Catalogue no. 89-552-MIE, no. 1

Literacy Skills of Canadian Youth

J. Douglas Willms

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International Adult Literacy Survey

Literacy Skills of Canadian Youth

J. Douglas Willms

Atlantic Centre for Policy Research in Education
University of New Brunswick

The International Adult Literacy Survey (IALS) was a seven-country initiative conducted in the fall of 1994. The Canadian component of the IALS study was primarily funded by the Applied Research Branch and the National Literacy Secretariat of Human Resources Development Canada.

Published by authority of the Minister responsible for Statistics Canada

September 1997

Catalogue no. 89-552-MPE, no. 1

Frequency: Irregular

ISSN 1480-1566

ISBN 0-660-17125-2

Ottawa

Opinions are those of the author and do not necessarily reflect those of the granting agencies or reviewers.

Canadian Cataloguing In Publication Data

Willms, J. Douglas
Literacy skills of Canadian youth

Issued also in French under title: Les capacités
de lecture des jeunes canadiens.
ISBN 0-660-17125-2
CS89-552-MPE no.1

1. Young adults -- Education -- Canada -- Statistics.
2. Literacy -- Canada -- Statistics. 3. Young adults --
Canada -- Books and reading -- Statistics.
4. Young adults -- Canada -- Statistics.
I. Statistics Canada. Special Surveys Division.

LC154.W54 1997 302.2’244’08420971
C97-988027-0

Acknowledgements

This report was prepared for Statistics Canada under Contract No. 85300950423. The author is grateful to the Applied Research Branch and the National Literacy Secretariat at Human Resources Development Canada for providing support for this research, to the U.S. Spencer Foundation for its funding of the project, "School and Community Effects on Children's Education and Health Outcomes," and to the Canadian Institute for Advanced Research, which provides the primary funding for the Atlantic Centre for Policy Research in Education. The author is also appreciative of Robbie Case, Patrice de Broucker, Stephan Dupré, Stan Jones, Paul Labelle, Doug Norris, Scott Murray, Monique Bélanger and Michael Wolfson for comments received on an earlier draft of this paper, and of Sandy Harris for help in preparing the manuscript.

Note of Appreciation

Canada owes the success of its statistical system to the long-standing co-operation of 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 goodwill.

Literacy Skills of Canadian Youth

A country's economic performance relies heavily on the ability of its labour market to adapt quickly to developments and changes in the global economy. Neoclassical theories of economic growth claimed that production was simply a function of capital and labour. New theories maintain that production is also a function of knowledge and ideas. The new theories stress that "knowledge workers" at all levels of an organization can contribute knowledge that enhances productivity (Romer, 1993). Moreover, with the increased importance of the service sector and high-technology industries, and the decline of low-skilled manufacturing jobs, the new knowledge workers require greater skills in literacy. "Literacy" refers broadly here to the ability to read and comprehend written materials, including reports, documents, and mathematical charts and displays; to use that information to solve problems, evaluate circumstances, and make decisions; and to communicate that information orally and in writing. Better educated workers constitute only one of several complementary factors needed to energize an economy (Levin & Kelley, 1994). However, a growing body of research shows a relationship between literacy and economic performance thereby lending support to the new economic theories and the calls for a more literate workforce (The Creative Research Group, 1987; DesLauriers, 1990; Snow, Barnes, Chandler, Goodman, & Hemphill, 1991; Statistics Canada, 1991; Shapiro & Purpel, 1993; OECD & Statistics Canada, 1995).

Economic and social inequalities—along social class lines, between the sexes and among ethnic groups—are associated with the distribution of literacy skills. Human capital theories assume a direct relationship between literacy and economic success: in a competitive labour market, individuals' skills and capabilities affect their productivity, which in turn is closely related to their remuneration (Schultz, 1963; Becker, 1964). Inequalities in literacy, therefore, contribute directly to inequalities in income and occupational status, in that those with low literacy skills have restricted access to certain labour markets. Those with high literacy skills are more likely to attain high-paying jobs and be rewarded for their skills. Large studies of occupational attainment have shown that some, but not all, of the disparities in income and employment are attributable to the schooling and literacy levels attained by individuals in high and low status groups (Carnoy, 1995; Raudenbush, Kasim, Eamsukkawat, Liu, & Miyazaki, 1996). These studies not only draw attention to persisting structural inequalities and prejudice in the workplace, they also provide strong evidence that policies which reduce inequalities in schooling and literacy skills also reduce economic inequalities.

Literacy is, itself, a defining characteristic of social class. People become part of a culture by learning to interpret and use its particular signs and symbols (Langer, 1991). They use language in social relations that increase their knowledge and develop their potential. As such, literacy is an instrument of social power. The prominent French sociologist, Bourdieu, used the term "cultural capital" (1977) to describe the values, forms of communication, and organizational patterns possessed by the dominant class. Cultural capital entails a familiarity and knowledge of high culture, and a disposition—what Bourdieu calls "habitus"—toward linguistic and social competencies. Sociologists use this concept to explain why persistent inequalities cannot be fully attributed to human capital. For example, occupational attainment is strongly related to the quantity and quality of schooling children receive during their formative years. But schools are middle-class institutions, which value middle-class language patterns, authority relations, and organizational structures (Lamont & Lareau, 1988). Parents with strong literacy skills feel comfortable relating to school staff and being involved in school activities. Their strong literacy skills give them a range of strategies to achieve the best for their child as they perceive it (Lareau, 1987). Similarly, children raised in middle-class environments possess the "cultural capital" to appreciate the curriculum and adapt to school life.

Because literacy is so central to social and economic status, policy measures that decrease inequalities in literacy are fundamental to achieving tolerance, social cohesion, and an equitable distribution of economic opportunity. The concern that we may be becoming two societies (e.g., Beach & Slotsve, 1996; Canadian Council on Social Development, 1993) encompasses disparities in literacy skills as well as inequalities in income and polarization in labour markets.

Therefore, the level of literacy of a society's youth, and disparities in literacy skills among youth with differing characteristics and family backgrounds, are two important societal indicators. They indicate how the previous generation's investments of material, social, and cultural resources have translated into skills and competencies in the present generation. An explicit goal of public education is to assure equal opportunity across successive generations; therefore, levels of literacy and inequalities mark the success of a society's educational system. But these indicators also measure the pool of economic and cultural capital for sustaining the labour market over the next two or three generations. Thus they stand as measures of past investments and as measures of future success.

The International Adult Literacy Survey

Because literacy skills are central to a country's economic success and social cohesion, seven countries collaborated on the first *International Adult Literacy Survey* (IALS) in 1994 to determine the level and distribution of literacy among their adult populations. The study was to "investigate and compare factors relevant to literacy in a variety of countries" (OECD & Statistics Canada, 1995, p. 55). The seven partners—Canada, Germany, Netherlands, Poland, Sweden, Switzerland, and the United States—were supported by the Organisation for Economic Co-operation and Development (OECD), the European Union Task Force for Human Resources, and UNESCO. The survey entailed a background interview and intensive testing of a representative sample of adults in each country. The background interview questions about the respondents' early linguistic experiences, experiences in the labour force, participation in adult education, and personal and family background. The test covered three domains of literacy—prose, document, and quantitative. These domains encompassed a common knowledge and skill set for "using printed and written information to function in society, to achieve one's goal, and to develop one's knowledge and potential" (OECD & Statistics Canada, 1995, p. 14). The three literacy domains are distinct, however, to accommodate various purposes and presentations for which the information is needed. Prose literacy required participants to read, understand, and use information from texts such as stories and editorials. Document

literacy required readers to locate and use information from texts such as job applications, transportation schedules, and maps. Quantitative literacy required the ability to find, understand, and use mathematical operations embedded in texts—to read weather charts found in the newspaper, for instance, or to calculate interest using a loan chart. Each participant's achievement was expressed by a scaled score for each of the three domains. These scaled scores were grouped into five literacy levels ranging from simple tasks at Level 1 to complex literacy tasks at Level 5. The international report (OECD & Statistics Canada, 1995) described the distribution of literacy scores in each domain for seven participating countries. The Canadian national report (Statistics Canada & Human Resources Development Canada, 1996) provided more detailed findings for Canada.[1]

The national report suggests that the labour market economically rewards those with strong literacy skills and penalizes those with low skills, and that net employment growth in Canada is largely restricted to jobs that demand high literacy skills. Therefore, it is particularly disturbing that a substantial number of Canadian adults scored in the bottom two levels on all three literacy scales. Although over 20% achieved Levels 4 and 5, over 40% were rated at the lower end of the scale at Levels 1 and 2, and of these, nearly 20% were at Level 1. These adults with low literacy skills are likely to see their future economic opportunities further eroded. Canada's overall literacy ratings were comparable to the United States; however, a high proportion of our population achieved the lowest level of literacy in all three domains. The Canadian and American results are markedly worse than those of the European countries in the study, and stand in sharp contrast to Sweden, which had only about 8% of its adult population score at Level 1 (OECD & Statistics Canada, 1995, Figure 3.1).

Purpose and Research Questions

This study examines in greater detail the distribution of literacy skills of Canadian youth. A thorough analysis for this age group is significant for many reasons. Adults aged 16 to 25 can be described as "in transition" from completing their formal schooling to entering the labour market. Thus, the analyses examine the effects of formal schooling on literacy levels. The analyses also examine interprovincial differences in literacy levels and gradients, with substantial implications for educational policies. In Canada, provincial governments have jealously guarded their constitutional jurisdiction over education (Fullan & Stiegelbauer, 1991), and they exclusively determine educational policies. The federal role in education has been limited to transfer payments for postsecondary education, and now federal transfers do not even refer to this level of education (Dupré, 1996). In this setting, interprovincial differences have considerable implications for provincial policy-makers who are accountable for the success of the schooling system. This study includes three sets of analyses.

The first set of analyses examines the relationships between the literacy achievement of all Canadian adults and their family background or personal characteristics:

(1) What is the relationship between the literacy skills of Canadian adults and family background (i.e., mother's education, father's education, father's occupation) and personal characteristics (i.e., sex, age, French or English first language or years speaking the language of the test, years of education, income, employment, occupational status, and type of community)?

