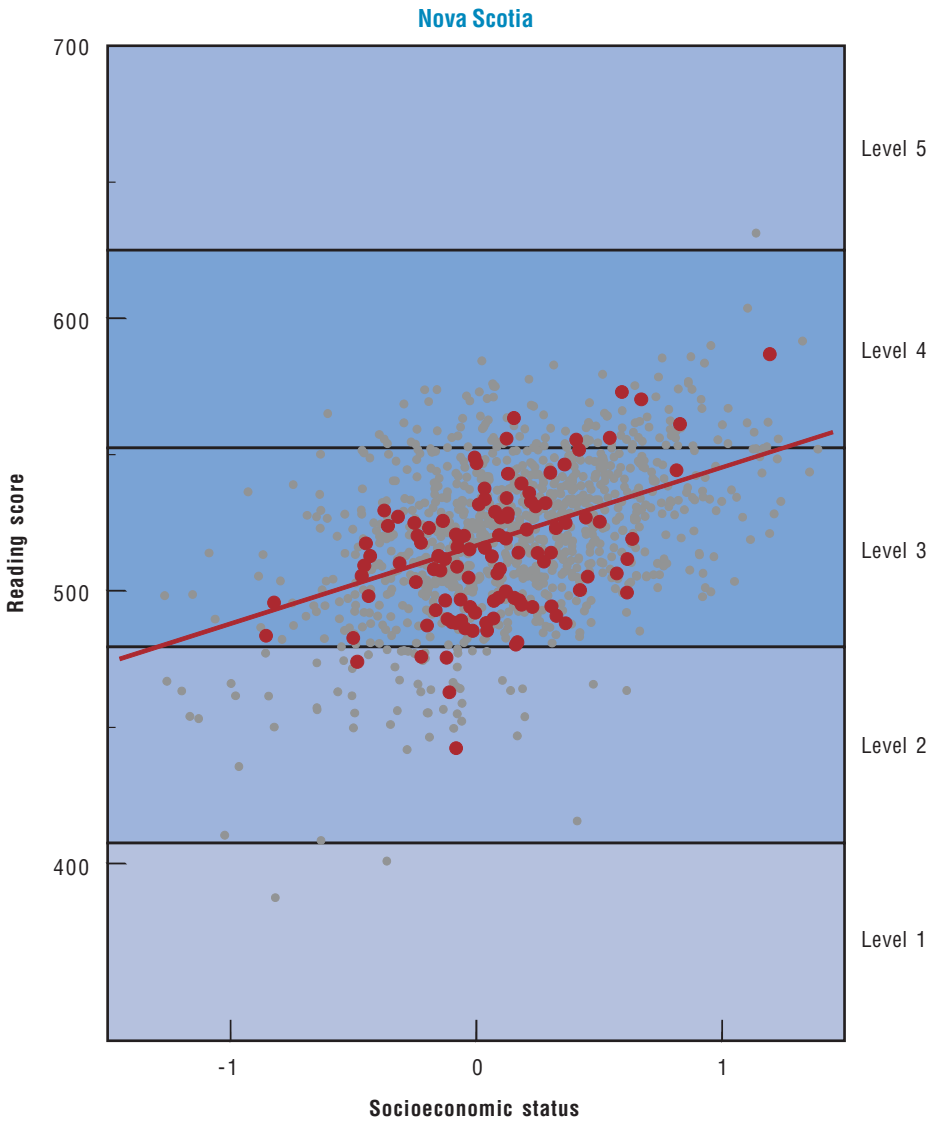
School profile for Prince Edward Island



The profile for Prince Edward Island shows that the majority of its schools are in the middle of the SES range (e.g., between -0.5 and 0.5), and among these there is a wide range in performance. However, Prince Edward Island also has several schools with very low average SES, and on average these schools are scoring below the norms set by other Canadian schools with comparable student intake.

Figure 5c

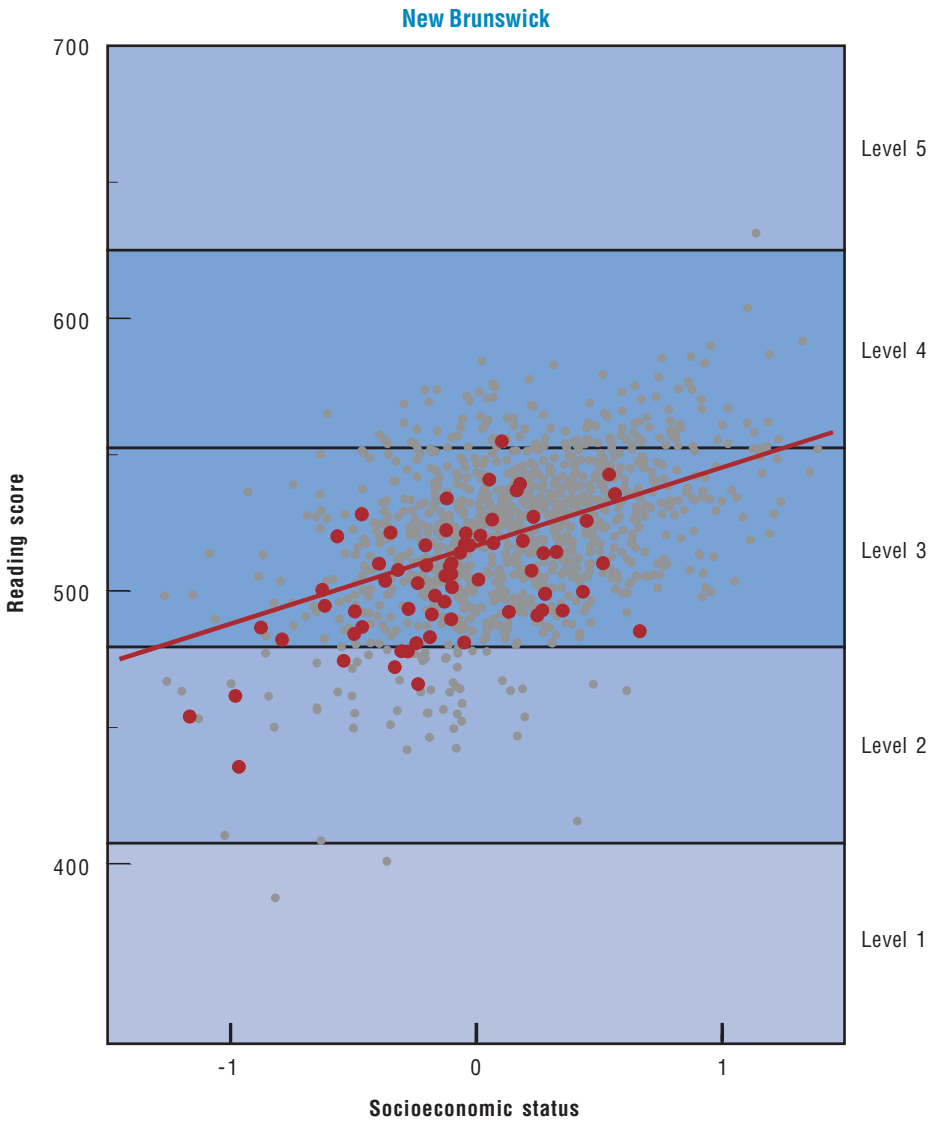
School profile for Nova Scotia



The profile for Nova Scotia indicates that most schools are in the middle of the SES distribution, and only a few schools have a very high or very low SES. A number of Nova Scotia's schools, particularly those in the middle of the SES distribution, scored well below the norms set by other Canadian schools serving comparable student populations.

