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Literacy Gaps by Educational Attainment: A Cross-National Analysis

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Abstract

Existing cross-national research on educational attainment does not fully address whether the same level of educational attainment generates the same level of literacy skills in different countries. We analyze literacy skills data for young adults from 19 countries in the 1994–1998 International Adult Literacy Survey and find that in all countries, individuals with a higher level of educational attainment tend to have greater literacy skills. However, there is substantial variation across countries in the size of literacy gaps by levels of educational attainment. In particular, young adults in the United States show the largest literacy gaps. Using two-level hierarchical linear models, we find that cross-national differences in the literacy gap between more- and less-educated individuals are systematically linked to the degree of between-school inequality in school resources (instructional materials, class size, teachers' experience and certification).

Changes in work organization, ongoing technological development and globalization have increased the demand in industrialized nations for highly skilled workers (Berman, Bound and Machin 1998; OECD 2000). These trends make it critically important that nations enhance their populations' levels of knowledge and literacy skills. Macroeconomic studies have shown a positive relationship between a country's economic development and its population's overall literacy skills (Coulombe, Tremblay and Marchand 2004). At the micro level, literacy skills are equally important because they are significantly associated with labor market outcomes such as earnings and occupation, even after educational qualifications are held constant (Kerckhoff, Raudenbush and Glennie 2001). Research also suggests that literate people may have greater self-esteem and participate more actively in political discussions and community activities (UNESCO 2005). Finally, in countries where increasing shares of the age cohorts obtain secondary and tertiary education and thus variation in the level of formal educational attainment decreases, the quality of schooling (often measured by literacy skills) is likely to become increasingly important for individuals' socio-economic outcomes (Somers 2005).

Given the significance of literacy skills for national development and for individual well-being, it is important to examine how these skills are distributed across populations. In this study, we use data for adults ages 26–35 in 19 countries, drawn from the 1994–1998 International Adult Literacy Survey. The IALS defines literacy skills in terms of three broad areas. The survey measures participants' proficiency in reading and understanding documents (e.g., job applications, maps, schedules) and prose (e.g., news stories, editorials, manuals), and their ability to do print-based quantitative operations (e.g., balancing a

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checkbook, filling out an order form, calculating a tip). We focus our analysis on the literacy gap between those with high levels of formal educational attainment and those with low levels, hypothesizing that the size of the gap will vary across countries. We account for potential structural sources of cross-national variation using a multi-level modeling technique that incorporates country-level and individual-level data simultaneously. Our analysis shows that countries with greater inequalities in key educational resources among middle schools have larger disparities in literacy skills between more- and less-educated adults. This suggests that early unequal schooling experiences have long-term consequences for adult literacy skills.

Cross-National Studies of Literacy Skills

Educational attainment has been extensively examined in cross-national studies (e.g., Shavit and Blossfeld 1993). Literacy skills, however, especially those of adults, have received much less attention from comparative education researchers. There is considerable variation in literacy levels among countries with similar levels of formal educational attainment. In the IALS, for example, Swedish and British adults ages 26 to 35 have similar average years of schooling (12.6 and 12.9 years, respectively), but their average levels of literacy skills differ substantially. Swedish young adults have the highest average score on the quantitative literacy test among all 19 countries, while their British counterparts have one of the lowest scores. This comparison highlights the need for cross-national research on literacy skills as an educational outcome separate from educational attainment.

In contrast to the relatively small number of cross-national studies of adult literacy skills, numerous studies have compared levels of educational achievement among school-age children, typically measured using reading, mathematics or science scores. Although post-schooling experiences such as adult learning also enhance adult literacy skills, a substantial base of adult literacy skills is probably established through formal schooling during childhood (OECD 2000). The distribution of adult literacy skills may reflect the cumulative effects of formal schooling. Therefore, comparative studies that have explored sources of cross-national differences in educational achievement among school-age children may provide useful insights into structural factors leading to cross-national variation in adult literacy skills.

Using 1970s data, Heyneman and Loxley (1982, 1983) found that the effects of family socio-economic status on achievement were smaller than the effects of school factors in less developed countries, while the reverse pattern was found in developed countries. Their findings were understood to reflect considerable between-school inequality in school resources in poor countries. Using data from the mid-1990s, however, Baker, Goesling and LeTendre (2002) found that the relative effects of school resources and family SES on student achievement no longer depend on economic development. According to the authors, developing countries increased public expenditures on schools and raised the minimum levels of school quality during the 1980s and ‘90s, which likely reduced between-school resource inequalities and may have made school effects no longer dependent on economic development. Schiller, Khmelkov and Wang (2002) found that the effect of parental education on middle school students’ math test scores does not vary by countries’ level of economic development. However, the authors found that, for math scores, the relative advantage of living with two parents was more substantial in economically developed countries.

Cross-national research on the literacy skills of adults can provide important contributions to the existing literature on literacy that heavily relies on student academic achievement. The distribution of educational achievement among school-age children is likely correlated with

the distribution of literacy skills among adults, but an empirical assessment of the magnitude and pattern of this correlation is needed. A strong correlation between the literacy skills of adults and the educational achievement of school-age children indicates a persistent, long-term effect of formal schooling experiences. Determining whether unequal schooling experiences during childhood have lingering effects on subsequent literacy disparities among adults will enrich the literature on school factors and educational outcomes (Card and Krueger 1992; Hedges, Laine and Greenwald 1994). The importance of examining adult literacy skills becomes more substantial when considering that inequalities in adult literacy skills may have an important impact on the distribution of educational achievement and attainment of the next generation, highlighting long-term implications of adult literacy for intergenerational transmission of inequality (Wagner and Spratt 1988; Bynner and Parsons 2005).

Further, literacy skills measured in adult literacy surveys like the IALS evaluate the ability to understand and use information to solve problems that are typically encountered in daily activities. Achievement tests like those of the Third International Mathematics and Science Study, in contrast, measure children's mastery of school-based curricula (Brown et al. 2005) that may not have an equivalent practical application. Empirical examinations of both types of outcomes would help us understand the extent to which the two differ.

Finally, studies of educational achievement such as those of Heyneman and Loxley (1982, 1983), Baker et al. (2002), and Schiller et al. (2002) have focused mainly on national levels of economic development as a country-level factor that potentially conditions the relationships among family, school and achievement. However, other country-level factors may also explain the observed cross-national variations. Schiller et al. (2002) acknowledged the need to explore how schooling systems and cultural and political factors mediate educational stratification. This point is particularly relevant for comparative studies of countries with similar levels of economic development.