These analyses reveal a dramatic relationship between literacy and age, consistent across the ten provinces. Much of the variation in literacy associated with age however, can be accounted for by differences in the schooling and the employment experiences of the respondents. Also, because many Canadians have a first language other than English or French, the analyses examine the effects of having a first language other than the languages of the test.

The second analyses are for youth aged 16 to 25. These analyses also examine the relationships between literacy skills and family background and personal characteristics. Because many youth are completing their formal education, the analysis attempts to estimate more precisely the effects of completing secondary school, college, or university:

(2) Do the relationships specified in (1) above differ for Canadian youth? In particular, what is the effect of completing secondary school and postsecondary education?

The third analyses examine interprovincial differences. A statistical technique called Hierarchical Linear Modelling (HLM) (Goldstein, 1987; Bryk & Raudenbush, 1987), is used to examine data that are nested at two or more levels. In this case, data on individuals are nested within provinces. In these analyses, data for the entire country are used to produce estimates of literacy levels, differences in literacy levels between the sexes, and the relationships between literacy and socioeconomic status (SES) (see Willms & Kerckhoff, 1995). The modelling also yields provincial estimates of literacy levels adjusted for differences in the provincial social class distributions. The following research questions are addressed:

(3) To what extent do provinces vary in their levels of literacy skills for youth (16 to 25)?

(4) To what extent do provinces vary in their SES gradients (i.e., in the relationship between literacy scores and socioeconomic status)?

(5) To what extent do provinces vary in their inequalities in literacy skills between males and females?

(6) Are interprovincial differences in literacy levels associated with performance of a particular group; for example, youth with high versus low SES, or males versus females?

(7) Is some of the variation among provinces in levels of literacy, SES gradients, and sex inequalities attributable to differences in years of schooling and occupation?

The remainder of the paper is in four sections—one section for each set of analyses, and a concluding section that summarizes and discusses the findings. The next three sections include a brief description of the methods and models used and a summary of the findings.

A Model for Describing Adult Literacy Scores

Background

The analyses in this study are based on a model of social mobility commonly used by sociologists (e.g., Bielby, 1981; Sewell, Hauser, & Featherman, 1976; Kerckhoff, 1996). The model presumes that an individual's academic attainment, and ultimately occupational attainment, are largely determined by educational experiences and family origins. In this model, family origins have a direct effect on attainment, through a variety of mechanisms that begin at birth, or even prenatally, as well as an indirect effect through education. For example, the model suggests that children from more advantaged backgrounds are more likely to have access to quality education, and greater financial and cultural capital to support educational activities during the elementary and secondary years. Children with these resources are then more likely to have good grades and financial resources to pursue further education. These experiences contribute to their level of literacy. Literacy is also affected by experiences at

work, and through other experiences related to economic, cultural, and social capital. At this stage, the model is complicated because levels of literacy affect the types of jobs acquired and income obtained, but these, in turn, affect levels of literacy. This model, therefore, attempts to explain variation in literacy by using occupational attainment and income as explanatory variables. It does not attempt to untangle the possible reciprocal relationships between literacy and occupational attainment.

The study employs International Adult Literacy Survey data for Canada, collected in 1994. The data include literacy scores and interview results for a nationally representative sample of 5,660 adults aged 16 to 90. The analysis begins by examining the relationship between the three literacy measures (prose, document, and quantitative) and age. Three effects influence the variation in literacy scores by age: *age* effects—people acquire skills through education and experience, but may lose some skills in their later years; *period* effects—there may be more emphasis on acquiring literacy skills now than in an earlier period; and *cohort* effects—the cohort of Canadian adults born during World War II and the first "baby-boomers" (born between 1947 and 1956) have had more opportunities for education, housing, and good jobs than the later baby-boomers (born between 1957 and 1966) (Foot and Stoffman, 1996). However, the three types of effects are impossible to separate with cross-sectional data (Glenn, 1977).

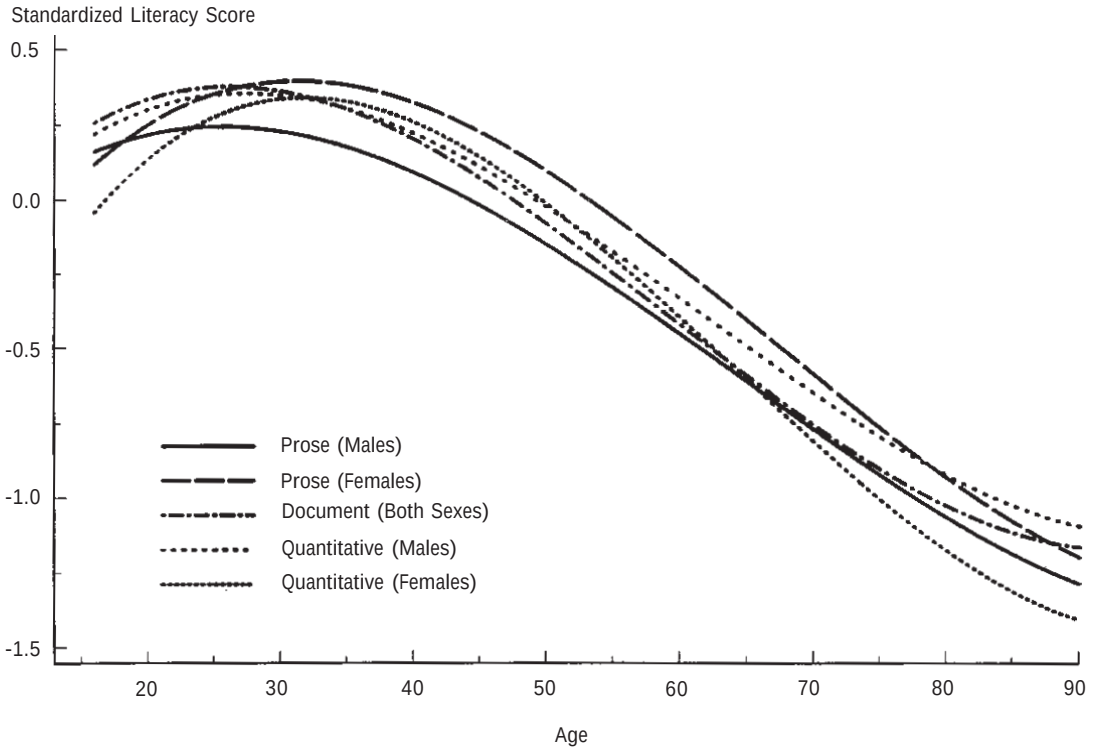
The initial analysis also examines gender differences in the three literacy domains. Gender differences could also be attributable to factors associated with age, period, and cohort effects, and thus these data are unsuitable for understanding the *causes* of these differences.

Literacy Scores by Age, Sex, and Type of Literacy

Figure 1 shows the relationships between the three literacy measures and age. The lines essentially follow the average literacy scores at each age.[2] The scores were standardized to a mean of zero and a standard deviation of one for the full Canadian sample. This standardization makes it easier to compare results across the three measures, and to compare the findings from this study with those of other studies.

The relationship between literacy and age is dramatic. The highest literacy scores on these tests were attained by adults aged (approximately) 20 to 40. After age 40, the scores decline sharply, and continue to decline through to age 90. The relationship with age is not only statistically significant, it is also substantively large: the scores decline more than 3% of a standard deviation per year. Analyses that follow (see Figure 2) will show that much of the decline is associated with the educational attainment of individuals of different ages (i.e., a cohort effect), and not with aging *per se* (i.e., an age effect). Nevertheless, the unadjusted age distribution of literacy scores is important in that literacy proficiency is a key indicator of human capital. Moreover, the age distribution adjusted for adults' schooling experience provides evidence that literacy proficiency is resistant to the effects of aging until late in life.

Figure 1 **Literacy Scores by Age, Sex, and Type of Literacy, 1994 International Adult Literacy Survey, Canada**



The figure shows differences between the sexes for the three tests. Because the differences between males and females in document literacy scores were statistically insignificant (and the sex-by-age interactions were also statistically insignificant), only one line is shown for document literacy. Females scored substantially higher on prose literacy than did males; the difference is apparent at all ages, except for those younger than 20. On average, the difference is about one-quarter of a standard deviation—about the effect associated with two additional years of schooling. (This "years of schooling" metric will be discussed in a separate analysis.) Males performed slightly better than females in quantitative literacy. The difference was only about 4% of a standard deviation on average, but the analysis uncovered sex-by-age interactions that suggest sex differences are larger for youth (aged 16 to 25) and for adults older than 60.

The analyses shown in Figure 1 were repeated for each province. Provinces vary substantially in their literacy scores. However, some of this variation is attributable to sampling error. The sample sizes for some provinces are small, and therefore, average literacy scores cannot be accurately estimated across the full age range. An examination of interprovincial differences in literacy scores for youth aged 16 to 25 is reported below, based on results from a statistical technique that accounts for sampling error (see Figure 4).

The Full Model. Table 1 presents the results for the full model [3] describing adults' literacy scores on each of the three literacy tests. In these analyses, the coefficients are unstandardized. They show the change in literacy scores, expressed as a fraction of a standard deviation (i.e., an effect size), for a one-unit change in the independent variable, given other variables in the model are held constant. In the case of categorical (dummy) variables, the coefficient represents the difference (again expressed as an effect size) between the described category and the reference category, given other variables in the model are held constant.