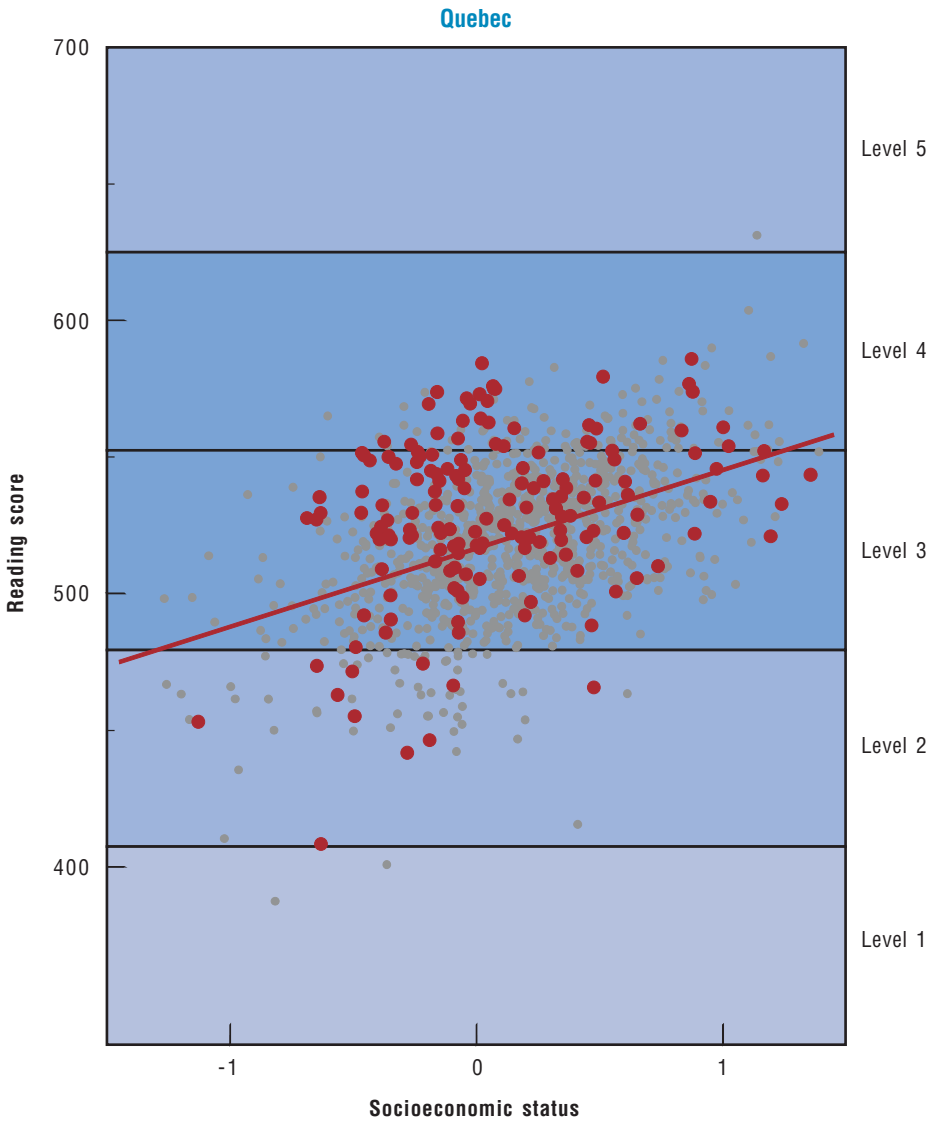
Figure 5d

School profile for New Brunswick



New Brunswick's school profile is similar to that of Prince Edward Island. It has a number of schools in the middle of the SES distribution, and several schools of very low SES. Moreover, the majority of its schools scored below the regression line, indicating that they do not fare well compared with other Canadian schools with comparable student intake.

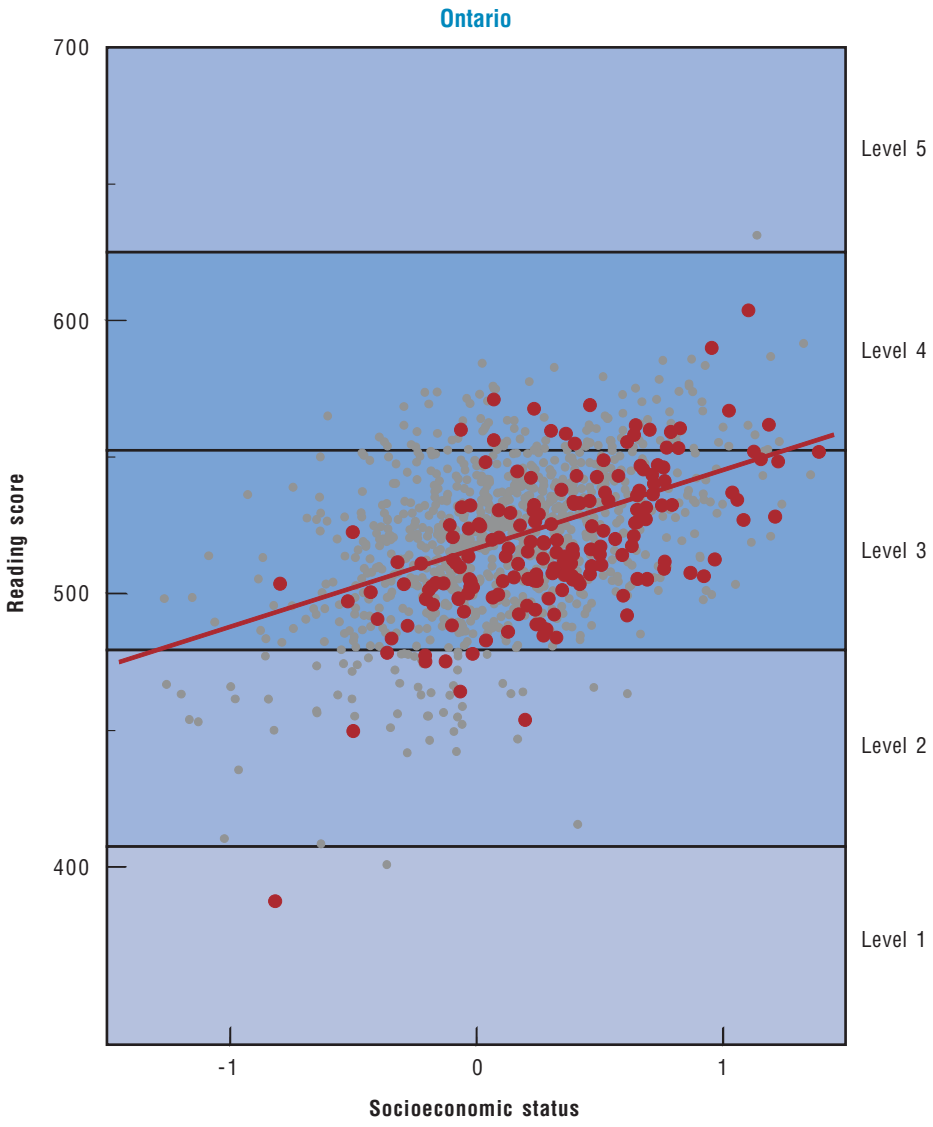
Figure 5e
School profile for Quebec



The profile for Quebec shows that the high average level of reading performance achieved by Quebec students is not attributable to students in a few elite schools. Instead, Quebec's success rests with it outstanding performance among schools serving students of average SES. There are a few schools of very low SES, and these tend to have relatively low school performance.