Sources of Cross-National Variation in Literacy Gaps

Why are some countries more successful than others in achieving high literacy skills, especially among the less educated? Among many potential explanatory factors, we focus on the role of national school systems. Home and school are the most important places to acquire literacy skills, especially for young people for whom the impact of post-schooling literacy acquisition can be reasonably controlled for (OECD 2000). After family background is held constant, therefore, school plays a pivotal role in shaping literacy skills. Examining structural features of school systems that significantly affect the learning opportunities of individuals may offer insights into potential sources of cross-national differences in the literacy gaps by formal educational attainment.

Existing research has highlighted the institutional arrangements of educational systems as relevant for mediating educational stratification processes (e.g., Kerckhoff 1995). Some studies have shown that countries where students are sorted into different types of schools at an early age tend to have larger disparities in student achievement or stronger effects of family background than countries with no tracking (or with tracking only at later ages) (Ammermüller 2005; Hanushek and Wößmann 2006). Some evidence suggests that the relationship between family background and student achievement is weaker in countries with standardized, central exit exams administered by an agency external to schools than in countries without these exams (Wößmann 2002).

However, other aspects of educational systems also shape the relationships between family background and student achievement. Indeed, institutional factors such as between-school tracking and central exams are not universally present. The number of countries where

students are sorted into different types of schools before high school is much smaller than the number of countries with no tracking or those with tracking only after high school (OECD 2005). Because we are interested in literacy gaps between adults who did not graduate from high school (or may never have attended high school) and adults with high school degrees or higher, tracking is much less relevant for our study, even for countries with tracking systems (unless the tracking occurs at an early age). Moreover, studies that focus on tracking effects cannot address differences in other important aspects of educational systems among countries with the same type of tracking system.

In this study we look at institutional factors that are likely to be more universally relevant. Particularly, we pay attention to cross-national variation in between-school inequality in basic school resources such as instructional resources, class size, teachers' level of experience and teachers' certification status. The distribution of various instructional resources across schools has been examined frequently in studies of school effects (Heyneman and Loxley 1983; Baker et al. 2002). A negative correlation between class size and student achievement has been found in both developing and developed countries (Fuller 1987; Mosteller 1995). Similarly, the significant role of high-quality teachers for enhancing student achievement has been documented for both developing and developed countries (Fuller 1987; Akiba, LeTendre and Scribner 2007). Teachers' experience and certification have been used as key indicators of teacher quality in those previous studies.

We examine the extent to which cross-national variation in between-school inequalities in our four key school resources is related to between-country differences in the literacy gap between adults with higher and lower educational attainment. We expect that in countries where schools differ considerably in their resources, students from different family backgrounds will have substantially different learning opportunities. Given residential segregation, students from disadvantaged families are more likely to attend schools with fewer resources and poorer quality of instruction (Baker and LeTendre 2005; Kozol 1991). When between-school inequalities in school resources persist from primary to secondary schools, their effects are accumulated throughout individuals' school careers. Thus, the lower quality of teaching and learning and the fewer educational resources among schools with high concentrations of disadvantaged students should worsen achievement gaps between students from advantaged and disadvantaged families as students get older. As a result, when students become adults, their literacy gaps should be considerable, especially compared to those of adults in other countries who went through school systems in which between-school inequality in educational resources was relatively small.

Of course, most educational systems do not explicitly distribute resources unequally; nevertheless, certain structural factors lead some countries to have a relatively larger degree of between-school resource inequality than others. For example, countries with a higher degree of socio-economic residential segregation are likely to have more substantial between-school inequalities in resources. Baker and LeTendre (2005) consider the U.S. tax system, which links local property tax revenues to school finance, responsible for much of the difference in educational expenditures among U.S. schools. In contrast, several European and Asian countries have more centralized funding systems that distribute educational funding to schools on the equal or needs base, contributing to less between-school inequalities in educational resources and teacher quality than in the decentralized U.S. funding system (Akiba et al. 2007). Some countries such as France and the Netherlands even implement compensatory funding policies to provide more resources to schools serving economically disadvantaged students and ethnic minorities (Holdaway, Crul and Roberts 2009). In the current analysis of 19 countries, we do not aim to identify particular mechanisms that produce between-school inequalities within each country. Instead, we

focus on empirically estimating the degrees of between-school resource inequality across countries and their linkages with the distribution of adult literacy skills.

Most studies of the school resources have not systematically examined how between-school resource inequality is related to unequal student achievement. Instead, they have focused mainly on whether more school resources are associated with increased student achievement. Some studies have assessed the level of between-school inequality but have not empirically related it to unequal student achievement (Raudenbush, Fotiu and Cheong 1998; Goesling, Baker and LeTendre 2001). An exception is work by Akiba et al. (2007), which showed a tenuous relationship between differences in teacher quality and inequality of student achievement. However, that study examined only teacher quality and not other school resources, and it relied exclusively on country-level correlations. We conduct a more sophisticated set of analyses, using a multi-level technique across four types of school resources.

Despite our focus on formal school systems as a major source of literacy acquisition, we readily acknowledge the importance of post-schooling opportunities that may enhance adult literacy skills in the workplace or community. Literacy acquisition does not occur through formal schooling alone, nor does it necessarily end with the end of formal schooling. Individuals may continue to acquire literacy skills by, for example, attending occupation-specific or general adult education/training programs. However, countries vary considerably in the extent to which the state or employers provide opportunities for adult education and training to individual workers, especially to those who have less formal education (OECD 2000, 2007). Given the impact of adult learning and training on acquisition of literacy skills, countries where life-long learning opportunities are equally distributed across people with different formal educational attainment are likely to show narrower literacy gaps by educational attainment than are countries where those with already higher educational attainment are more likely to participate in adult learning and training than those with lower educational attainment (O'Leary and Oakley 2008; Bloom et al. 1997). Thus, any models that attempt to account for cross-national variation in disparities in literacy skills among adults with different levels of education should consider between-country differences in the provision of post-schooling opportunities for further literacy acquisition.