Table 1 Regression Analysis Predicting Literacy Scores with Respondents' Characteristics, 1994 International Adult Literacy Survey, Canada

	Prose		Document		Quantitative	
Respondent's Characteristics	b	SE	b	SE	b	SE
Constant	-.055*	.023	.036	.024	.126**	.024
Female (Male = 0)	.223**	.021	.040	.021	-.008	.021
Age (43 Years = 0)						
Linear	-.001	.001	-.008**	.001	-.001	.001
Quadratic ($x10^3$)	.145**	.049	.143**	.049	-.038	.049
Cubic ($x10^6$)	-10.135**	1.573	-6.436**	1.582	-6.443**	1.560
Other Language (Test Language = 0)	-1.373**	.087	-1.232**	.088	-.935**	.087
Years Speaking Language (20 Years = 0)						
Linear	.068**	.010	.055**	.010	.049**	.010
Quadratic ($x10^3$)	-1.412**	.313	-.973**	.315	-1.176**	.310
Cubic ($x10^6$)	10.242**	2.803	6.688*	2.819	9.698**	2.781
Employment Status (Employed = 0)						
Student	.130**	.046	.029	.046	.087	.045
Homemaker	.257**	.048	.012	.048	.145**	.047
Unemployed	-.027	.043	-.038	.043	-.198**	.042
Retired	-.028	.048	-.097*	.049	-.065	.048
Income	.004**	.001	.004**	.001	.003**	.001
Missing Income	-.098**	.029	-.060*	.029	-.154**	.029
Occupational Status (Standardized)	.022	.013	.039**	.013	.034**	.013
Missing Occupational Status	-.132**	.040	-.034	.041	-.098*	.040
Years Education	.135**	.003	.120**	.003	.132**	.003
Mother's Education (Grade 8 = 0)	.013**	.003	.019**	.003	.019**	.002
Father's Education (Grade 8 = 0)	.007**	.003	.007**	.003	.007**	.002
Father's Occupation (Standardized)	-.006	.011	.020	.011	.034**	.011
Rural Community (Urban = 0)	.148**	.025	.103**	.025	.111**	.025
R-Squared	.546		.541		.554	

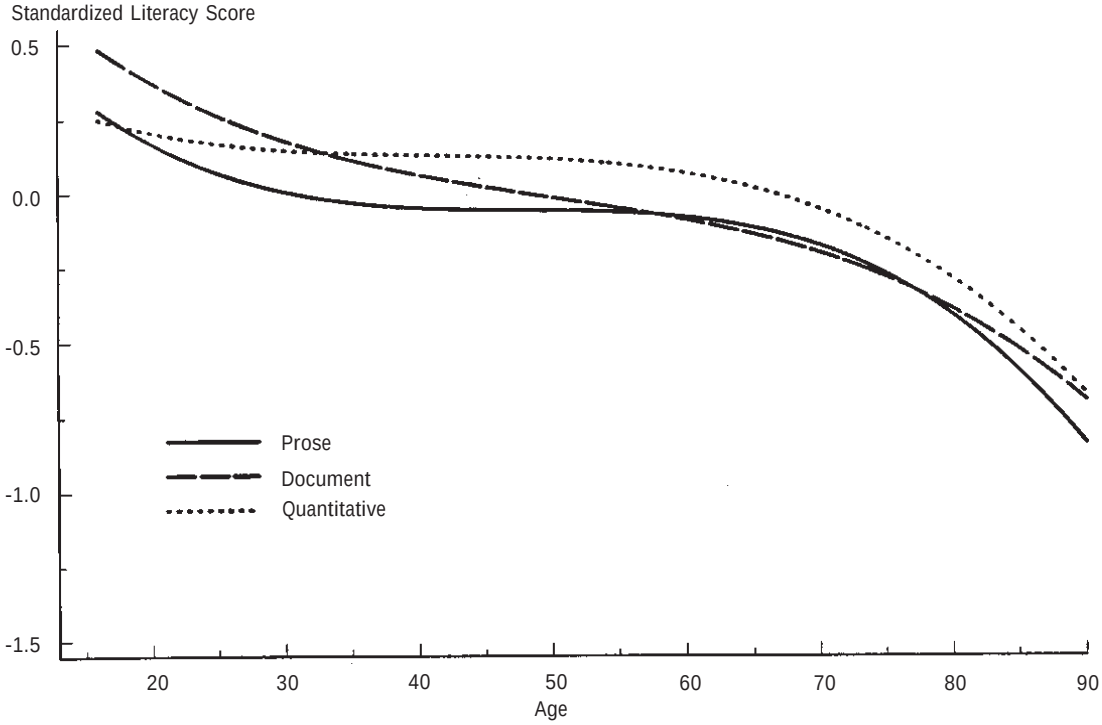
* $p<.05$.

** $p<.01$.

Sex Differences. Males and females differed in their prose scores by about 22% of a standard deviation, slightly less than the effect in Figure 1. The sex differences on the document and quantitative scores were small and not statistically significant.[4]

Age Effects. The three coefficients for age (linear, quadratic, and cubic) together describe the relationships between literacy and age, after accounting for other factors in the model. The cubic coefficients are statistically significant for all three tests; thus it is necessary to include all three age effects in the model. The relationships are depicted in Figure 2. For the prose and quantitative scores, the figure indicates a modest decline in literacy scores between age 16 and 25, and thereafter, virtually no relationship with age until age 65, when it declines further. The document scores follow the same pattern, except that they decline modestly but steadily between age 25 and 65.

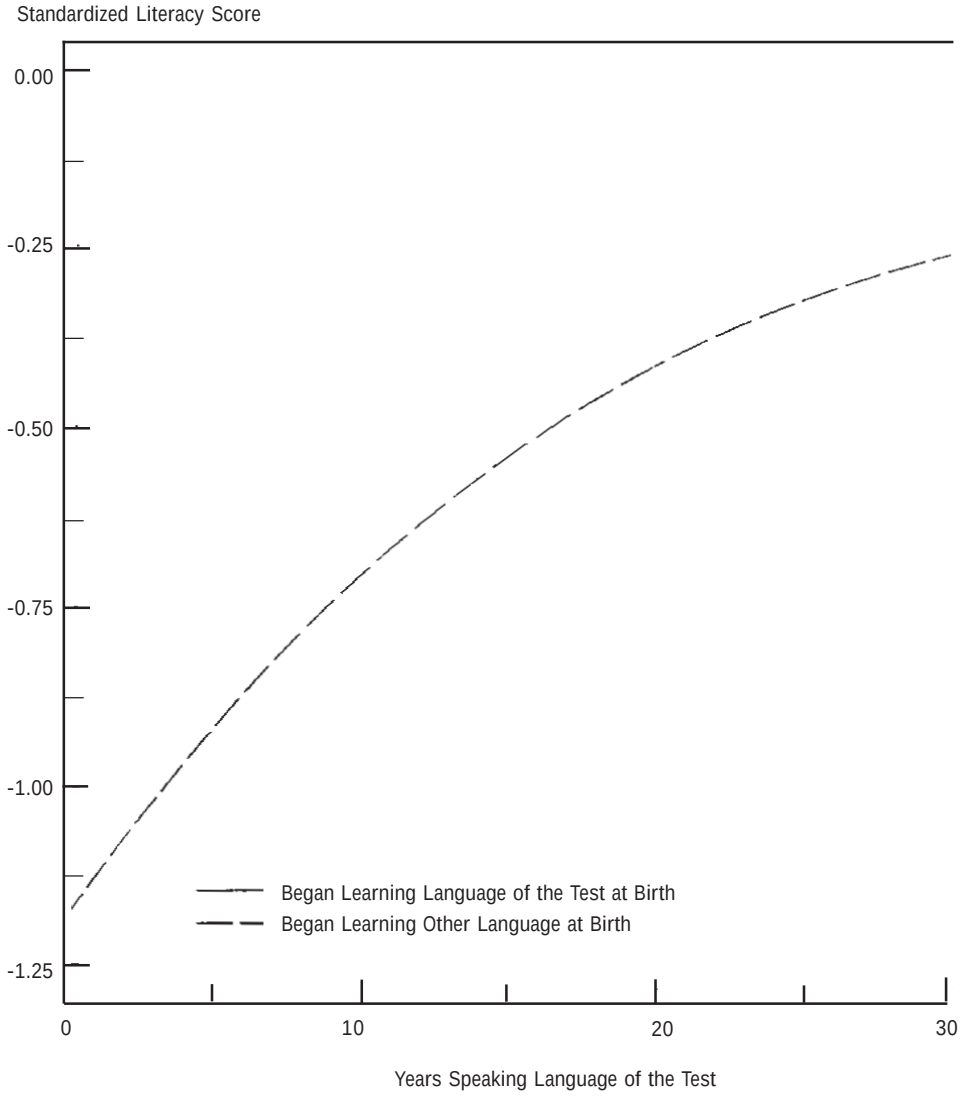
Figure 2 **Literacy Scores by Age, Adjusted for Respondents' Background, 1994 International Adult Literacy Survey, Canada**



Other Language. The effects on literacy associated with being in a minority group are complicated. Many Canadians have one parent who was born in Canada, and another born elsewhere. Others have two parents who were born outside of Canada, but who spoke either English or French in their country of origin. Some second or third generation Canadians may face prejudice and discrimination because they may be in minority in their community. Variables such as "time spent in Canada" or "country of origin" do not capture these effects. After examining several assessments of how cultural background might affect literacy scores, the best, and perhaps simplest, approach seems to be to discern whether the respondent's first language was one of the test languages (French or English), and if not, the length of time they had spoken the language of the test.

The effects of having a first language other than English or French are dramatic. They are shown graphically in Figure 3, using the overall literacy score (i.e., the average of the three literacy tests combined).[5] As expected, a large difference exists—more than one full standard deviation—between the literacy scores of people whose first language was English or French compared with those who had a different first language. Also as expected, this gap narrows slowly over time. Even after 30 years of having spoken the language of the test, a gap of over 25% of a standard deviation remains. This gap translates to about two years of schooling (as described in the years of education metric discussed later).

Figure 3 **Average Literacy Score by First Language Learned, 1994 International Adult Literacy Survey, Canada**



Employment and Occupational Status and Income. The next set of coefficients describes the effects of employment and income on literacy. The model includes four dummy variables describing employment status (student, homemaker, unemployed, and retired), with "employed" as the reference category. The effects of being a full-time student are positive, although statistically significant only for prose. For example, adults who were full-time students scored 13% of a standard deviation higher on prose literacy than those who were employed, given other factors in the model were held constant. Generally the results indicate positive effects associated with being a student or homemaker, and negative effects associated with being unemployed or retired. Note, however, these effects are net of other factors included in the model. The variables include two dummy variables used when a respondent was missing income or occupation data. Both of these variables have large negative coefficients that probably capture many of the negative effects of prolonged unemployment.