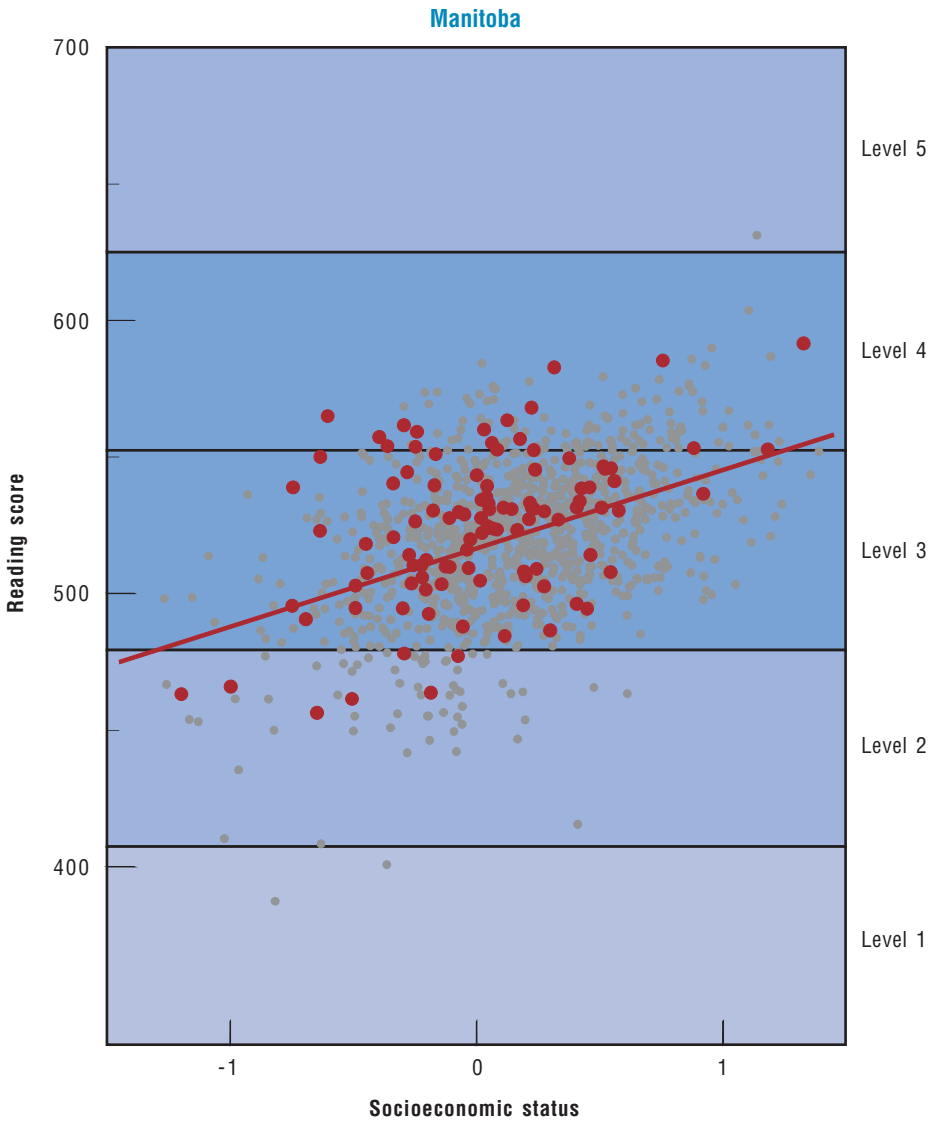
Figure 5f

School profile for Ontario



The analysis of socioeconomic gradients (Figure 3) indicated that Ontario students scored well below their counterparts in Quebec and Alberta, across the full range of SES. The school profile above shows that the SES intake of most schools in Ontario is above the OECD mean. However, the majority of Ontario's schools scored below the regression line, indicating that they were not performing as well as other Canadian schools with comparable student intake. Thus, Ontario's relatively low overall performance is not attributable to a few low SES schools with low performance. Rather, it is associated with a more general pattern of slightly lower than expected performance among the majority of its schools.

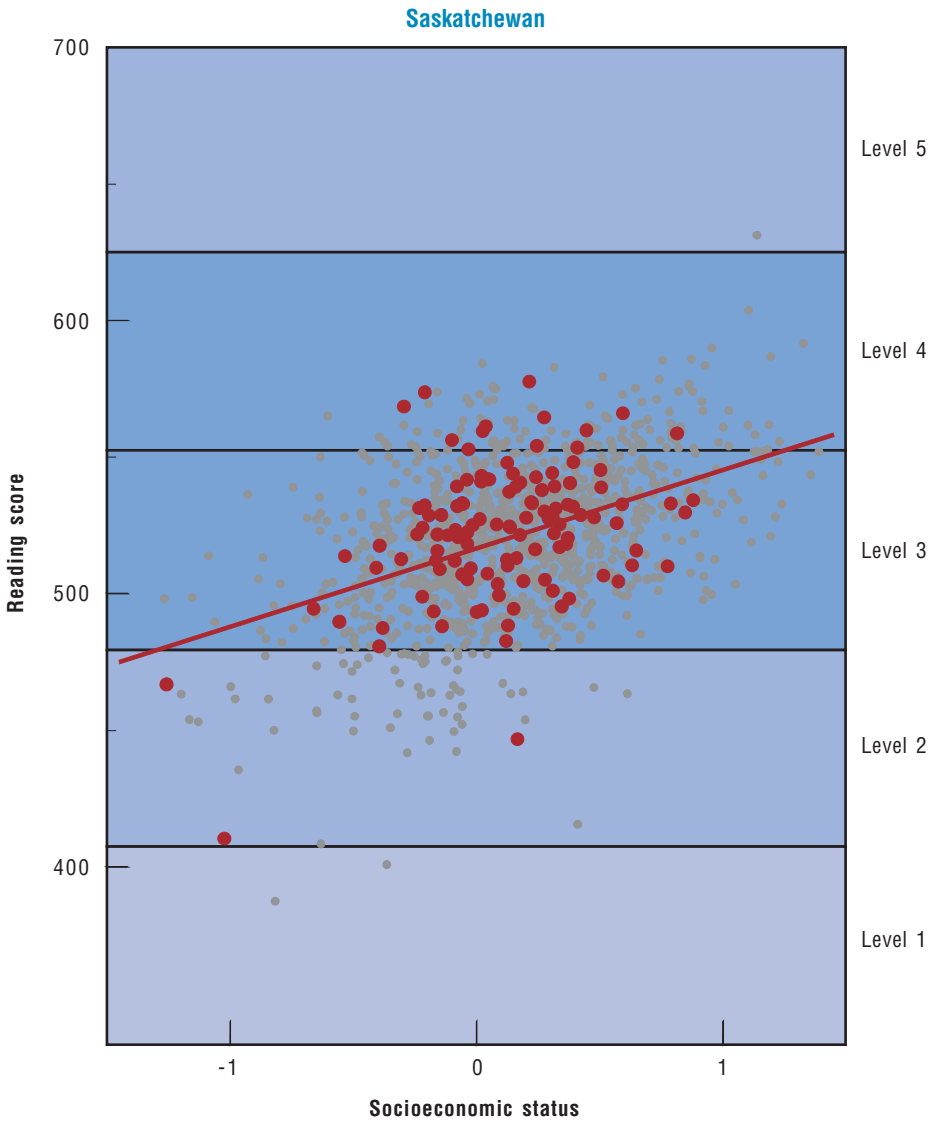
Figure 5g
School profile for Manitoba



Manitoba's school profile shows that there is considerable variation among schools in their socioeconomic intake. Most of the schools serving students in the middle of the SES range performed quite well, although there is considerable variation. Manitoba also has a number of schools that have very low SES intakes, and these schools did not score well compared with other schools with comparable student intake.