Data and Measures

Data

The 1994–1998 International Adult Literacy Survey administered tests aimed at producing reliable and comparable measures of literacy skills of adults ages 16–65 in 19 countries: Belgium, Canada, Chile, the Czech Republic, Denmark, Finland, Great Britain, Germany, Hungary, Ireland, Italy, the Netherlands, New Zealand, Norway, Poland, Slovenia, Sweden, Switzerland and the United States (OECD 2000). We restrict our study sample to adults ages 26 to 35 in order to include only individuals who have likely completed their formal education. Although the IALS provides a measure with which to consider cross-national variation in the degree of opportunities for adult education and training, we acknowledge that this simple measure cannot fully address the complicated nature and type of adult education or training received. Therefore, to minimize potential influences of cross-national differences in the provision of post-schooling learning opportunities, we include only adults young enough to still be in the early stages of developing literacy skills that are based on post-schooling experiences.

The practical difficulty of finding data for between-school resource inequality among older cohorts also forces us to focus on younger cohorts, for whom relevant school-level data are more likely to be available. However, there is still a serious data limitation with the 26- to

35-year-old cohorts. To gather information on the degree of between-school inequality, we use the TIMSS survey of middle school principals, conducted in most countries in 1995 (and some in 1999). Given that adults ages 26 to 35 in the 1994–98 IALS surveys would have been in middle schools mostly in the 1980s, TIMSS school-level data, collected in the 1990s, do not necessarily reflect resources of middle schools in the time period when our respondents were attending them.Given the lack of information about how between-school inequality in resource has changed between the 1980s and 1990s in each of our 19 countries, it is difficult to gauge the degree of potential bias caused by the usage of the 1990s TIMSS school-level data. We can only speculate on the trend suggested by Baker et al. (2002) that between-school inequalities are likely to be less evident in most countries in the 1990s than in the earlier periods.1 If this trend is true, young adults in our IALS data who were in middle schools during the 1980s might have attended schools that differed in educational resources more substantially than schools in the 1990s. Because our measures of between-school inequality are based on the 1990s school data, the effect of between-school inequality on literacy disparities we report may be underestimated. However, the trend suggested by Baker et al. (2002) should be verified with more empirical evidence, and we urge caution in anticipating the direction of bias.

Individual-Level Variables

In our analyses, the outcomes of interest are literacy test scores. The IALS assessed prose, document and quantitative literacy skills in order to account for the multiplicity and complexity of skills required for understanding and using printed information. Proficiency in each area was measured on a scale of 0 to 500. The multiple measures allow us to examine the extent to which the findings vary across three different dimensions of literacy.2 National means and standard deviations for the three literacy test scores for each country are presented in Table 1 (columns 2–4).

Educational attainment is the focal independent variable. Respondents were asked to indicate their completed level of education, which was classified according to the International Standard Classification of Education. We grouped respondents into three categories: ISCED 0–2, ISCED 3 and ISCED 5–7. In the U.S. system, these categories are equivalent to less than high school, high school (upper secondary education) and college education (including both junior college and four-year college/university). We control for gender, employment status and parental education. We distinguish those currently employed from others (including those unemployed or not employed). In the workplace where they are constantly involved in various literacy activities such as reading, writing and calculation, individuals should have more opportunities to enhance their literacy skills than those who are not employed and thus do not utilize their literacy skills regularly (OECD 2000). Similar to respondent's own education, parental education is classified into less than high school, high school degree and college degree. In order to limit our analysis to those who were continuously educated within their country's school system, we examine natives only. Table 2 presents unweighted descriptive statistics by country for each of our individual-level independent and control variables.

[1]According to Baker et al. (2002), there was a global trend toward increased state commitment to and investment in public education throughout the 1980s and 1990s. However, the increased public expenditure and state commitment on education may not necessarily lead to less between-school inequality within the country. It is important to examine how the increased school funding has distributed equally across schools and how countries differ in this aspect.

[2]There is some disagreement on the extent to which the three dimensions are distinctive (see Committee on Performance Levels for Adult Literacy 2005 for a discussion of dimensionality with respect to the 1992 National Adult Literacy Survey which is similar to the IALS). Dimensionality analysis has not been systematically conducted for the IALS. Following the Committee's (2005) position, we consider prose, document, and quantitative skills as separate dimensions of literacy, but we expect high intercorrelations among them.

Country-Level Variables

For the multi-level analysis, we use country-level variables indicating the degree of nations' between-school resource inequality in each of four school resources: (1. instructional resources, (2. class size, (3. teachers' experience, and (4. teachers' certification. Our measures of school resources draw mainly on the 1995 TIMSS data of nationally representative samples of middle schools in each of the more than 40 participating countries (Martin et al. 1999). Among our 19 countries, Chile and Finland did not participate in the TIMSS in 1995 but did so in 1999; therefore, for these two countries we use 1999 data.[3] Only Poland did not participate in either TIMSS survey, requiring that we impute its values.[4]

The TIMSS gathered information about school characteristics from school principals' responses to a questionnaire. Using a four-point scale (from "none" to "a lot"), principals indicated the extent to which their school's instructional capacity was affected by inadequate resources in each of the following 17 areas: instructional material, budget for supplies, school buildings/grounds, heating/lighting, instructional space, equipment for handicapped pupils, computer hardware (math and science), computer software (math and science), calculators (math and science), library tools (math and science), and audio-visual resources (math and science), and science laboratory equipment. To construct our measures, we began by recoding each question so that high values indicate more resources (least affected by inadequacy). Following the procedures of Goesling et al. (2001), we averaged a principal's responses to the 17 questions to create a composite measure for the level of instructional resources available at the respondent's school. Then, we calculated a measure of resource inequality across schools within a country to summarize a country's level of between-school resource inequality in a single number.[5] Among the possible indices of inequality, we rely on the Theil index. Countries with higher values of the index show higher levels of between-school inequality in instructional resources. Interpreting this variable, however, requires caution because we rely on self-report of school principals rather than external, objective observations of school environments. Reports of school conditions by school principals can be affected by social desirability response bias (OECD 2001). In cross-national surveys, self-reports by school principals may be also influenced by cultural and linguistic differences in interpreting and responding question items.

Using the TIMSS principals' report on the average class size in their school and the percentage of teachers who have been teaching at their school for five or more years, we calculated the Theil index for between-school inequality in class size and the index for between-school inequality in teachers' experience.[6] Higher values of the indices signal higher levels of between-school inequality in each school resource.