The results show a relatively strong effect for family income, and a moderate effect for occupational status. The income effect is about 0.3% to 0.4% of a standard deviation for each $1,000 of additional income. Thus the literacy score of someone with a $60,000 income would be 9% to 12% of a standard deviation higher than someone with an income of $30,000, other factors being held constant.

The effects of occupational status are statistically significant for document and quantitative literacy, but are relatively small—on average less than 4% of a standard deviation for a one-standard deviation increase in occupational status.

Years of Education. One of the strongest effects on literacy scores is the respondent's years of education. Each year of schooling translates to increased literacy scores of about 12% to 13.5% of a standard deviation. This relationship is estimated with a high degree of accuracy (standard error is 0.003) making it a useful metric for considering the importance of other effects. For example, female advantage in prose literacy (22.3% of a standard deviation) is the same as about one-and-two-thirds additional years of schooling.

Parents' Socioeconomic Background. The education levels of respondents' parents were significantly related to literacy scores. The observed effects are relatively small, however, because most of the parental background influences are captured by the respondents' education and occupation measures. Interestingly, the effect of the mother's education is about twice that of the father's education. This finding is common among studies of children's early literacy development (e.g., see Willms, 1996).[6] The effect of father's occupational status was statistically significant only for quantitative skills, and was relatively small.

Type of Community. About one-sixth of respondents lived in rural areas. On average, they scored as well on the prose test as did urban residents. Rural respondents averaged 7% of a standard deviation lower on the document test, and 9% lower on the quantitative test than urban residents. However, the regression results show rural residents scoring higher than urban residents once the respondents' background characteristics are taken into account. The effect translates to about one additional year of schooling.

The Effects of Schooling and Background on Youth Literacy Scores

The remaining analyses are for youth aged 16 to 25 in 1994. These analyses examine the effects on literacy of completing high school and attending a postsecondary institution. They also examine the strength of the relationships between literacy and background factors that were reported for all adults in Table 1.

Table 2 displays the results of a regression analysis for this cohort. The first model examines the relationship between literacy scores and educational attainment. Because most youth were completing their formal schooling, their ultimate level of education could not be determined. Four variables were constructed using information from two survey questions—one on the respondent's highest level of education, and the other on participation in training toward an elementary or secondary diploma or some postsecondary credential. The categorical variable, *High School* (the reference category in the regression analysis) refers to youth who had completed high school, or those who were younger than 20, were still in school, and were working towards a high school diploma. Therefore, *Dropout* refers to youth who had not completed high school and were no longer in school, and youth who had not completed high school and were older than 20. The variable, *College*, refers to youth who had completed some non-university postsecondary training, or youth who had completed high school and were taking some non-university postsecondary training. The variable, *University*, refers to those who had completed a university degree, or youth who had completed high school and

were pursuing a university degree. With this coding, the estimated effect for *College* is the increment to literacy scores associated with attending college, compared with the scores for those with high school or those unlikely to pursue a college diploma. The estimated effect for the variable, *University*, can be interpreted in the same way. This classification likely underestimates college or university effects, as the high school category includes some 20-year-olds who had not yet completed high school (but who may eventually have been university or college bound).

Table 2 Regression Analyses Predicting Effects of Schooling on Youth Literacy Scores, 1994 International Adult Literacy Survey, Canada

	Prose				Document				Quantitative			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	b	SE	b	SE	b	SE	b	SE	b	SE	b	SE
Constant	.193**	.045	.282**	.044	.240**	.049	.381**	.047	.010	.047	.201**	.047
Amount of Schooling (High School = 0)												
Dropout	-.365**	.060	-.299**	.051	-.382**	.065	-.297**	.054	-.208**	.062	-.158**	.055
College	.212**	.066	.066	.056	.349**	.071	.217**	.059	.341**	.068	.217**	.060
University	.590**	.068	.391**	.059	.644**	.072	.429**	.062	.741**	.070	.528**	.063
Female (Male = 0)			.103**	.039			-.062	.041			-.165**	.042
Other Language (Test Language = 0)			-2.005**	.124			-2.020**	.131			-1.544**	.133
Years Speaking Language (20 Years = 0)												
Linear			.293**	.027			.307**	.029			.245**	.029
Quadratic ($x10^3$)			-10.030**	1.337			-9.900**	1.410			-8.671**	1.428
Occupational Status (Standardized)			.060**	.025			.073**	.026			.106**	.027
Missing Occupational Status			-.087	.052			-.105	.055			-.049	.055
Mother's Education (Grade 8 = 0)			.030*	.006			.042**	.006			.041**	.006
Father's Education (Grade 8 = 0)			.011*	.005			.010	.005			.007	.006
Father's Occupation			.082**	.020			.095**	.021			.091**	.021
R-Squared	.206		.468		.219		.492		.202		.422	

* $p < .05$.

** $p < .10$.

The first model simply indicates differences in the average scores among youth classified into these four categories. For prose literacy, the average score for dropouts is 36.5% of a standard deviation lower than for high school graduates. The difference for document literacy is comparable, but the difference for quantitative literacy is less—only 20.8% of a standard deviation. College graduates (or those enrolled in college courses) scored 21.2% of a standard deviation higher than high school graduates on the prose test, and nearly 35.0% of a standard deviation higher on the other two tests, suggesting that higher education has a stronger effect on document and quantitative literacy. The estimates for university attendance are considerably larger, ranging from 59.0% to 74.1% of a standard deviation. Again larger effects are associated with document and quantitative literacy.

The first model's estimates include both schooling effects and selection effects; that is, youth attending college or having completed a college diploma are likely to have higher literacy scores because of their college training, but also because they are more likely to apply for and be accepted into college than youth with low literacy scores. The second model attempts to control for some of the selection effects by including controls for sex, having a first language other than the language of the test, occupational status, and parents' background characteristics. (The model is not as extensive as the model presented in Table 1, because a number of variables were statistically insignificant or had very small effects for youth.)

One result, immediately apparent, is that the effects associated with dropping out of school remain large and statistically significant. Dropouts had prose and document literacy scores about 30% of a standard deviation lower than those who had completed high school; the gap for quantitative literacy was less at 6% of a standard deviation. Moreover, the estimated differences between dropouts and high school graduates were only slightly reduced when the control variables in the second model were included. This suggests that the lower scores associated with dropping out are not simply an artifact of the respondent's family background. In this study, the difference in literacy scores between dropouts and those who completed high school translates to two years of additional schooling. Raudenbush *et al.* (1996) observed similar effects for completing high school, and in their study, dropouts were one-and-two-thirds times as likely to be unemployed than those who had earned a high school diploma. Projecting United States findings to Canada requires caution; however, the effects are likely to be large here also, especially given the generally high unemployment among youth.

The extended models in Table 2 show that including control variables for family background reduces the effects associated with attending college by nearly one-half, and the effects associated with attending university by about one-third. The adjusted effects are, however, statistically significant. If it takes about one-and-a-half years, on average, to obtain a college diploma, and about four years to obtain a university degree, the estimated effect for postsecondary training is roughly 11% of a standard deviation per year. This is close to the effect of one additional year of schooling observed for all Canadian adults in the first analysis.

The results in Table 2 also provide estimates of the effects of family background on youth literacy. Mother's education is a strong and statistically significant predictor of literacy scores: each additional year of mother's education is associated with a 3% of a standard deviation increase in prose scores for youth, and over 4% of a standard deviation increase in document and quantitative scores for youth. These effects are more than twice the effects for mother's education estimated for all Canadian adults. The effects of father's education were of about the same magnitude as those estimated for all Canadian adults, but were statistically significant only for prose. Father's occupation, however, had a strong and significant effect. A one standard deviation increase in the (prestige) score associated with father's occupation was associated with about 8.2% to 9.5% of a standard deviation increase in literacy scores.

Taken together, the three parental background measures are powerful determinants of the literacy scores of Canada's youth. For example, consider two youth of the same sex, and with the same schooling and occupational experience. One youth had parents who had dropped out of school after grade 10, and the father was in a skilled manual occupation (e.g., a skilled agricultural or fisheries worker, or a machine operator). The other youth had parents who had completed two years of postsecondary education, and the father was in a skilled non-manual occupation (e.g., a clerk, service worker, or a market sales worker). These results suggest that the youth with the less educated parents would score about 30% of a standard deviation lower than one with the more educated parents. This is slightly more than the effect associated with a youth remaining in formal schooling for at least two additional years.

Inter-Provincial Differences in Literacy Scores for Youth

Average Literacy Levels

The third set of analyses examines provincial variations in average literacy scores for youth, in gender scores, or in socioeconomic status gradients. The results of these analyses are presented in Table 3 and in Figures 4 and 5. The analyses used a single measure of literacy, which is the respondent's average score for the three tests, standardized on the full Canadian adult population (see Footnote 4).

Table 3 Hierarchical Regression Analyses of Inter-Provincial Diffferences in Literacy Scores for Youth

	Model 1		Model 2		Model 3	
	b	SE	b	SE	b	SE
Average Within Province Equation						
Constant	.294**	.051	.340**	.041	.288**	.041
Female (Male = 0)			-.007	.070	-.024	.063
Socioeconomic Status (SES)			.282**	.042	.197**	.031
Occupational Status					.034*	.020
Missing Occupational Status					-.103**	.044
Years Education					.131**	.007
Other Language (Test Language = 0)			-2.168**	.133	-1.607**	.123
Years Speaking Language (20 Years = 0)						
Linear			.240**	.029	.219**	.026
Quadratic (x10^3)			-.006**	.001	-.007**	.001
Variation Among Respondents	.5986		.3818		.2936	
Variation Among Provinces						
Average Literacy Level	.0202**		.0124**		.0126**	
Sex Differences			.0335**		.0259**	
SES Gradients			.0136**		.0062**	
Proportion Variance Explained						
Among Respondents			35.2		50.2	
Among Provinces			38.6		37.6	
Correlation Between Parameter Variances	(1)	(2)	(3)	(1)	(2)	(3)
Average Literacy Level (1)	1.00			1.00		
Sex Differences (2)	-.39	1.00		-.11	1.00	
SES Gradients (3)	-.72	-.07	1.00	-.57	-.19	1.00

* p<.05.