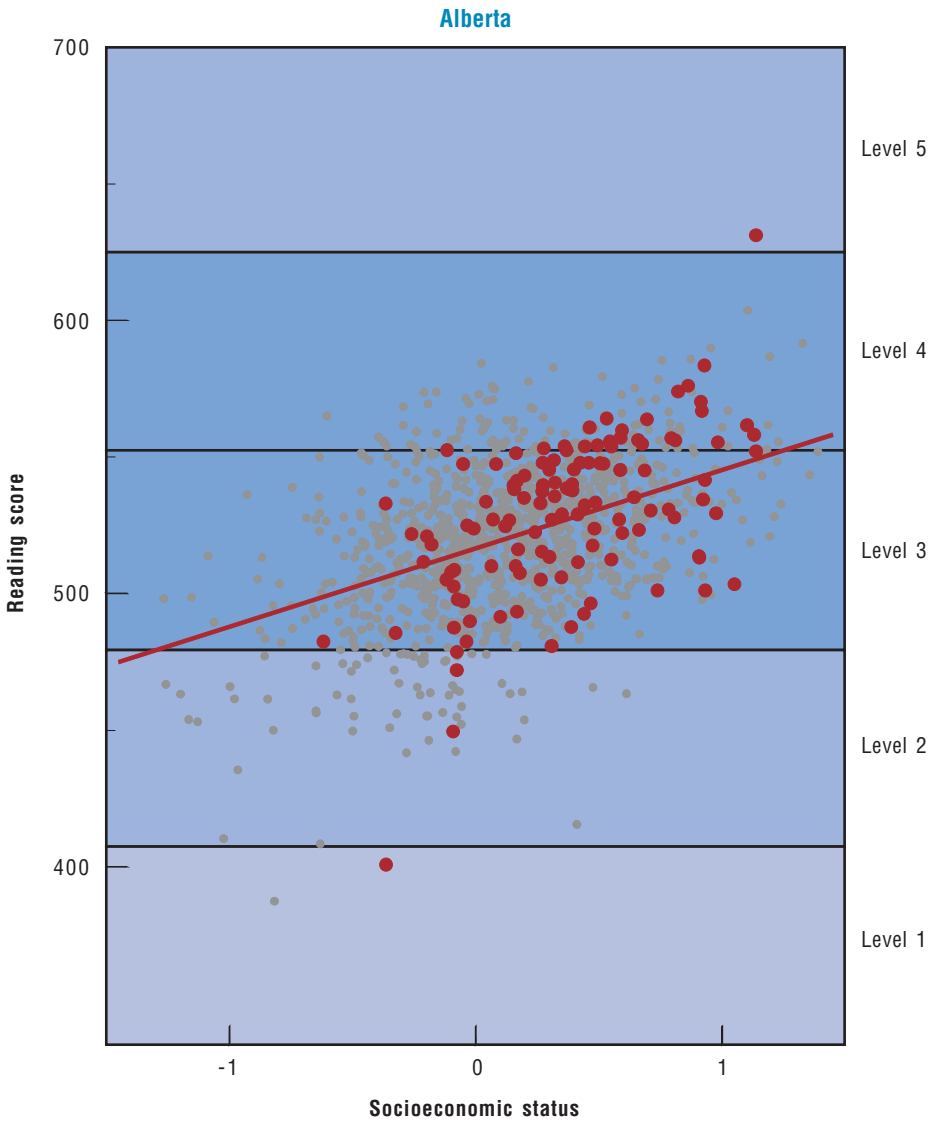
Figure 5h

School profile for Saskatchewan



Saskatchewan's mean school performance was close to the Canadian average. Its school profile shows that the majority of its schools are in the middle of the SES range, although there are a few schools of very low SES. Also, nearly every school had scores that were close to the norms set by other Canadian schools serving similar student populations. There were only a few schools with very high performance or very low performance, given their socioeconomic intake.

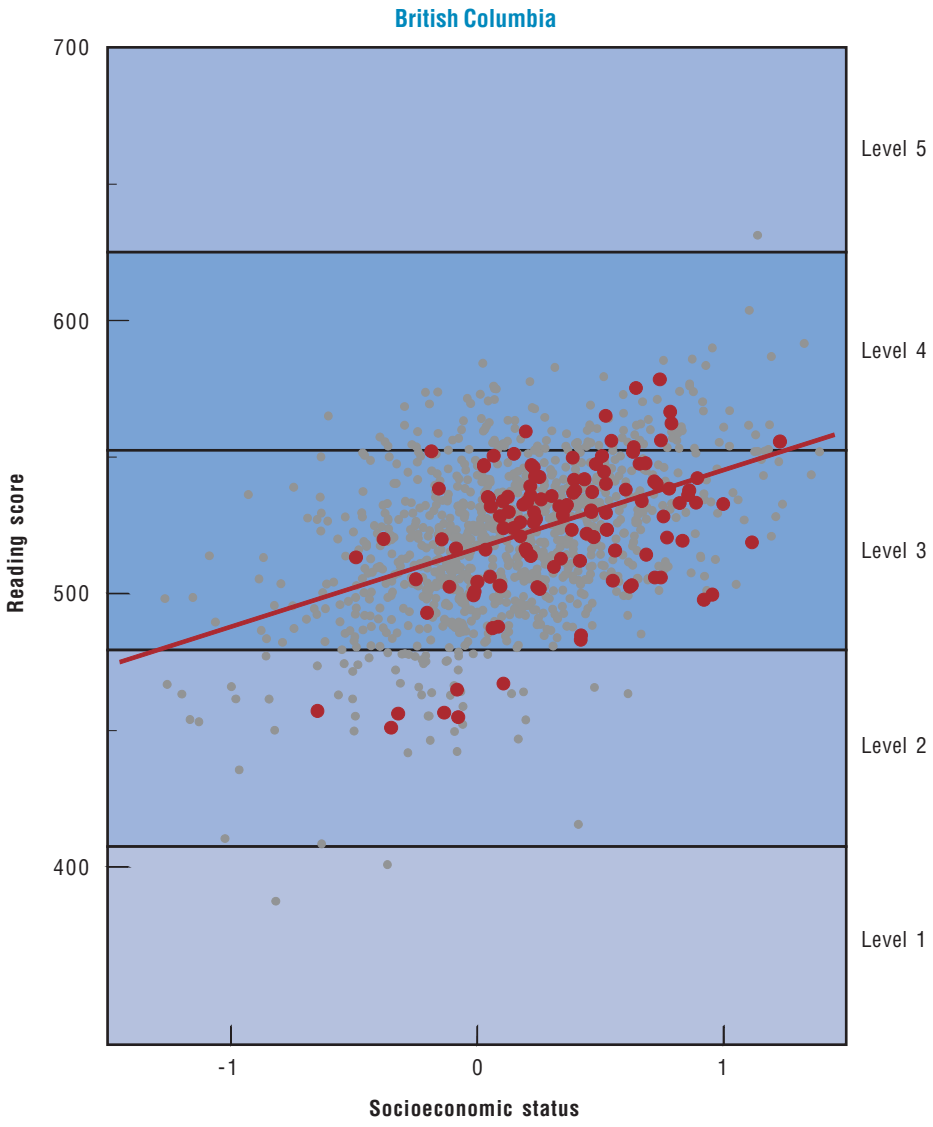
Figure 5i
School profile for Alberta



The relatively high performance of Alberta students is partially owing to its relatively high level of SES. The results in Tables 2 and 3 indicated that its mean score after adjusting for SES was about 535, similar to the Canadian average. This is reflected in its school profile as well. Most of the schools in Alberta serve a relatively advantaged population. Among these schools there are many that are performing well above norms, but there are others that have relatively low performance, given their SES intake.

Figure 5j

School profile for British Columbia



The school profile for British Columbia is similar to that of Alberta, with most schools having relatively high average SES intakes. Also, there is a wide range of performance among its schools, even after account is taken of the SES intake of the schools. There are very few schools with outstanding performance, even among those with very high SES intake.

The Effects of School Context and Schooling Processes

The PISA student and school administrator questionnaires included a number of questions describing school resources, school policy and practice, and classroom practice. A three-level hierarchical linear model, with students nested within schools, and schools nested within provinces, was used to estimate the potential effects associated with school-level factors. Inset 2 discusses the use of multilevel models. Earlier I noted that PISA is an assessment of the cumulative effects of students' experiences at home and at school from birth to age 15, and not simply the effects of school experiences during the last few years of schooling. Thus, a major limitation of the PISA data for estimating "school effects" is that the descriptions of school policy and practice given by students and school administrators pertain to the schools students were attending at the time of the assessment, and mainly refer to students' most recent experiences. Consequently, the analysis is likely to underestimate the effects of school factors.[7] Moreover, it is also possible that the composition of student intake to schools, particularly the level of ability and family socioeconomic status of the students, affects certain school processes (Willms & Kerckhoff, 1995). It may be, for example, that teachers are better able to maintain a positive disciplinary climate when their students are predominantly from high socioeconomic status families. It is not possible with cross-sectional data to disentangle the potential effects associated with school context from those attributable to various school processes.