Unfortunately, the TIMSS did not collect information on teachers' certification. For this information, therefore, we use school-level data from the 2000 Program for International Student Assessment that surveyed 15-year-old students across 32 countries (OECD 2001). The PISA asked principals to indicate how many teachers at their schools were fully

[3]There are many more countries with no information on educational resources, class size, or teacher experience in TIMSS 1999 than in TIMSS 1995. For those countries that have both 1995 and 1999 data on these school variables, correlations between the 1995 and 1999 measures are generally more than .6.

[4]We substituted mean values among 18 countries for values for Poland. To check robustness, we also conducted analyses without Poland. These yielded results very similar to those reported in this article.

[5]Goesling et al. (2001) calculated indices of between-school resource inequality using 1995 TIMSS data. To calculate Theil indices for our study, we used the STATA code that Brian Goesling kindly provided. In the few cases where we noticed slight differences between our estimates and those reported in Goesling et al., we relied on our estimates.

[6]The 1995 TIMSS survey for Hungary did not ask about class size. Therefore, we use 1999 TIMSS data for Hungary across all the country-level measures. Information on class size was not collected in Great Britain even though it participated in both 1995 and 1999 TIMSS. We assigned the average value of 17 countries to Poland and Great Britain.

certified. There are several differences between PISA and TIMSS, including date of administration (2000 vs. 1995), target population (15-year-old students vs. 7th and 8th graders), and school level (high school vs. middle school). However, PISA is the only international dataset that provides data on teacher certification for a time period close to that of the TIMSS. Using the school principals' report, we calculated the Theil index of between-school inequality in teachers' certification. We exclude three countries from the analysis of teachers' certification: Canada and Hungary for which information regarding certified teachers is not available in their PISA school data, and Slovenia which did not participate in PISA. Columns 5–8 in Table 1 present Theil indices for between-school inequality in instructional resources, class size, teachers' experience and teachers' certification for each country.

We take into account differences across countries in the opportunities for participating in adult learning by including an additional country-level control. In the IALS, respondents indicated whether, in the previous 12 months, they had taken part in any "courses, private lessons, correspondence courses, workshops, on-the-job training, apprenticeship training, arts, crafts, recreation courses or any other training or education." With regard to inequality of literacy skills, inequality of life-long learning opportunities between the more and the less educated is relevant. For the purpose, in each country we calculated the odds ratio indicating the likelihood for adults with no high school diploma, relative to those with high school or college education, to receive adult education and training. An important feature of the odds ratio is that it is independent of the marginal distribution (Rudas 1998). The degrees of inequality of life-long learning opportunities as measured by the odds ratios are not affected by cross-national differences in the overall levels of adult learning and the distributions of educational attainment.

The last column in Table 1 displays the odds ratio for each country. Interestingly, this ratio is less than 1 in all 19 countries, indicating that the more educated are more likely to receive adult education and training than are the less educated. However, it is also important to note considerable cross-national variation in the extent of disadvantage to those with the least education. The disadvantage is relatively smaller in countries like Sweden, Switzerland and the Netherlands, all of which show the odds ratio closer to 1, as compared to countries like Finland, Italy and Slovenia, where the odds ratio is far from 1.7

Hierarchical Linear Models

To assess whether cross-national differences in literacy gaps by educational attainment are systematically related to between-country differences in between-school resource inequality, we use two-level hierarchical linear models that utilize individual-level and country-level data simultaneously (Bryk and Raudenbush 1992). In the HLM framework, literacy gaps among people with different levels of education, which are estimated in individual-level equations within a country, become dependent variables in country-level equations. Their values are predicted by the Theil indices of between-school inequality in instructional resources, class size and teachers' experience and certification.

Specifically, in the individual-level equation, the literacy score for a respondent *i* in country *j* is predicted as follows:

[7]Including the GDP per capita in the models hardly affected the coefficients of between-school resource inequalities or the odds ratios of receiving training. Moreover, the net effects of the GDP per capita on countries' mean literacy levels or on the slopes of educational attainment were mostly non-significant. Therefore, we did not include the GDP per capita in the models.

$$(\text{Literacy})_{ij}=\beta_{0j}+\beta_{1j}(College)_{ij}+\beta_{2j}(HS)_{ij}+\sum_{3}^{k}\beta_{kj}X_{kij}+r_{ij} \quad (1)$$

where β_{0j} represents the average literacy score of those with less than high school (omitted category of educational attainment) in country *j*, adjusted for other individual-level characteristics included in the model. β_{1j} is the slope of the dummy variable of college in country *j*, which indicates the literacy gap between those with a college degree and those with less than high school. Similarly, β_{2j} indicates the literacy gap between those with high school diplomas and those with less than high school; and r_{ij} is the individual-specific error. The effects of other individual-level control variables, including gender, employment status and parental education, are represented by β_{3j} to β_{kj}, centered around corresponding grand means.

In order to examine how country-level variables influence the literacy gaps by educational attainment, in country-level equations we model the slope of college (β_{1j}) and the slope of high school education (β_{2j}) to be predicted by the Theil index of betweenschool inequality and the odds ratio of receiving training. We do not allow the effects of other individual-level variables, represented by β_{kj}, to vary across countries. We estimate models separately for each of four Theil indices of between-school inequality. The country-level equations are:

$$\beta_{0j}=\gamma_{00}+\gamma_{01}(\text{Theil index of between}-\text{school inequallity})_j+\gamma_{02}(\text{Odds Ratio})_j+u_{0j} \quad (2)$$

$$\beta_{1j}=\gamma_{10}+\gamma_{11}(\text{Theil index of between}-\text{school inequallity})_j+\gamma_{12}(\text{Odds Ratio})_j+u_{1j} \quad (3)$$

$$\beta_{2j}=\gamma_{20}+\gamma_{21}(\text{Theil index of between}-\text{school inequallity})_j+\gamma_{22}(\text{Odds Ratio})_j+u_{2j} \quad (4)$$

$$\beta_{kj}=\gamma_{k0} \quad (5)$$

Results

Regression Models

Before presenting the HLM results, we first discuss results of regression models in Table 3, estimated with the pooled data across all 19 countries to predict each of quantitative, prose and document literacy skills by educational attainment; other individual-level characteristics (gender, employment status and parental education); country dummy variables; and interaction terms between each of the country dummy variables and each of two dummy variables for educational attainment. Without controlling for any other independent variables, Model 1 shows the gross differences in literacy skills between those with less than high school (the reference category) and those with college education (dummy variable, College) and between those with less than high school and those with high school (dummy variable, High School). Because the United States is the reference country, a coefficient of 69.2 for High School in the analysis of document literacy skills means that the average score of high school graduates in the United States is higher by 69.2 points than the average score (209.9 points, as shown in the intercept) of those who did not graduate from high school.