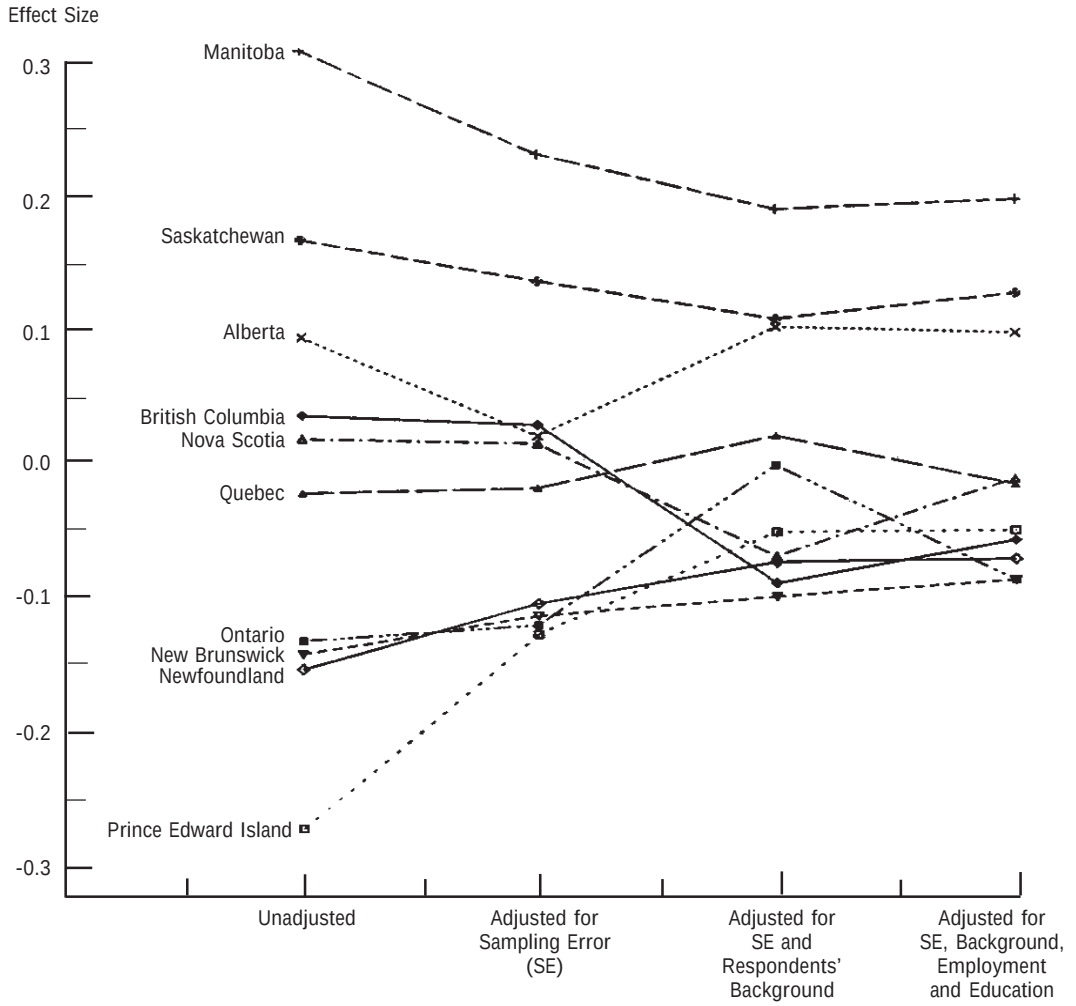
** p<.10.

Estimates in the first column of Table 3, and the first two sets of effect sizes displayed in Figure 4, were derived from a "null hierarchical linear model,"[7] which simply separates the variation in literacy scores into within- and among-province components. The first estimates in Figure 4 display unadjusted provincial means, expressed as deviations from the national mean. They suggest there is substantial variation among the provinces, with scores ranging from about -0.30 to 0.30. Recall that an effect of about .12 to .13 is associated with one additional year of schooling, so a range of 0.60 indeed represents substantial variation. Some of the variation is undoubtedly attributable to sampling error. The mean scores for Manitoba and Prince Edward Island, for example, were based on relatively small sample sizes, and therefore extreme scores could be due to random variation associated with sampling. However, some of the variation is "true" variation. It stems from historical differences in educational attainment in both the previous and current generations, differences in demographic

composition, differences in the quality of education, differences in the occupational and industrial structure, and a host of other factors.

The hierarchical analysis determines how reliably each mean score was estimated. It also calculates an estimate of the "true" variance among the provinces that is smaller than the "observed" variance displayed by the first set of estimates because the observed variance includes measurement and sampling error. The analysis also estimates provincial means that have been shrunken towards the national mean according to how reliably each mean was estimated. The first column of Table 3 displays the results for the null model. The grand mean for this cohort is 0.294, which indicates that the average youth scored about 30% of a standard deviation above the mean for the entire adult population. Approximately 96.7% of the variance in youth's scores was within provinces [i.e., 0.5896/(.5896+.0202)], and 3.3% was among provinces. Although 3.3% appears small, it is statistically significant, and is large in substantive terms. It is also much larger, for example, than the variation among Local Education Authorities in Scotland in pupils' educational attainment upon finishing secondary school (Willms, 1987), or the variation among English and Welsh Education Authorities in pupils' reading scores at age 16 (Willms & Kerckhoff, 1995).

Figure 4 **Average Literacy Scores for Youth by Province, 1994 International Adult Literacy Survey**



The second estimates in Figure 4 are shrunken; that is, they were adjusted for sampling error. Prince Edward Island and Manitoba, for example, which had relatively small sample sizes, were shrunken considerably; whereas Ontario and New Brunswick, which had relatively large sample sizes, were shrunken very little. These estimates can be considered the mean scores we would expect to obtain if we repeated the study under similar conditions. The variation among the provinces in these estimates is associated with a number of factors, including family, school and community influences.

The second model includes measures of the respondents' sex, socioeconomic status, and first language (language of the test or years speaking the language of the test).[8] The estimated national average is 0.340, which is the expected score of a nationally representative mix of female and male youth who are of average SES and whose first language was one of the test languages. The coefficient for *Female* is -0.007, which indicates that on average, across the ten provinces, there are no significant differences between females and males in their literacy scores. The estimate for *Socioeconomic Status* is 0.282, which is the national average SES gradient. The inclusion of these variables accounts for about 35% of the variation among respondents within provinces (variation was reduced from 0.5896 to 0.3818), and 39% of the variation among provinces (variation was reduced from 0.0202 to 0.0124).

The variation among provinces in their adjusted average scores is displayed by the third set of estimates in Figure 4 (and in the first column of Table 4). A youth with average SES attained considerably higher scores in Manitoba, Saskatchewan and Alberta, and considerably lower scores in Ontario, New Brunswick and Newfoundland. The scores for Quebec and Prince Edward Island were close to the national average. The estimates from this model better indicate the effects associated with schooling because some, but likely not all, of the family background effects have been removed. Some of the variation among provinces is probably also associated with social and economic influences that lie outside the school (e.g., see Raffe & Willms, 1989).

Table 4 Variation Among Provinces in Levels of Literacy, Sex Differences, and Socioeconomic Gradients

	Literacy Level	Sex Differences	SES Gradient
Average Level	**.340**	**-.007**	**.282**
Differences from Average Level			
Newfoundland	-.078	.015	.072
Prince Edward Island	-.055	-.146	.068
Nova Scotia	-.073	-.032	.144
New Brunswick	-.104	.185	.042
Quebec	.018	.123	-.140
Ontario	-.005	-.180	.059
Manitoba	.187	-.244	-.089
Saskatchewan	.105	.104	-.114
Alberta	.099	-.011	-.123
British Columbia	-.094	.186	.081

A plausible hypothesis, then, is that some provincial variation in literacy scores is attributable to the time youth spend in school and their employment experiences after completing formal schooling. The third model extends to include years of schooling and occupational status of the respondent. These factors explain an additional 15% of the variation among respondents within provinces, but do not explain any of the interprovincial differences in average literacy scores. Years of schooling and occupational success, did, however, reduce the SES gradient from 0.282 to 0.191, which suggests that some of the inequalities associated with parental background are attributable to these factors. The inclusion of these factors also

explained over half of the variation among provinces in their SES gradients, which is discussed in the next subsection.

Sex Inequalities

The second model in Table 2 shows significant variation among the provinces in their sex inequalities and SES gradients. Although nationally there were no sex differences on the full literacy test (the estimate -0.007 was not statistically significant), the provinces did vary substantially in their sex differences. The variance was 0.0335 (i.e., a standard deviation of .183), which is statistically significant ($p<.01$). The "shrunken" estimates of the sex differences for each province are shown in the second column of Table 4. Two provinces[9]—Ontario and Manitoba—have substantially large sex differences in literacy favouring males, while two other provinces—New Brunswick and British Columbia—have large sex differences favouring females. In these last two provinces, the sex difference is more than .15 of a standard deviation, which suggests that the sex with the lower scores would need at least one more year of formal schooling to redress the inequality. The correlation between adjusted average literacy scores and the inequality between males and females is -0.39 (see bottom of Table 3), suggesting that provinces with high average scores have sex differences favouring males. However, Manitoba is an outlier, and when data for that province are removed the correlation is negligible.