Inset 2

Hierarchical Linear Models (HLM)

In most educational surveys, the data are structured *hierarchically*. In PISA, for example, students are nested within schools, which are nested within countries. Hierarchical linear modeling (HLM) is a specialized regression technique designed to analyse hierarchically structured data (Goldstein, 1995; Bryk & Raudenbush, 2002). The most common type of regression analysis, multiple regression, assumes that the observations are *independent*; that is, the observations of any one individual are not in any way systematically related to the observations of any other individual. This assumption is violated, however, when students are sampled from the same classroom or school. Regression coefficients can be biased when this assumption is violated, and the estimates of standard errors are smaller than they should be. As a result, there is a risk of inferring that a relationship is statistically significant when it may have occurred by chance alone.

Moreover, most policy-makers are interested in the relationships within schools, whether these relationships vary among schools, and if so, whether the variation is related to school characteristics. For example, the average level of students' reading performance, and the relationship between reading performance and socio-economic status, may vary among schools within each province. Policy-makers may also be interested in whether schools with high average reading performance and more equitable performance have smaller class sizes, different kinds of instructional techniques, or differing forms of school organisation (Lee, Bryk, & Smith, 1990; Raudenbush & Willms, 1995).

The basic idea underlying HLM is that there are separate analyses for each school (or the unit at the lowest level of an hierarchical structure). The results of the separate within-school analyses – in this case, the regression coefficients – become the dependent variables for analyses at the school level. Willms (1999b) provides an introduction to HLM for the non-statistical reader, with a general discussion of its applications to educational policy issues. Goldstein (1995), and Bryk and Raudenbush (2002) provide comprehensive texts on HLM that can be understood fairly easily by those familiar with basic regression analyses.

Table 4 presents the estimates of four separate regression models. Model 1 is a "null" model. It simply partitions the variance in reading performance into student, school, and provincial-level components. The variance components at these three levels, respectively, were 7618, 1532, and 238, yielding a total variance of 9388. These results indicate that only about 2.5% of the total variance is among provinces, while 16.3% is among schools within provinces, and 81.1% is among students within schools. Although the magnitude of the variance components at the school and provincial levels seems small, there are sizable differences among the highest and lowest performing schools within each province, and between the highest and lowest performing provinces. Also, the analysis indicated that the variation among school means was statistically significant, as was the variation among provinces in the mean scores.

The second model includes student gender and the measures of SES and "foreign-born" as explanatory variables. The SES slope is 30.9, which indicates that a one standard deviation increase in SES is associated with a 30.9 point increase in reading performance. On average, across the provinces, females outperformed males on the reading test by 35 points, while those who were foreign-born scored about 20 points lower than students who were born in the country. These three factors accounted for 13.3% of the variance among students within schools, 43.3% of the variance among schools within provinces, and 40.8% of the variance among provinces. The effects of each of these three factors varied significantly among schools within provinces, and among provinces. Figure 6 shows the proportions of variation accounted for by these variables within each province.[8]

Table 4

The effects of pupil and school level variables on academic performance

	Unadjusted		Family background (FB)		FB and school context (SC)		FB, SC, and school process (SP)	
	Coeff.	(S.E.)	Coeff.	(S.E.)	Coeff.	(S.E.)	Coeff.	(S.E.)
Canadian mean	**518.9**[sp]	(5.1)	**518.8**[sp]	(3.9)	**512.82**[sp]	(3.2)	**508.7**[sp]	(5.3)
Student background and student characteristics								
SES (pupil-level)			**30.9**[sp]	(1.1)	**28.0**[sp]	(1.2)	**27.9**[sp]	(1.2)
Female			**35.0**[sp]	(1.6)	**34.3** [s]	(1.5)	**34.2**[sp]	(1.6)
Foreign-born			**-20.4**[sp]	(3.3)	**-25.3**[sp]	(2.8)	**-24.6**[sp]	(2.8)
School context – Effect of school Mean SES on:								
Average scores					**50.9** [p]	(3.1)	**40.8**	(2.8)
SES slope					**-6.0**	(2.1)	**-6.5**	(2.1)
Female-male performance gap					-7.2	(4.0)	-6.8	(3.8)
School resources								
Student-staff teaching ratio (unit is 1 student)							-0.2	(0.4)
School size (unit is 100 students)							**2.1**	(0.9)
School size^2							**-0.1**	(0.04)
Students have computers (unit is 10%)								
Teachers have specialized training (unit is 10%)							**1.54**	(0.4)
Teachers get prof. development (unit is 10%)							-0.4	(0.2)
Quality of school infrastructure (10-point scale)							-0.3	(0.4)
Students' use of resources (10-point scale)							**2.6**	(0.7)
School policy and practice								
Conduct formal assessment (10-point scale)							0.2	(0.5)
Quality of teaching staff (Administrators' assessment) (10-point scale)							-0.1	(0.3)
Teacher morale (10-point scale)							-0.1	(0.3)
Teacher autonomy (10-point scale)							**0.5**	(0.2)
Principal autonomy (10-point scale)							(0.1)	(0.5)
Classroom practice								
Conduct informal assessment (10-point scale)							-0.4	(0.5)
Teacher-student relations (10-point scale)							**2.3**	(0.5)
Disciplinary climate (10-point scale)							**2.7**	(0.3)
Academic press (10-point scale)							0.0	(0.5)
Percentage of variance explained								
Among students within schools (Variance = 7,618)		0.0		**13.3**		**13.4**		**13.5**
Among schools within provinces (Variance = 1,532)		0.0		**43.0**		**62.4**		**72.2**
Among provinces (Variance = 238)		0.0		**40.8**		**63.0**		**50.8**

The third model introduces the school mean level of SES as an explanatory variable at level 2. A number of studies have found that the average level of school SES has an effect on student performance, over and above the effects associated with a student's individual level of SES (Willms, 1999c). Also, the average level of SES was related to school performance in every country that participated in PISA (see Chapter 8, OECD, 2001). The estimate of the "contextual effect" in this study was 50.9 points. This indicates that if a student with average family background attended a school with an SES that was 0.5 standard deviations above the OECD mean for SES, rather than a school that was 0.5 standard deviations below the mean, the students' expected reading performance would be about fifty points higher. The school profiles in the previous section show that there are schools in every province that have SES averages close to -0.5 and 0.5, and even outside that range.

The third model also included school mean SES as a predictor of the SES slopes and the gap in performance between females and males. The effect of mean SES on the SES slopes was statistically significant. The negative coefficient estimate, -6.0, indicates that slopes are more gradual in high SES schools. This is evidence of "triple jeopardy" (Willms, 2002). Consider two students, one of high SES (0.5 standard deviations above the mean) and one of low SES (0.5 standard deviations below the OECD mean). The expected achievement gap between these two students would be 25 points in a high SES school (i.e., a school with a mean SES of 0.5). However, if these two students were in a low SES school (i.e., a school with a mean SES of -0.5), the achievement gap between them would be 31 points. It is called triple jeopardy because youth from low SES families have lower performance, youth have lower score if they attend low SES schools, and the effect is particularly pronounced if it is a low-SES student attending a low-SES school. The results also suggest that the same phenomena operates for males when they attend a low SES school, although the contextual effect on the gender performance gap was not statistically significant at a .05 level of probability (but was significant at $p<.10$, $p = 0.07$). These results suggest that concentrating students in low SES schools may be especially detrimental to boys from low SES families.

The last model includes a number of school-level variables describing school resources, school policy and practice, and classroom practice[9]. These variables were constructed following the same procedures as used in Chapter 8 of *Knowledge and Skills for Life* (OECD, 2001), although the method of scaling was slightly different as described in the note above. The school-level variables in this analysis were scaled on a ten-point scale, ranging from zero to ten such that the score represents a school's position relative to other schools in the OECD. For example, a score of 3.4 on the scale for disciplinary climate indicates that the school's score on this index was at the 34th percentile among all OECD schools. A score of 5.0 indicates that the school was at the median.