Similarly, the average score of those with a college degree is 104.7 points higher than that of those with the least education. The results for quantitative and prose literacy skills are very similar to those for document literacy.

A country dummy variable indicates the difference in the average score of those with less than high school in the United States and those with less than high school in a specific country. For example, those with less than high school in Belgium score 57 points higher in document proficiency than their counterparts in the United States. The positive coefficients of most country dummy variables indicate that the average score of those with less than high school in the United States is lower than that of their counterparts in all countries except Chile and Slovenia.

Interaction terms between each country dummy variable and the dummy variable College indicate the extent to which the literacy gap between those with a college degree and those with less than high school in a specific country is different from the corresponding literacy gap in the United States. For example, the coefficient of College*Belgium (−49.2) means that the literacy gap between the least and most educated in Belgium is smaller by 49 points than the corresponding gap in the United States. Because the literacy gap between the least and the most educated in the United States is 105 points (the coefficient of College), the corresponding literacy gap in Belgium is 56 points (105–49). All coefficients of interaction terms are negative and most are statistically significant (exceptions are Canada, Hungary and Slovenia), indicating that the literacy gap between the least and most educated is largest in the United States.

To further clarify the cross-national variation in literacy gaps by educational attainment, we draw on the results of Model 1 to present figures that show the average scores of the three educational groups within countries for document, quantitative and prose literacy skills, respectively. Countries are sorted in descending order according to the size of the literacy gap between the least and most educated. Figures 1–1 through 1–3 show a very similar order of countries across all three literacy dimensions. The United States, Canada, Chile and Slovenia show the widest gap, while Germany, Denmark and the Netherlands show the narrowest. The figures reveal that for all three types of skills, the cross-national variation stems mostly from between-country differences in the level of literacy skills among the *least* educated. The difference across countries in the level of literacy skills among college graduates is much smaller than the difference across countries among those with less than high school. In short, the cross-national variation in the literacy gap by educational attainment is due primarily to how countries differ in the level of literacy skills among the least educated.

Model 2 shows the results when other individual-level characteristics are taken into account. Controlling for those variables reduces the literacy gaps by educational attainment in the United States, as indicated by the reduced effects of education (Table 3.) However, comparing Model 1 and Model 2 shows that the interaction terms between country and college degree and between country and high school degree change only slightly when covariates are controlled. Moreover, although reduced, the interaction terms remain significantly negative, confirming the relatively larger gap in the United States.

Hierarchical Linear Models

The results of our regression models have revealed considerable cross-national differences in literacy gaps by educational attainment. To explore whether the cross-national differences are related to between-country differences in between-school resource inequality, we now discuss two-level hierarchical linear models. The basic conclusions that emerge from the HLM results are very similar across the three literacy skills, although the magnitude of

between-school inequality effects on the slopes of educational attainment is somewhat different. Table 4 presents the HLM results for quantitative literacy skills.8

The second column in Table 4 shows the result for between-school inequality in instructional resources. 9 The intercept (the average score for those with less than high school) decreases by 21 points per .01 unit change in the Theil index of between-school inequality in instructional resources. Recall that in Table 1, countries with the highest and the lowest level of between-school inequality in instructional resources differ by .03 units in the Theil index. Belgium (.008) and the Netherlands (.010) show the lowest level of between-school inequality, while Chile (.037) and Italy (.036) show the highest level. Therefore, the coefficient of −21 shown in Table 4 indicates that the average score of those who did not graduate from high school is lower by about 63 points in countries with the highest level of inequality compared to countries with the lowest level of inequality, all other factors held constant. This means that countries with higher levels of between-school inequality tend to show poorer literacy skills among the least educated.

Turning to the effect of between-school inequality on the slope of College, the effect is positive and statistically significant, indicating that the literacy gap between the least and the most educated tends to be larger in countries with higher levels of between-school inequality in instructional resources. In regard to the magnitude of the effect, a .01-unit change in the Theil index is associated with a 10-point increase in the college-degree effect, after controlling for the odds ratio of receiving training. This means that the literacy gap between the least and the most educated in countries with the highest level of between-school inequality, such as Chile, is 30 points larger than the corresponding gap in countries with the lowest level of between-school inequality, such as Belgium. The results for the variance components (shown at the bottom of the table) indicate that two country-level variables, the Theil index of between-school inequality of instructional resources and the odds ratio, account for 63 percent of the variance of the intercept, 46 percent of the variance of the college slope, and 64 percent of the variance of the high-school slope.

The third, fourth and fifth columns in Table 4 present the results for between-school inequality in class size, teachers' experience and teachers' certification, respectively. There is a consistent pattern in the effect of between-school inequality across all educational resource measures, although the size of the effect differs. Regardless of the measures of school resources, countries with a greater degree of between-school inequality tend to show a lower level of quantitative literacy skills among the least educated (the effect of between-school inequality on the intercept is negative). The effect of a college degree (i.e., literacy gaps between those with less than high school and those with college education) becomes stronger in countries with the greater degree of between-school inequality. Similarly, the literacy gap between those with less than high school and those with high school education increases as the degree of between-school inequality rises.

Finally, the effect of inequality in opportunity for adult education and training, as measured by the odds ratio, merits attention. The odds ratio indicates the extent to which adults with less than high school education receive adult training, as compared to their counterparts with high school or college education. Across all the models in Table 4, the odds ratio is positively associated with the intercept. This suggests that the literacy level of adults with less than a high school education tends to be higher in countries where these individuals have a greater likelihood, relative to their counterparts with higher levels of education, of

[8]The statistical tables of HLM models for document and prose literacy skills are available upon request.
[9]In this analysis, we excluded Denmark which is an outlier. Denmark shows the largest between-school inequality in school resources (see Table 1), but it also shows one of the smallest gaps in literacy skills by educational attainment.

receiving adult training. Moreover, the relationship between the odds ratio and the slope of college degree (or the slope of high school degree) is significantly negative. This indicates that literacy gaps by educational attainment tend to be smaller in countries that have greater opportunities for adults with the least formal education (compared to those with higher education) to receive adult education and training.