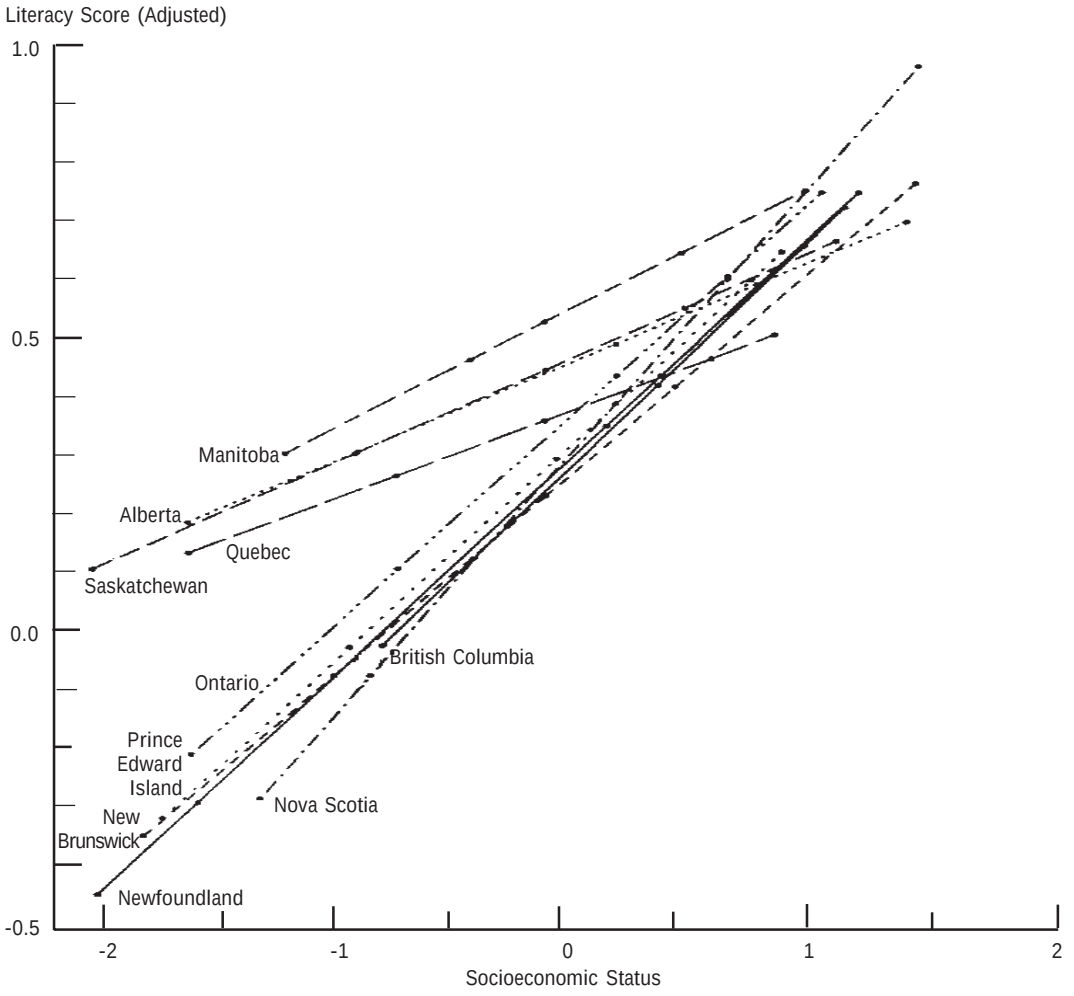
Results from another investigation support these findings. Appendix A shows the relationship for males and females between reading scores on the 1996 Grade 6 Assessment and a measure of socioeconomic status.[10] The dramatic difference between boys and girls, which is especially large for low socioeconomic status students, is consistent with the findings in the IALS data for young adults.

SES Gradients

The national SES gradient for youth literacy scores was 0.282. However, the analysis reveals substantial variation among the provinces in their SES gradients. The variance in gradients was 0.0136 (i.e., a standard deviation of 0.117), which is statistically significant ($p<.01$). The "shrunken" gradients are shown in the third column of Table 4. The provinces are clustered into two distinct groups: Quebec and the three Prairie provinces have relatively shallow gradients, and British Columbia, Ontario, and the four Atlantic provinces have relatively steep gradients. Moreover, the analysis shows that provinces with high adjusted average scores tend to have shallow gradients: the correlation between average levels of literacy and gradients is -0.72.

Figure 5 displays the gradients for each of the ten provinces.[11] Two conclusions are immediately apparent: (1) provinces that do well overall do so by raising the levels of performance of their youth from lower socioeconomic backgrounds; (2) differences among provinces are relatively small when considering youth from average or above average socioeconomic backgrounds, but there are large differences among provinces in the performance of youth from lower socioeconomic backgrounds.[12]

Figure 5 **SES Gradients for Youth by Province, 1994 International Adult Literacy Survey**



The third model presented in Table 3 suggest that at least half of the variation among provinces in SES gradients is associated with years of schooling and early occupational success. The variance in SES gradients decreases from .0136 (SD=.112) to .0062 (SD=.079) when controls for these factors are in the model. Nearly all the reduction is associated with years of schooling—the variance of the gradients is .0063 without occupational status in the model. Therefore, part, but not all, of the explanation for the large variation in gradients may be explained by young adults from lower socioeconomic backgrounds remaining in school longer in provinces with shallow gradients. This hypothesis warrants further investigation using more detailed data on retention rates from each province.

Summary and Conclusions

This study used data from the 1994 International Adult Literacy Survey (IALS) to examine the distribution of literacy scores of Canadian adults. The analysis set out a general regression model for explaining variation in adult literacy scores, and used this model to conduct detailed analyses on the effects of schooling and interprovincial differences in the literacy scores of youth. The nine principal conclusions from the work are summarized and discussed below.

(1) ***Large effects associated with age.*** **The literacy skills of Canadian adults older than 45 were markedly lower than the skills of adults aged 16 to 45 (see Figure 1); however, most of the difference is attributable to respondents' socioeconomic background, years of education, and whether their first language was the test language (see Table 1 and Figure 2).**

The relationship of literacy skills with age is not surprising; however, two important aspects of the relationship warrant discussion. One is the magnitude of the relationship: adults older than 65 had very low average scores—more than one standard deviation lower than the national average—and the average scores of those who will be reaching retirement age over the next ten years are not much higher. Although most of these adults have sufficient literacy skills to meet their daily needs and contribute to their quality of life, a large minority have very low skills. As this latter group ages, they are likely to require considerable assistance from family members and social agencies. Moreover, evidence is growing that literacy, economic self-sufficiency, and health are associated (Borjas, 1995; Britton, Fox, Goldblatt, Jones, & Rosato, 1990; Hertzman, 1994; Ross & Wu, 1995). Communities and governments may find investments in educational programs that both increase adult literacy skills and meet some of the recreational needs of older adults will bring reduced costs for medical care and social assistance.

A more uplifting aspect of the literacy-age relationship is that the baby-boomers—those aged 28 to 47 at the time of the survey—have strong literacy skills. This group is a third of the Canadian population and holds many influential jobs in the public and private sectors. Consequently, as our population ages over the next decade, the "pool of ability", in terms of literacy skills, will increase dramatically. This should strengthen the Canadian economy; however, it may also heighten competition for jobs and drive up entry requirements, especially if the skills demanded by the labour force increase during this period.

(2) ***Sex differences in prose and quantitative literacy.*** **Female scores in prose literacy were higher than those of males across the full age range 16 to 90. However, no statistically significant differences existed between the sexes in document literacy scores. Males scored higher in quantitative literacy than females; however, the differences were evident only for youth (16 to 25) and for adults older than 65 (see Figure 1, and Tables 1 and 2)**.

These differences were evident even after accounting for adults' occupational status, income, and years of education. After controlling for these factors, the female advantage in prose literacy was equivalent to about two years of schooling (i.e., about one-quarter of a standard deviation) for all adults (Table 1), and about one year of schooling (i.e., one-tenth of a standard deviation) for youth aged 16 to 25. On the quantitative literacy test, the male advantage for youth was just over one full year of schooling.

Girls tend to do better in reading throughout their schooling years. In the recent study conducted by the International Association of the Evaluation of Educational Achievement (IEA) (1992), girls scored higher than boys at age 9 in all 27 participating countries. On average the difference was 11.6% of a standard deviation. At age 14, the average difference was only 7.1% of a standard deviation for 31 participating countries. British Columbia was the only province participating as a "member country". In British Columbia, females outperformed males by 11% of a standard deviation at age 9, and 21% of a standard deviation at age 14. British Columbia was one of only three "countries" with significantly larger sex differences at age 14 than at age 9. Those findings are consistent with the findings for youth aged 16 to 25 in this study, where British Columbia had 18% of a standard deviation difference favouring females. British Columbia ranked 5th in the IEA study, 7% of a standard deviation behind Sweden, and 21% of a standard deviation behind Finland.[13] If the males in British Columbia had scored as well as the females, it would have tied with Hungary for second place internationally, only 10% of a standard deviation (about six months of schooling on the international scale) behind Finland.

Twenty years ago, studies of elementary and secondary achievement suggested that girls did better than boys in mathematics during early elementary years, but that boys reached the same level as girls by the end of elementary school, and surpassed them by the end of high school (Block, 1976; Fennema, 1984; Fox, 1980). Ma and Willms (1996) found that for a large representative sample of American high school students, males and females were equally likely to enrol in advanced mathematics courses through to grade 11, but in the transition from grade 11 to grade 12, females were more likely to drop mathematics. If this is the case for Canada, it would account for most of this study's sex differences in quantitative literacy scores. Given that mathematics is often considered the "critical filter" for access to many postsecondary programs and participation in rewarding segments of the labour market, females may be at a substantial disadvantage upon entering the labour market, despite their superior skills in non-quantitative literacy. Moreover, inequality in literacy measure is likely to hinder gender equality in the labour market.

(3) ***Large effects for staying in school.*** **Years of education is one of the strongest predictors of literacy scores. Youth who dropped out of secondary school scored substantially lower (about 16% to 30% of a standard deviation) than those who completed high school (or were on schedule for completing high school). Adults who were attending or had completed college had scores that were about 22% of a standard deviation higher in document and quantitative literacy (but only 7% higher, and statistically insignificant for prose literacy) than high school graduates. Those who were attending or completed university scored about 40% to 50% of a standard deviation higher than those who had only completed secondary school. These results held after controlling for respondents' family background, first language learned, and occupational experience.**

Overall, for youth and for adults older than 25, each year of formal schooling is associated with about 12% to 13.5% of a standard deviation, other factors being held constant (Tables 1 and 2). This is a useful figure as it can gauge what gains in literacy might be realized through policies that keep certain subgroups of the population in school for a longer period. However, the quality of schooling plays an important role too. In a study of children's growth in mathematics skills in one British Columbia school district, Willms and Jacobsen (1990) found that students with average ability on the Canadian Cognitive Ability Test at age 8 gained about two months of schooling per year more, from grade 3 through to grade 7, if they had attended one of the four best-performing schools in the district than if they had attended one of the four worst-performing schools. In most well-controlled national studies of school achievement, the variation in schooling outcomes equals at least one-half of a standard deviation (i.e., about one full year of schooling) by the time children reach the end of the eighth grade (see Willms, 1992; 1996).