The first block of variables indicate that larger schools perform slightly better on average than small schools; however, the effect is quite small: an increase in school size of 100 students is associated with an increase in reading performance of only 2 points. The negative coefficient for the square of school size indicates that there is an optimal level of school size, and thereafter school performance begins to decline. Schools where the teacher had a specialized training in language arts scored slightly higher: on average, a 10-percent increase in the percentage of specialized teachers was associated with a 1.57 point increase in performance. The quality of school infra-structure and the availability of computers for students were not significantly related to school performance; however, in schools where students made better use of resources, the scores were higher. Each 1-point increase on the scale was associated with a 2.6 point increase in reading performance.

Figure 6

Variance within and between schools explained by family background

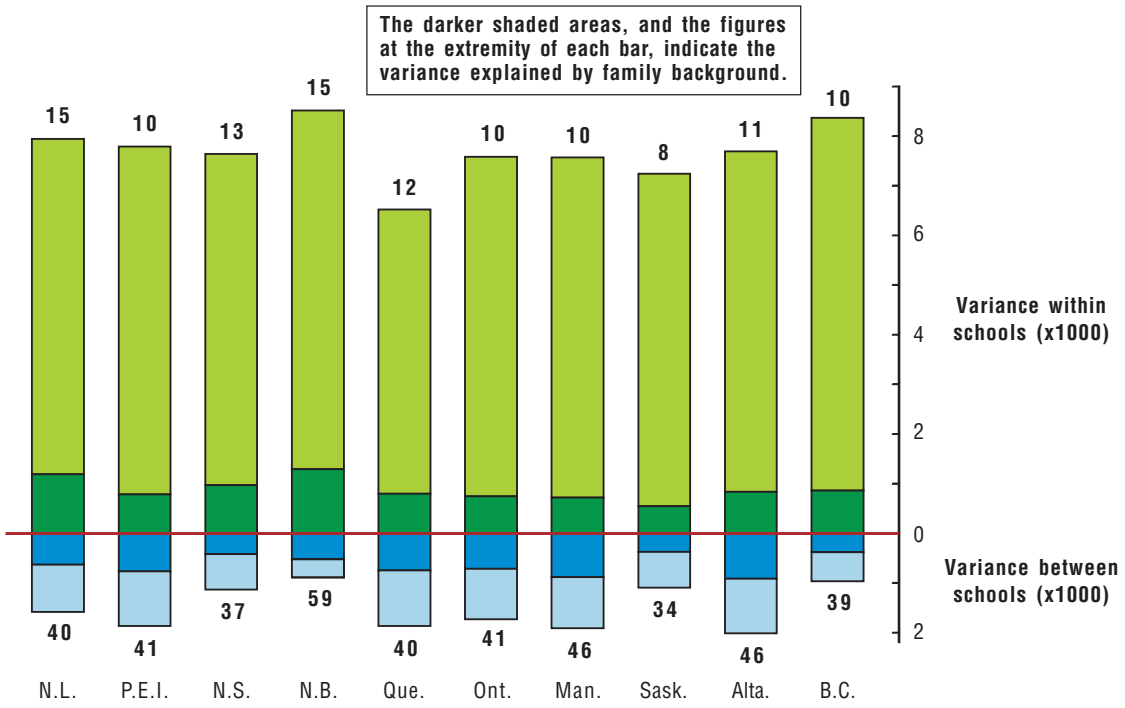
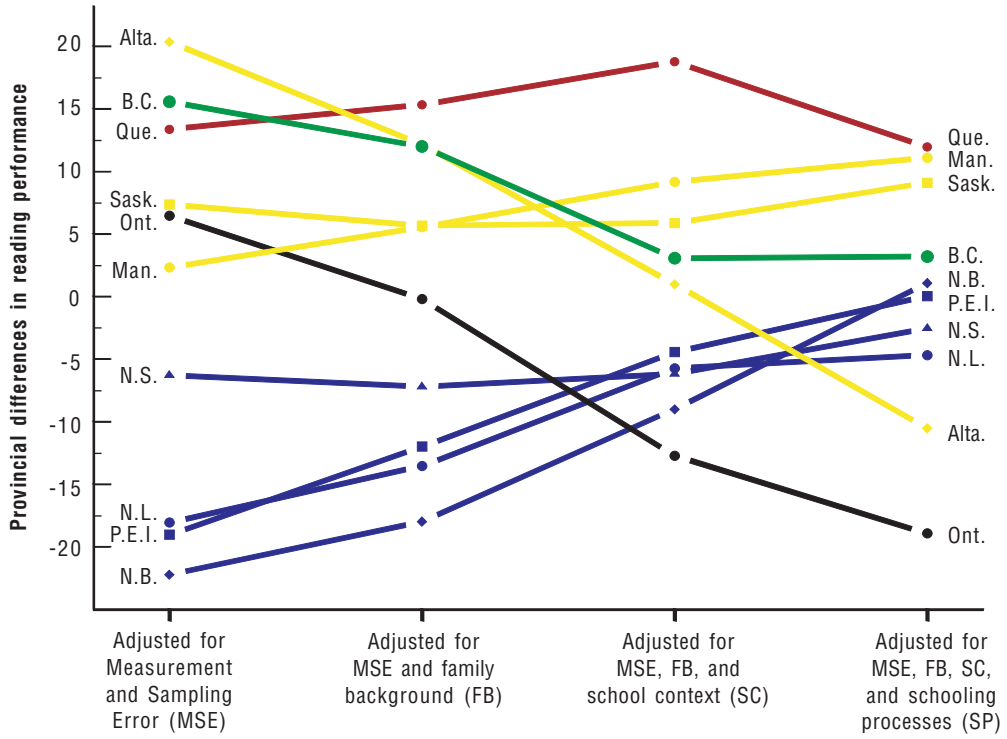


Figure 7

Variation in provincial reading performance explained by family background, school context, and schooling processes



The factors pertaining to school policy and practice were weak in their effects. The only significant factor was school autonomy, which indicated that a 1-point increase on the school autonomy scale was associated with a 0.5 point increase in reading performance.

Two of the measures of classroom practice were the most significant factors. A one-point increase on the scale regarding teacher-student relations was associated with an increase in reading performance of 2.3 points, while a one-point increase in the disciplinary climate scale was associated with an increase of 2.6 points.

Figure 7 provides a summary of the variation in provincial scores that are explained by the four models. The first set of estimates shows the provinces' scores relative to the Canadian average. These estimates are Empirical Bayes "shrunken estimates" (see Bryk & Raudenbush, 2002), which are mean scores adjusted for measurement and sampling error.

The second set of estimates includes adjustment for gender, SES, and whether the student was foreign-born. The results show clearly that some, but not all, of the variation in student performance is attributable to students' family background. These findings indicate that about 40% of the variation in provincial performance is attributable to family background. The third set of estimates includes control also for the mean SES of schools. It essentially addresses the question, "to what extent would provinces vary in their performance if they served students with similar

socioeconomic background, and the schools had comparable levels of SES?". The provinces are grouped slightly closer together than in the previous model. About 63% of the variation in provincial performance is attributable to family background and school context combined.

The final set of estimates includes control for all of the factors included in the last model of Table 4. This model addresses the question, "What would be the expected score in each province of a student with average background characteristics if the student were in an average SES school, and a school with average levels of school resources, and classroom and school policy and practice?" Thus, provinces that generally had high scores on the measures of schooling process will decline in their scores after adjusting for school process (e.g., Quebec, Alberta, and B.C.), while those with low scores on the process measures will increase in their scores. The results make three points. First, the results for eight of the ten provinces are quite similar after controlling for these factors. Second, Alberta's high scores are attributable partially to the high SES of its students, but also to positive school policies and practices. Third, Ontario's high performance is partially attributable to positive classroom policies and practices, but a substantial portion is due to its relatively high socioeconomic status.