A Supplementary Analysis

Earlier, we pointed out a data problem: our school measures do not reflect conditions of middle schools in the period when young adults in the IALS were enrolled in school, due to the lack of school-level data during the 1980s. To address this limitation at least in part, we conduct a supplementary analysis. Using data from middle schools in 14 countries that participated in the 1980–81 Second International Mathematics Study, Stevenson and Baker (1991) constructed several indicators in regard to the coverage of the mathematics curriculum in each country. In particular, they calculated the standard deviations of a number of mathematics items taught by teachers among different classrooms within nations. A large standard deviation indicates a large degree of difference in the amount of instruction across classrooms (or schools) within a given nation. We consider this measure to indicate a degree of difference between schools in students' educational experiences. Given the unavailability of SIMS raw data, this measure is extremely valuable for gauging the degree of between-school inequality during the early 1980s.10

Among all 14 countries covered in Stevenson and Baker's study, only nine countries – Belgium, Canada, Great Britain, Finland, Hungary, the Netherlands, New Zealand, Sweden and United States – participated in IALS (five countries not in the IALS – France, Israel, Japan, Luxembourg and Thailand). Considering the data limitation, we created a dichotomous variable that simply separates countries with a high degree of between-school differences in mathematics curriculum from those with a small degree. Only 5 of those 14 countries – England, Hungary, Israel (not included in our analysis), New Zealand and the United States – had standard deviations above the average of all 14 countries. These countries stand out because of their high degree of between-school differences in the amount of curriculum taught. Therefore, among our 19 IALS countries, we grouped England, Hungary, New Zealand and the United States together and separated them from the rest of the IALS countries in our analysis. We added a fifth country, Chile, to this subgroup because the substantial decentralization and privatization that characterized Chile's educational system during the 1980s likely resulted in considerable differences between schools in the content and amount of curriculum taught (Keller 2001).

The last column in Table 4 shows how the dichotomous variable of between-school differences in curriculum is associated with literacy disparities among young adults with different levels of educational attainment. The general pattern is similar to that of the other school resources measures. The five countries with a markedly high degree of between-school difference in the amount of mathematics curriculum taught tend to have lower average scores for the least educated compared to the rest of the countries, as the negative effect on the intercept indicates. The literacy gaps by educational attainment tend to be larger in these five countries compared to the rest of the countries, as the positive effects on college degree and high school education suggest. The finding that the measure for curriculum coverage behaves similarly to other measures of school resources in explaining cross-national variation in literacy disparities by educational attainment confirms the robustness of our study's conclusions.

[10]The SIMS raw data seem to have been lost. Despite searching diligently, and contacting scholars who have used the data in the past, we were not able to locate the original raw data.

Conclusion

Our results reveal that although in all countries examined, more-educated individuals tend to have higher levels of literacy skills than do less-educated individuals, countries significantly vary in the degree of literacy gaps by educational attainment. The pattern of cross-national difference is similar across prose, document and quantitative literacy skills. Our analyses, furthermore, reveal that the major reason for the relatively larger literacy gap in some countries such as the United States, Canada and Slovenia than others including Germany, the Netherlands and Denmark is attributable primarily to the substantially lower level of literacy skills among the least educated in the former countries. Cross-national variation in the level of literacy skills among the most educated is not substantial.

Results from our hierarchical linear models show that the cross-national variation in literacy gaps by educational attainment can be accounted for in part by between-country differences in the levels of between-school inequality in educational resources. Countries with higher levels of between-school inequality tend to show larger gaps in literacy skills between the least and most educated. This basic conclusion is robust across the four school resource measures we examined: instructional resources, class size, teachers' experience and teachers' certification. In estimating the lingering effects of unequal schooling experiences during childhood on the distribution of adult literacy skills, we relied on a sophisticated multi-level modeling technique that takes into account the nested structure of the data (individuals within countries). Moreover, we controlled for cross-national differences in the opportunity of adult education and training that has turned out to be an important factor affecting adults' literacy skills.

Our finding, which highlights significant consequences of between-school inequality in resources for adult literacy skills, suggests the importance of understanding how school resources are unequally distributed within a country. Despite the commonly accepted assumption that basic educational resources should be equally distributed across schools, in reality, context-specific mechanisms can prevent equitable distribution. In this study, we were not able to address specific mechanisms that lead to between-school inequality within each country. Depending on contexts, several factors such as school funding systems and residential segregation interact in a complex way to produce a specific degree of between-school inequality within a country. A detailed analysis of a national case can provide better understanding of specific mechanisms that underlie between-school inequality in the country.

Our findings have particularly useful implications for U.S. researchers and policymakers. U.S.-focused researchers can benefit from vigorously engaging with evidence of comparative education (Baker 1994). Our result shows that for each of the three literacy measures, young adults in the United States have a greater literacy gap by educational attainment than their counterparts in any of the other 18 countries in the sample. Combined with the underperformance of U.S. secondary students often found in international surveys of student achievement (OECD 2001; Baker and LeTendre 2005), the largest disparity in adult literacy skills highlights the seriousness of challenges that U.S. education faces. Our finding also suggests that a comparably high level of inequality in resources and teacher quality among U.S. secondary schools is responsible, to some extent, for the large disparity in U.S. adult literacy skills. Therefore, achieving equal distribution of resources and teacher quality across schools may contribute to students' academic achievement and also adult literacy skills.

Although we did not investigate the role of opportunities for adult learning as systematically as we did between-school resource inequality, our results suggest that more equal

opportunities for adult education and training among those with the least education should help reduce literacy disparities between the more and the less educated. This is another area in which researchers and policymakers must direct more attention. Providing more opportunities for life-long learning and devising programs to facilitate participation of the least educated in adult education and training should become high-priority goals. Enhancing job opportunities for the less educated is also an important strategy for addressing inequalities in literacy skills. As our empirical results show, being employed is significantly associated with increased literacy skills. In the workplace, people are engaged in various literacy activities which maintain and enhance their literacy skills. Having stable employment may also facilitate workers to regularly participate in skills development programs and training available.

We have found the macro-level relationship between unequal schooling experiences during childhood and literacy disparities on the basis of cross-national, cross-sectional data. We are not in a position to ascertain the causal relationship between the two. To establish that connection, future research may benefit from well-designed longitudinal studies that follow individuals from childhood to adulthood. Such a longitudinal design would provide data that better support individual-level causal inferences regarding the lasting effects of childhood schooling experiences on adult literacy skills.