These differences are important to provinces, especially when considering structural changes to secondary systems and devolvement of transfer payments for postsecondary education. For example, Ontario is changing its secondary system, such that students graduate after grade 12 instead of grade 13. This might increase overall levels of schooling if students who would have dropped out after grade 11 see their way to staying for one more year. Or, the change may result in more high school graduates being available to pursue a two- or four-year postsecondary program. Given the effects of educational attainment and literacy on the likelihood of employment, these changes need to be monitored closely as they could have profound social and economic costs.

(4) ***Other Language.*** **As expected, adults whose first language differed from the test language scored substantially lower than those whose first language matched the language of the test. However, the gap does not close quickly, and even after 30 years, a gap representing two years of formal schooling still remains (see Figure 3).**

After five years of being exposed to English or French, most non-indigenous speakers might be expected to score close to the average of those whose first language was the test language, other factors being equal. But these findings suggest that this is not the case for most Canadians: the learning curve is long. The samples in this study do not allow for a detailed study of learning curves for people with differing backgrounds or for those who begin learning a new language early in life compared with those who begin later. These results suggest, however, that tracking the progress of a representative sample of Canadian immigrants would be useful in discerning conditions for rapid growth in literacy acquisition.

(5) ***Community Effects.*** **Adults in rural communities scored slightly lower than those in urban areas (a difference of about five months of formal schooling); however, after accounting for their background characteristics, rural adults scored higher with a difference of about one full year of schooling (Table 2).**

This is unlikely to be a "school effect" attributable to better schooling in rural areas; most large studies of school effects do not indicate that either rural or urban schools in developed countries have stronger effects (e.g., see Ho & Willms, 1996; Willms & Warwick, 1996). The effect more likely arises from differences in the way rural and urban residents maintain and improve their literacy skills through their employment experiences and personal activities. Or, it may simply be a selection effect, if the IALS measures of income and parental occupation under-represent the economic and cultural capital available to rural residents. Regardless of the source of the effect, these results belie any misconceptions that low scores in literacy are attributable to the proficiency of the rural population.

(6) ***Provinces vary in literacy skills:*** **The ten provinces varied substantially in their literacy scores. The unadjusted results for youth can be clustered into three groups, with Manitoba and Saskatchewan scoring more than one year of schooling above the national average; British Columbia, Alberta, Nova Scotia, and Quebec scoring near the national average; and Ontario, New Brunswick, Newfoundland and Prince Edward Island scoring the equivalent of about one year of schooling below the national average (see Figure 4).**

About three-eights of the variation among the provinces was attributable to differences in youths' socioeconomic background. After adjusting for socioeconomic differences, the provinces cluster into two distinct groups, described in conclusion (8).

This study's variation among provinces is comparable to the variation in reading and writing scores of 16-year-old students observed in the 1994 School Achievement Indicators Program (SAIP) (Council of Ministers of Education, Canada, 1994).[14] The SAIP data do not include measures of socioeconomic status, so it is impossible to estimate adjusted estimates with the SAIP data. Saskatchewan did not participate. Also, the percentage of students who participated varied considerably within provinces, from a low of 76% to 77% in British Columbia to a high of close to 90% in some provinces. Often schools with poorer performance are less likely to participate; thus, the SAIP estimates of the mean are likely to be biased upward due to non-response. Nevertheless, the IALS unadjusted (Empirical Bayes) estimates correlated 0.39 and 0.64 with the age 16 SAIP reading and writing scores respectively, and there were no unusual outliers.[15, 16] These findings also suggest that some of the interprovincial differences observed in this study are apparent before students reach high school.

(7) ***Provinces Vary in Sex Inequalities.*** **Although nationally females and males scored equally well on the three literacy tests taken together, sex differences varied among the provinces. In New Brunswick and British Columbia, females substantially outperformed males, whereas in Ontario and Manitoba, the reverse was true. In these cases, the inequalities were more than equal to one year of formal schooling (see Table 4).**

This is perhaps the most curious finding of the study, and there are few plausible explanations. Possibly informal streaming mechanisms exist: males and females may be selected differently for gifted programs, tracking during high school, or French immersion programs. For example, Ontario has been "destreaming" part of its secondary schools. Many of the youth in this study would have attended streamed schools, and if boys were more likely than girls to pursue academic rather than general or vocational steams, the differential selection would likely result in a sex difference favouring boys. Similarly, if girls were more likely than boys to leave school early, either as dropouts or "push-outs," we would see a similar effect. In New Brunswick, girls outnumber boys in French immersion programs and, on average, girls and students in French immersion programs do substantially better in reading and writing assessments. This could account for the large sex difference in the New Brunswick Provincial Assessment (see Appendix A). Also, as discussed above, the 1993 IEA study found a large female advantage in British Columbia, which is consistent with this study's findings. Whatever the cause of the large sex differences, these inequalities are large and deserve further investigation.

(8) ***Provinces vary in their SES gradients.*** **The SES gradients (i.e., the relationship between literacy skills and socioeconomic status) varied dramatically among the provinces. Quebec and the three Prairie provinces had relatively shallow gradients; that is, the distribution of literacy skills along social class lines was considerably more equitable. Ontario, British Columbia, and the four Atlantic provinces had relatively steep gradients. In these provinces, youth from less advantaged family backgrounds scored much lower than youth with similar backgrounds in Quebec and the three Prairie provinces (see Table 4 and Figure 5).**

(9) ***Shallow gradients means high overall literacy scores.*** **A strong negative correlation exists (-.72) between adjusted literacy levels and SES gradients, indicating that on average provinces with shallow gradients had high average literacy levels. In other words, the provinces with high adjusted literacy levels have higher average scores for respondents from low SES backgrounds (see Table 3 and Figure 5).**

These last two findings are surely the most important and dramatic results of the study. First, they indicate that youth with advantaged family backgrounds fare well in all provinces, and that provincial literacy levels vary little for this group. What differentiates the provinces in literacy levels is the performance of youth from disadvantaged backgrounds. The large inequalities in literacy skills in these provinces have tremendous social and economic costs. Unemployment rates for youth were above 16% at the beginning of 1997, even though the proportion of young people working or looking for work declined from 71% in 1989 to 61% in 1997 (Waldie & Bourette, 1997). Although high unemployment is attributable to many factors, a youth's chances of employment are likely to improve with higher education and literacy, and therefore reduce social welfare costs. Moreover, high literacy skills are associated with more rewarding jobs, a greater sense of control over one's health, and a healthy lifestyle (Ross & Wu, 1995).

The IALS data are inadequate for addressing the causes of the steep gradients. Data from the National Longitudinal Survey of Children and Youth (NLSCY) could be used to discern whether these SES gradients become apparent during the pre-school or elementary school years. The NLSCY data also have the best information on family and schooling processes to test hypotheses about the causes of these gradients. The achievement tests of the NLSCY, however, are not as comprehensive as the tests used in studies of school achievement, such as studies by the International Association of the Evaluation of Educational Achievement (1992) or the 1994 School Achievement Indicators Program (SAIP). In light of these findings, future SAIP assessments might attempt to collect data on some indicators of socioeconomic status and school process, so that these relationships can be examined further.

Endnotes

[1] The IALS study provides representative proficiency data for the non-institutional civilian population of Canada aged 16 and older. Residents of the Northwest and Yukon Territories and residents of Indian reserves were excluded from the study. Collectively, these excluded populations represent less than 2% of the total population in the target age range.

[2] The lines were determined by fitting a multiple regression model of literacy scores on age, age-squared, age-cubed, sex, and the sex-by-age interactions. The fitted regression lines follow very closely to a locally-weighted least squares (lowess) running regression.

[3] The variables for this model were coded as follows:

Female was coded 0 for males and 1 for females.

Age was coded in years, and centred on 43 years old (approximately the national mean age). The analysis includes a linear, quadratic (age-squared), and a cubic (age-cubed) component.

Other Language was coded 0 for those whose first language was the language of the test, and 1 otherwise.

Years Speaking the Language of the Test was coded in years. The analysis includes a linear, quadratic, and cubic component.

Employment Status was described with a set of four dummy variables denoting employment status at the time of the survey, with "employed" as the reference category.

Income was coded in thousands of dollars, and centred on the national average income of $26,686. This average is relatively low because it includes a substantial number of respondents who were unemployed or retired.

Occupational Status was grouped into five categories—Professionals, Semi-Professional and Managerial (legislators, senior officials, managers, technicians, associate professionals, and members of the armed forces); Skilled Non-Manual (clerks, service workers, and shop and market sales workers); Skilled Manual (agricultural and fishery workers, craft and related trades workers, and plant and machine operators and assemblers); and Unskilled Occupations. Following on a technique recommended by Mosteller and Turkey (1977), the ordinal data were scaled on a logit distribution, assigned an interval value, and standardized.

Years Education was coded in years, and centred on 12 years of education.

Mothers' Education and *Fathers' Education* were coded in years of education, and centred on eight years of education.

Fathers' Occupation was scaled and coded in the same fashion as the respondent's occupation.

Rural Community was coded 1 for those living in rural communities, and 0 otherwise.

Substantial data were missing for *Income* and *Occupational Status*. Therefore, following a procedure recommended by Cohen and Cohen (1980), missing data for *Income* and *Occupational Status* were set to 0, and two dummy variables were constructed which identified respondents who were missing data on these variables. With this technique, the analysis provides estimates of the effects of *Income* and *Occupational Status* for those with valid data, and estimates of the difference in literacy scores between those with valid data and those with missing data.