Summary and Conclusions

Statistics Canada and Human Resources Development Canada took a lead role with the OECD in developing the International Adult Literacy Study (IALS), and Canada was among the first seven countries to participate in the assessment. Canada is also an active participant in the OECD Programme for International Student Assessment (PISA). A cooperative effort of the Council of Ministers of Education Canada (CMEC), Human Resources and Skills Development Canada, and Statistics Canada resulted in the active participation of every Canadian province in PISA. The number of students and schools participating in each province is comparable to that of most OECD countries. Consequently, PISA provides a key source of information to help assess how well youth are faring in their literacy skills in each province vis-à-vis international norms. PISA also enables us to examine the variation in literacy skills among provinces within Canada, and to some extent gauge the relative importance of family and school factors associated with this variation.

There is broad agreement among researchers and the policy community that the kinds of skills measured in IALS and PISA are essential for participation in the labour market, and are a precursor to the long-term health and well-being of our youth (Rychen & Salganik, 2002). Moreover, the demand for these skills has been steadily increasing, and is likely to increase further over the next decade (OECD, HRDC, and Statistics Canada, 1997). This study found that youth's literacy skills, as measured in PISA, are strongly related to whether youth will enroll in post-secondary education during the six-year period following high school graduation. The PISA study categorized students into six literacy levels, and, given the comparability of the IALS and PISA instruments, these findings suggest that there is a substantial premium associated with being in the top two literacy levels.

This study had five principal aims. One was to situate the performance of Canadian provinces in their literacy skills in an international context, with attention to the magnitude of the differences. The second was to estimate and compare the socioeconomic gradients of the ten provinces. Socioeconomic gradients describe the relationship between students' literacy skills and socioeconomic status (SES). The third aim was to describe the variation in student performance among schools within each province. The fourth was to estimate the relationship between school performance and the socioeconomic context of schools. Finally, the study aimed to discern whether some of the variation among provinces and schools in their performance was attributable to various aspects of classroom and school policy and practice.

1 **There is large variation among the Canadian provinces in their levels of literacy skills.** The mean scores for the ten provinces cover the full upper-half of the range of mean scores of OECD countries. The mean reading performance for New Brunswick, the lowest-performing province, was very close to the OECD mean of 500, while the mean for Alberta, the highest-scoring province, was comparable to that of Finland, which was the highest scoring OECD country. The mean score for New Brunswick was 33 points below the Canadian average. The mean scores for the other Atlantic provinces were on average about 16 points below the Canadian mean. If all provinces increased their scores by this amount, Canada would be the highest-performing country in the world. This study emphasizes that PISA scores are not mainly attributable to the quality of secondary school provision; they are the cumulative result of children's opportunities to learn at home and at school from birth to age fifteen.

2 **About 40% of the variation in provincial mean scores is attributable to students' family background.** The analysis of socioeconomic gradients provides a comparison of how students with differing levels of SES fared in their literacy skills in each province. The findings provide convincing evidence that some, but not all, of the differences are attributable to family background. After taking account of SES, there remains a gap of about 30 points between the highest and lowest scoring provinces.

3 **There is substantial variation among schools in their reading performance within every province, even after account is taken of students' family backgrounds.** If one considers only schools with average SES intake, in every province there is a gap ranging from 50 to 100 points between the highest- and lowest-performing schools. In every province there are schools *with average SES intakes* that score at or above the Canadian average, and some of these schools are among the top-scoring schools in the OECD study. Quebec's mean reading performance is high because it has disproportionately more schools with average SES intake scoring in that top range. These findings show that there are exemplary schools in every province, and these include "inclusive" schools that serve students from a range of socioeconomic backgrounds.

   In some national and provincial assessments, the relatively low performance of some schools has often been dismissed as being attributable to the low socioeconomic background of students attending them. These findings show that there are many schools with low SES intakes that have exceptionally high performance. Similarly, there are

some schools that do not perform well, even though they have a high SES intake.

4 **Students from less advantaged families tend to perform considerably worse if they attend a school of low SES than if they attended a school with a student population from a higher range of SES. The same applies for students from high SES families, but the effect is not as pronounced.** This finding provides strong evidence that when schools differ substantially in their socioeconomic intake, the disparities among students in their performance increase: "the rich become richer" (in terms of their reading performance), "while the poor become poorer".

5 **Some of the variation among schools and provinces in their reading performance is attributable to measurable aspects of school resources, and classroom and school policy and practice.** However, it is not possible to identify one or two factors that explain most of the variation among schools or among provinces. Instead, higher and less variable outcomes are associated with a broad set of classroom and school factors. Of the factors assessed in PISA, the most important school resource factor for reading performance pertained to whether students were taught by teachers who were trained in language arts. The results also suggested that the amount and quality of school resources was less important than students' use of available resources. Two aspects of classroom policy and practice also emerged as significant: schools where students reported better teacher-student relations and a stronger disciplinary climate had higher performance. Although the effects of any particular factor are fairly small, improvement of scores by one or two points on a few measures would noticeably improve school performance.

The PISA results come as Canada is on the eve of creating a national "learning institute" to monitor children's learning outcomes. Given the importance of literacy to human and economic development and the size of the effects identified in this study, further research is warranted. For example:

1 **A better understanding of children's learning *growth trajectories* would shed light on the educational and social processes that underlie the differences observed in PISA.** Other research based on Canada's National Longitudinal Survey of Children and Youth showed that differences among the provinces became evident as early as the end of grade 2, and that variation among the provinces increased at higher grades (add reference). It may be that most of the inter-provincial differences in school performance have to do with the foundation for learning that is established during the early years and during the critical first two years of elementary school. A study of students' growth in literacy skills would focus on student learning, rather than their status at a particular age.

2 **Studies such as PISA cannot examine the effects of curriculum in detail.** The "Quebec advantage" observed in this study is partially attributable to some of the school policy and practice factors measured in PISA. However, we do not have a detailed account of the curriculum differences between Quebec and the other provinces, which may give rise to the superior results that Quebec has achieved on national assessments for at least twenty years. A detailed study of the *intended* and *enacted* curricula in Quebec and in its neighbouring provinces, New Brunswick and Ontario, might help to explain the relatively high performance of Quebec students.

3 **Monitoring efforts at provincial and national levels need to collect better data on school processes, including school resources, and classroom and school policy and practice.** In particular, we need to understand how changes in school policy and practice effect changes in school performance. This can best be achieved through longitudinal studies, and whenever possible, studies where students or schools are randomly assigned to treatment and control groups.

4 **Qualitative studies of exemplary schools could provide some insights into the policies and practices that result in high performance.** It might be feasible and desirable, for example, to have a series of teacher exchanges among schools within and across provinces, with teachers conducting qualitative studies to discern what practices differ from their own school practice that appear to make a difference.

5 **Rigorous assessment of school-wide reform efforts.** A number of school reform models have emerged in the US, including *Success for All* schools, *Accelerated Schools*, and the *School Development* Program, which share a number of common features, such as an emphasis on reading and literacy development, small class sizes aimed at increasing individual instruction for students who require it, improved teacher-student relations, and active parent involvement (King, 1994). Comparable efforts in Canada, aimed in particular at schools serving students from low SES families, with a rigorous assessment of the intervention effects, have not seen widespread application in Canada.

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Endnotes

1. Data for 12 OECD countries were used to estimate the grade effect, while data for 14 countries were used to estimate the maturity effect. Canada was split into two "countries", as the age for entry to kindergarten varies by province. Data for France, Switzerland, and the United Kingdom were not used in these analyses, as it was not possible for these countries to determine a precise birth date that determined their likely grade placement at age 15.

2. After preliminary analyses, Levels 1 and 2 were collapsed for the logistic regression analysis, and the combined Levels 4 and 5 were used as the reference category. The "levels" in IALS are not the same as those in PISA. However, this analysis was also conducted by assigning youth aged 16 to 25 to PISA-like "levels", with levels created such that there was the same distribution across levels in the IALS as the Canadian distribution of PISA reading scores across the six levels. The results were very similar to those reported in Table 1.