Most IALS countries are economically developed; thus, we could not examine the distribution of literacy skills across as wide a range of developing countries as we would have liked.11 As Somers (2005) properly pointed out, developing countries are less likely to participate in international surveys of literacy skills because overseeing these surveys requires the allocation of economic and human resources. Data regarding literacy skills are scarce in developing countries. Given that between-school inequality in educational resources tends to be greater in developing countries than in developed countries (Heyneman 1982, 1983), if we had been able to include more developing countries in our analysis, we might have seen a stronger impact of between-school inequality on literacy disparities. Future efforts to collect international comparative data on adult literacy skills should pay special attention to attracting the participation of developing countries.

Finally, IALS participating countries are fairly similar culturally as well as economically. No East Asian countries such as Japan, Korea or Taiwan participated in the IALS. The omission of these countries is especially undesirable for comparative research on literacy skills. School-age children in East Asian countries persistently outperform their counterparts in other parts of the world in international assessments of academic achievement (OECD 2001). Moreover, highly standardized and centralized educational systems in East Asia have rendered the degree of between-school resource inequality relatively small (Baker and LeTendre 2005). If future studies examine how East Asian adults' literacy levels compare with those of adults in other countries, we may learn more about how schooling experiences during childhood can have lasting consequences for adult literacy.

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[11]The study Heyneman and Loxley (1983) conducted using 1970s data included a much wider range of countries across major regions of the world, including Africa, Asia, Latin America and the Middle East. Baker et al. (2002) used 1990s data but included a much smaller number of low-income countries than did Heyneman and Loxley.

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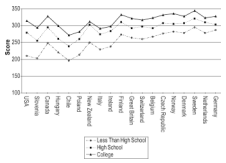