With the scaling used in this analysis, the intercept is the expected score for a 43-year-old male adult living in a rural community, whose first language was one of the test languages, who had average income and occupational status, who had 12 years of education, and who had parents with eight years of education.

[4] As with the analyses for the quantitative test reported in Figure 1, there were statistically significant sex-by-age interactions in the full model for all three tests. These interactions could be used to identify sex differences for adults of differing ages. The inclusion of these terms, however, accounted for only about one-fifth of 1% of the variation in literacy scores on each test, and therefore were not included in the model reported in Table 1.

[5] The combined score is the average of a prose, document, and quantitative literacy score. The analyses in this study are intended to examine interprovincial differences and the effects of background factors on the overall literacy score. If differences between provinces in their average literacy scores or in their social-class gradients stem mainly from differences in the effects of schooling, rather than the effects of wider social and economic factors, one would expect to observe more pronounced differences for quantitative and document literacy than for prose literacy, because "school effects" are generally stronger for mathematics than for subjects in the language arts (Willms, 1992). Testing hypotheses about whether interprovincial differences in levels or gradients vary across the three tests requires a multivariate, multilevel

model, which was considered beyond the scope of this paper. The recent versions of the multilevel software allow for the estimation of such models, and we intend to pursue this in further work.

6 This result does not change when fathers' occupation and family income are removed from the model.

7 In this two-level multilevel analysis, respondents are considered nested within provinces. The null model includes no independent variables. The first level of the model simply expresses a person's score as a provincial mean plus a residual:

$$(Literacy)_{ij} = \beta_{0j} + \varepsilon_{ij} \qquad (1)$$

where $(Literacy)_{ij}$ is the score for the *i*th person in the *j*th province. β_{0j} and ε_{ij} are parameters estimated from the data. β_{0j} is the estimated mean score for the *j*th province, and ε_{ij} are the "residuals" or the deviations of individuals' scores from their respective provincial averages.

The second level of the model describes provincial averages as a grand (Canadian) mean, plus a deviation about the grand mean:

$$\beta_{0j} = \theta_{00} + \upsilon_{0j} \qquad (2)$$

where θ_{00} is the national mean literacy score, and υ_{0j} is the deviation of each province's score from the national mean. The hierarchical analysis yields estimates of the parameters at both levels (top part of Table 3), estimates of the "true" variances of ε_{ij} and υ_{0j} (middle part of Table 3), estimates of the covariances or correlations among the parameters (bottom part of Table 3), and Bayesian estimates of the residuals, υ_{0j} (shown in Figure 4). The Bayesian residuals are residuals that have been "shrunken" towards the national average according to the reliability with which they were estimated. Thus, estimates for a province with a small sample size, such as Prince Edward Island, are shrunk considerably, whereas, the residuals for provinces with large samples, such as Ontario, are shrunk very little.

8 The first level of this model expresses a person's score as a function of the covariates plus a residual:

$$(Literacy)_{ij} = \beta_{0j} + \beta_{1j}\,(Female)_{ij} + \beta_{2j}\,(SES)_{ij} + \beta_{3}\,(Other\ Language)_{ij} +$$
$$\beta_{4}\,(Years\ Test\ Language)_{ij} + \beta_{5}\,(Years\ Speaking\ Test\ Language\ Squared)_{ij} + \varepsilon_{ij} \quad (3)$$

where $(Literacy)_{ij}$ is the score for the *i*th person in the *j*th province, and the covariates are coded as they were in the regression analysis presented in Table 2. This model represents *j* regression equations, one for each province. In this particular model, the regression coefficients for *SES* and *Female* were allowed to vary among the ten provinces, whereas the coefficient pertaining to whether or how long a respondent spoke the language of the test is fixed to a common value for all provinces. (This was determined by examining a number of models, and finding that the coefficients for the latter variables did not vary significantly among the provinces. Thus, their slopes were "fixed".) The intercept, β_{0j}, is the expected score for a group of respondents who collectively have a score of zero on all of the covariates. The variables, *(Female)* and *(SES)* were centred on the grand mean for all youth, whereas *Other Language* was left as a dummy variable with zero denoting those whose first language was one of the test languages. A value of zero on the last two variables represents someone whose first language was one of the test languages, or, in the case of those who had a different first language, someone who had spoken the test language for twenty years. Thus, estimates of β_{0j} are estimates of how well a group of young men and women with average SES, and whose first language was one of the test languages, scored in each province. The ε_{ij} are individual-level residuals.

The second level of the model describes each of the three parameters which vary among provinces as a grand mean (Canadian), plus a deviation about the grand mean:

$$\beta_{0j} = \theta_{00} + \upsilon_{0j} \qquad (4)$$
$$\beta_{1j} = \theta_{10} + \upsilon_{1j} \qquad (5)$$
$$\beta_{2j} = \theta_{20} + \upsilon_{2j} \qquad (6)$$

where θ_{00} is the national "adjusted' mean literacy score, and υ_{0j} is the deviation of each province's score from the national mean; θ_{10} is the national average difference between female and male literacy scores, and υ_{1j} is the deviation of each province's sex difference from the national mean; and θ_{20} is the national average SES gradient for literacy scores, and υ_{2j} is the deviation of each province's gradient from the national mean. The analysis also produces estimates of the covariance or correlation among the three parameters. Results from this model are displayed in the second column of Table 3, as the third set of estimates in Figure 4, and in Table 4.

9 The sex difference for Prince Edward Island was 14.6% of a standard deviation, favouring males. I did not include it here because the estimate for Prince Edward Island was based on a relatively small sample.

10 The SES measures is a statistical composite of four factors: number of siblings, single parent family, number of home possessions, and participation in cultural activities.

11 The small circles on each line denote the 10th, 25th, 50th, 75th, and 90th percentiles for SES. Each line was truncated at the 10th and 90th percentiles.

12 These observed differences are not due to ceiling effects on the tests. The upper tails of the distributions of scores were very thin for all three literacy tests, and for the combined literacy measure. There was however, a slight bulge in the distribution of literacy scores at the lower tail of the combined measure, with 1.2% of the respondents scoring the lowest score. All of the respondents at the bottom end were from Ontario. Thus, the steepness of the Ontario gradient may have been underestimated in these analyses.

13 Estimates were based on age-adjusted comparisons—see Appendix E of the IEA report.

14 Effect sizes were estimated by assigning each of the five SAIP levels (and the 'below level 1' category) a scaled score based on the logit scaling technique recommended by Mosteller and Turkey (1977).

15 These are simply unweighted provincial-level correlations.

16 The IALS scores were correlated 0.60 with the age 13 SAIP writing scores. It may be that the SAIP measures of writing include a strong reading component. Psychometric data to examine the validity of the SAIP measures or their comparability to the IALS measures are not presently available.

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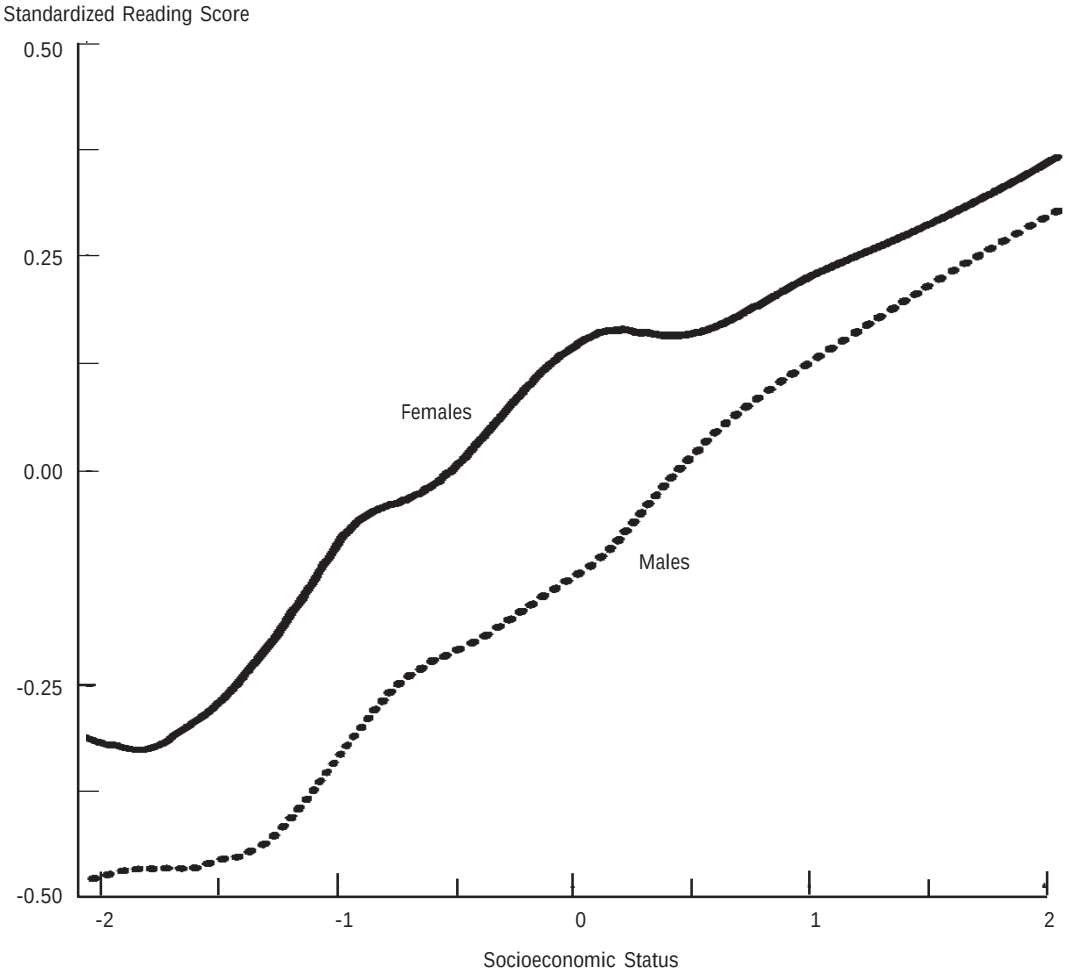
Appendix

Appendix A **Sex Differences in Reading Scores, 1996 New Brunswick Grade 6 Assessment**



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