3. The OECD PISA data include a set of design weights that differentially weight students to take account of the probability that a student is sampled within a particular country, and within a particular jurisdiction or strata within each country. The design weights are used in PISA to calculate most statistics and their standard errors. The PISA design weights are used in all analyses in this study. For most analyses, the design weights are "normalized" such that the average weight is 1.00. This ensures that the estimates of the standard errors are based on the actual number of students sampled in a jurisdiction, rather than the population-weighted number of students; it does not affect the estimates of the primary statistics (e.g., means, standard deviations, regression coefficients). In the analyses in this paper, the weights were normalized within provinces such that the weighted number of students for each province coincides with the actual number of students in the sample. This provides more accurate estimates of the standard errors for analyses conducted at the provincial level. In the multilevel analyses that examine inter-provincial variation, reported in Table 3, these normalized weights were also used. Because the sample sizes were similar for each province, each province contributes nearly equally to estimates of the variation among provinces. Therefore, for interprovincial analyses, the Canada-level estimates of means, variances and regression coefficients are different from those that would be obtained with the overall Canadian sample design weights. Subpopulations that were oversampled, such as the Atlantic provinces, have greater representation because normalized provincial design weights are used.

4. The socioeconomic gradients in Figure 2 and 3 were derived with a simple linear regression within each jurisdiction (Canada, OECD, or the province), by regressing reading scores on the measure of socioeconomic status, and socioeconomic status squared:

$$Y_i = \beta_0 + \beta_1 SES_i + \beta_2 SES^2{}_i + r_i,$$

where Y_i is the outcome measure, reading performance, b_o is the intercept, b_1 and b_2 are regression coefficients pertaining to the slope of the gradient, and ri are student-level residuals. For the provincial gradients, a two-level multi-level model, with students nested within provinces, yields virtually identical results, as the within-province sample sizes are relatively large. The quadratic term is included because the gradient is non-linear for some countries and provinces, as well as for the overall OECD gradient. The average gradient across all OECD countries was estimated using a two-level multilevel statistical model, with students nested within countries (e.g., see Bryk & Raudenbush, 2002).

5. The PISA International Socio-Economic Index of Occupational Status (ISEI) was derived from student responses on parental occupation. The index captures the attributes of occupations that convert parents' education into income. The index was derived by the optimal scaling of occupation groups to maximise the indirect effect of education on income through occupation and to minimise the direct effect of education on income, net of occupation (both effects being net of age). For more information on the methodology, see Ganzeboom, de Graaf and Treiman (1992). The PISA International Socio-Economic Index of Occupational Status is based on either the father's or mother's occupations, whichever is the higher.

6. The estimates of school mean reading performance were derived from a multilevel model which differentially "shrinks" the mean scores towards the Canadian average. This is done to take account of the measurement and sampling error inherent in the estimates for each school. To estimate the shrunken means, a two-level null model – students nested within schools – was fit separately for each province. See Bryk & Raudenbush (2002) for a detailed discussion of empirical Bayes shrinkage.

7. The results presented here differ somewhat from those presented in Chapter 8 of the international report. One of the main reasons is that this analysis includes province as a level in the analysis, and thus the estimated coefficients provide an indication of the average effects across provinces; whereas, the analyses in the international report were based on a two-level model, which for Canada yields estimates that are dominated by the results for its largest provinces. Also, the school-level variables in this analysis were scaled in a different way than in the international report. In the international report, each variable was scaled on 10-point scales by standardizing it across OECD countries, and setting the mean at 5.0 and the standard deviation at 2.0. In this analysis, the variables were also scaled on a ten-point scale, ranging from zero to ten. However, in this case, the score represents a school's position relative to other schools in the OECD, with each point representing a difference of one decile.

8. The variance components in Figure 6 were estimated by fitting separate two-level models for each province.

9. The measures of school resources, school policy and practice were derived as follows:

   Student-teaching staff ratio was defined as the number of full-time equivalent teachers divided by the number of students in the school. One unit on this variable represents a change of 1 student per teacher

   School Size was derived from the school administrators' report of the school enrolment. One unit on this scale represent 100 students. The model also includes the square of school size to capture any curvilinear relationship.

   Students have computers was derived from a question asked of the school administrator about how many computers were available to students. These data were used with total school enrolment to estimate the percentage of students who had computers. The percentage was divided by ten so that one unit on this scale represents an increase of 10% in the percentage of computers.

   Teachers get professional development was derived from a question asked of school administrators about the percentage of teachers who had received professional development in the previous three months.

   Quality of school infrastructure is a summary measure derived from school principals' reports of the extent to which the learning of 15-year olds was hindered by: (a) poor condition of buildings; (b) poor heating, cooling and/or lighting systems; (c) lack of instructional space (e.g., classrooms); (d) lack of instructional material (e.g., textbooks); (e) not enough computers for instruction; (f) lack of instructional materials in the library; (g) lack of instructional materials in the library; (h) inadequate science laboratory equipment; and (i) inadequate science laboratory equipment.

   Students Use of Resources was derived from a question asked of students: "At your school, how often do you use … (a) school library (b) computers (c) calculators (d) Internet (e) <science> laboratories?"

   Conduct formal assessment was derived from school principals' reports on the frequency with which standardised tests were used, and on whether or not the assessments were used to monitor the school's progress from year to year and monitor the school's progress from year to year.

   Quality of teaching staff (administrators' assessment) was derived from school principals' reports of the extent to which the learning of 15-year olds was hindered by: (a) low expectations of teachers; (b) poor student-teacher relations; (c) teacher turnover; (d) teachers not meeting individual student needs; (e) teacher absenteeism; (f) staff resisting change; (g) teachers being too strict with students; and (h) students not being encouraged to achieve their full potential.

   Teacher morale was derived from school principals' reports on the extent to which they agreed with these statements concerning teacher morale and commitment: (a) the morale of teachers in this school is high; (b) teachers work with enthusiasm; (c) teachers take pride in this school; and (d) teachers value academic achievement.

   Teacher autonomy was derived from a question asked of principals as to who had the main responsibility for: (a) hiring teachers; (b) firing teachers; (c) establishing teachers' starting salaries; (d) determining teachers' salary increases; (e) formulating the school budget; (f) deciding on budget allocations within the school; (g) establishing student disciplinary policies; (h) establishing student assessment policies; (i) approving students for admittance to school; (j) choosing which textbooks are used; (k) determining course content; and (l) deciding which courses are offered. This scale indicates the extent to which teachers had responsibility for these activities.

Principal autonomy was derived from the same question described above. In this case, the scale indicates the extent to which principals had responsibility for the various activities.

Conduct informal assessment was derived from school principals' reports on the frequency with which students were assessed using teacher-developed tests, teachers' judgemental ratings, student portfolios, and student assignments/projects/homework, and on how frequently assessment information was formally communicated to parents and the school principal.

Student-teacher relations was based on students' reports of the extent to which they agreed or disagreed with the following statements concerning student-teacher relations: (a) students get along well with teachers; (b) most teachers are interested in students' well-being; (c) most of my teachers really listen to what I have to say; (d) if I need extra help, I will receive it from my teachers; and (e) most of my teachers treat me fairly. The student scores were aggregated to the school level and scaled at the school level.

Disciplinary climate was based on students' reports of the extent to which they agreed or disagreed with the following statements concerning student-teacher relations: (a) the teacher has to wait a long time for students to quieten down; (b) students cannot work well; (c) students don't listen to what the teacher says; (d) students don't start working for a long time after the lesson begins; and (e) there is noise and disorder. The student scores were aggregated to the school level and scaled at the school level.

Achievement press was based on students' reports of the extent to which they agreed or disagreed with the following statements concerning teachers' expectations: (a) the teacher wants students to work hard; (b) the teacher tells students they can do better; (c) the teacher does not like it when students deliver careless work; (d) the teacher checks students' homework; and (e) students have a lot to learn. The student scores were aggregated to the school level and scaled at the school level.

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