Figure 1-1.
Document Literacy Gaps by Educational Attainment

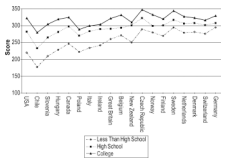

Figure 1-2.
Quantitative Literacy Gaps by Educational Attainment

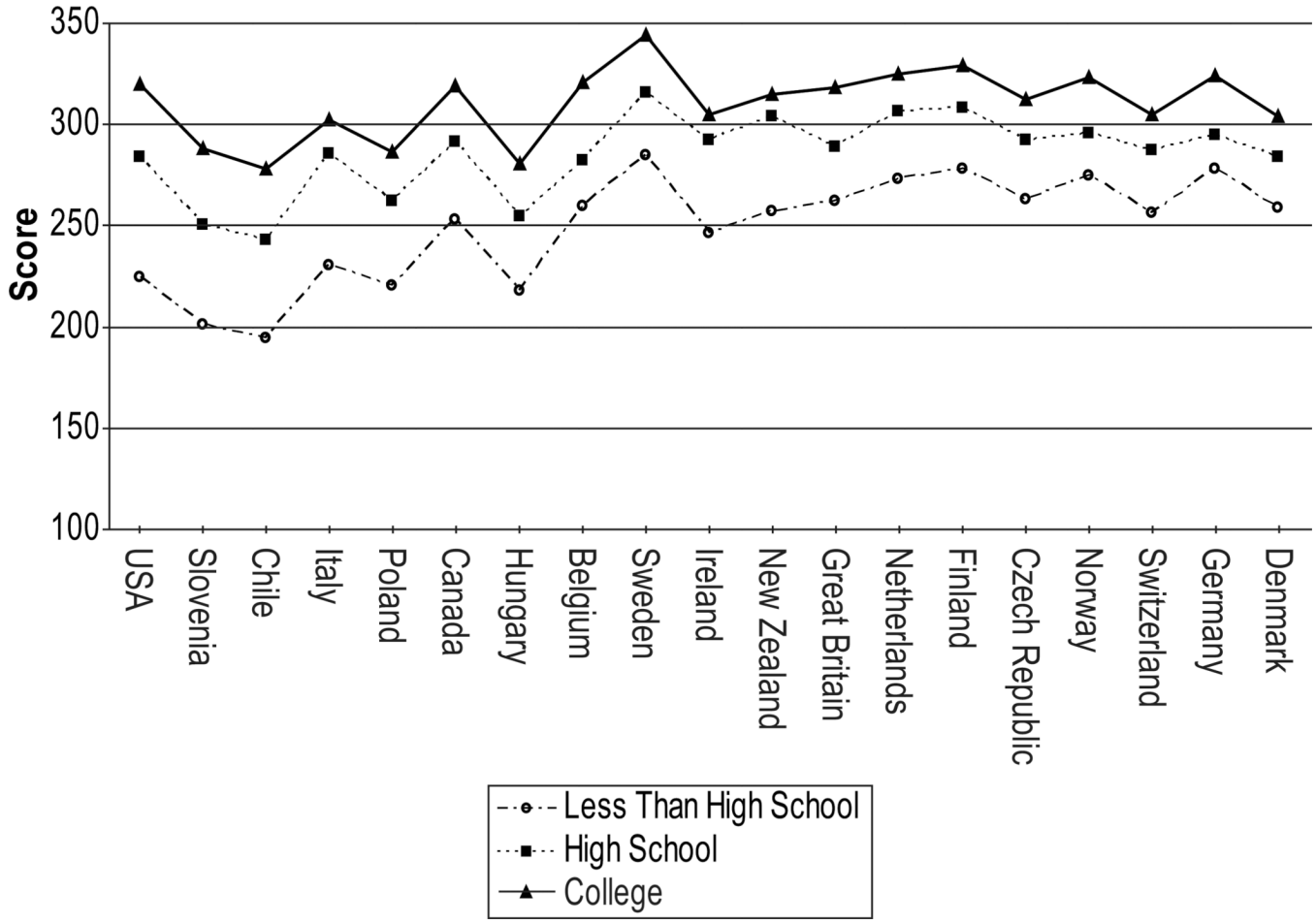

Figure 1-3.
Prose Literacy Gaps by Educational Attainment

Table 1

Country-Level Variables

Country	Mean Scores of Literacy[a]			Theil Index (Between-School Inequality)				Odds Ratio of Receiving Training (< High School vs. High School or Higher)[d]
	Quantitative	Document	Prose	Instructional Resources[b]	Class Size[b]	Teachers' Experience[b]	Teachers' Certification[c]	
Belgium	309 (49)	304 (44)	297 (46)	.008	.015	.035	.043	.284
Canada	284 (56)	284 (61)	284 (53)	.022	.014	.077	NA	.328
Chile	208 (68)	219 (53)	219 (55)	.037	.016	.069	.512	.259
Czech Republic	312 (53)	298 (51)	283 (41)	.010	.011	.036	.033	.429
Denmark	308 (41)	309 (40)	285 (32)	.036	.015	.029	.059	.481
Finland	301 (42)	311 (45)	308 (40)	.016	.012	.029	.020	.168
Germany	303 (43)	298 (45)	290 (46)	.020	.010	.070	.012	.473
Great Britain	277 (62)	281 (61)	279 (56)	.018	.016	.030	.060	.234
Hungary	274 (58)	256 (56)	249 (43)	.023	.076	.069	NA	.277
Ireland	269 (63)	265 (58)	273 (54)	.027	.007	.033	.015	.323
Italy	269 (56)	261 (53)	270 (55)	.036	.010	.034	.085	.201
Netherlands	304 (40)	305 (38)	302 (38)	.010	.007	.025	.027	.482
New Zealand	282 (55)	284 (56)	288 (51)	.019	.005	.054	.043	.399
Norway	312 (43)	317 (44)	305 (37)	.014	.026	.027	.013	.318
Poland	247 (64)	238 (66)	242 (54)	.021	.016	.046	.013	.255
Slovenia	261 (62)	252 (58)	247 (52)	.019	.012	.077	NA	.210
Sweden	322 (47)	325 (45)	319 (45)	.021	.008	.038	.007	.575
Switzerland	303 (40)	299 (42)	291 (37)	.011	.019	.037	.048	.486
USA	284 (63)	281 (61)	285 (59)	.029	.013	.053	.009	.285

[a] Calculated using 1994–98 International Adult Literacy Survey data. Values in parentheses are standard deviations.

[b] Calculated using 1995 (or, if not available, 1999) data from the Third International Mathematics and Science Study.

[c] Calculated using 2000 data from the Program for International Student Assessment.

[d] Calculated using 1994–1998 International Adult Literacy Survey data

NA: Not available

Table 2

Descriptive Statistics of Individual-Level Variables

			Education %			Parental Education %				
Country	Female %	Employed %	Less Than High School	High School	College	Less Than High School	High School	College	Missing	N
Belgium	53.6	84.8	16.9	32.1	51.0	44.8	26.2	21.9	7.1	420
Canada	58.0	68.4	26.8	35.0	38.2	49.2	25.5	19.0	6.3	922
Chile	56.0	57.2	54.8	25.6	19.6	73.1	14.1	6.3	6.6	925
Czech Republic	60.1	75.9	37.5	43.0	19.6	42.5	37.8	16.8	2.9	619
Denmark	49.5	78.0	16.5	53.5	30.0	24.3	49.2	26.1	0.4	701
Finland	50.7	77.6	13.1	59.4	27.6	40.7	31.1	26.0	2.2	588
Germany	59.4	63.2	54.7	27.6	17.7	70.5	11.0	10.4	8.1	492
Great Britain	58.6	71.2	48.7	24.0	27.4	68.9	6.4	13.5	11.3	914
Hungary	55.6	67.2	20.8	64.6	14.7	42.7	44.4	10.3	2.6	457
Ireland	55.0	65.3	46.3	32.8	20.9	70.6	13.3	8.0	8.0	473
Italy	57.5	71.9	34.8	49.7	15.5	72.3	19.4	8.1	0.1	690
Netherlands	54.9	76.0	29.2	40.4	30.4	56.3	23.3	17.5	2.9	730
New Zealand	59.6	70.4	45.6	26.9	27.6	46.5	13.6	25.4	14.5	722
Norway	51.9	81.1	9.9	40.2	49.9	24.9	42.9	30.2	2.1	676
Poland	51.8	69.1	56.1	26.2	17.7	72.1	16.4	9.9	1.7	599
Slovenia	54.9	89.1	22.6	56.8	20.7	47.7	39.4	10.4	2.4	576
Sweden	50.7	75.2	10.8	59.9	29.3	47.3	26.7	23.5	2.6	499
Switzerland	53.6	76.2	5.9	63.8	30.3	23.3	54.9	19.8	2.0	845
USA	55.4	79.7	17.1	39.0	44.0	15.1	44.4	34.5	6.0	498
Total	55.3	73.0	30.6	41.4	28.0	49.6	27.9	17.6	4.9	12,346

Source: 1994–98 International Adult Literacy Survey.

Table 3

Regression of Literacy Skills on Country Indicators and Individual Characteristics

	Document Literacy		Quantitative Literacy		Prose Literacy	
	Model 1	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Intercept	209.92***	200.03***	219.36***	213.34***	223.87***	211.68***
Education						
High school	69.16***	56.05***	62.18***	51.33***	58.47***	48.89***
College	104.73***	88.79***	102.74***	88.63***	94.54***	80.96***
Country						
Belgium	57.38***	56.33***	51.59**	49.72**	35.11*	34.50*
Canada	37.83*	36.38*	26.42	25.24	28.01	26.61
Chile	−14.12	13.39	−42.19**	−42.63**	30.02*	−28.57*
Czech Republic	66.27***	60.37***	69.34***	62.79***	38.34**	35.55**
Denmark	67.76***	59.91***	61.51***	54.21**	34.07**	29.88*
Finland	63.46***	57.76***	49.87**	44.10*	52.65***	49.27***
Germany	76.46***	76.46***	74.42***	73.54***	53.10***	53.07***
Great Britain	53.61***	54.30***	40.39**	40.34*	37.33***	37.37**
Hungary	8.76	8.76	8.44	7.08	−6.65	−7.55
Ireland	27.39*	29.73*	21.76	22.89	21.88^	24.34^
Italy	18.86	17.80	14.07	11.75	6.10	6.17
Netherlands	68.23***	66.90***	59.06***	57.04***	48.07***	47.52***
New Zealand	39.26**	38.56**	30.26*	28.73^	32.55**	32.38**
Norway	71.66***	65.28***	59.99***	54.03**	49.77***	46.14***
Poland	3.06	1.65	2.84	0.16	−4.67	−4.54
Slovenia	−6.72	−11.49	−10.08	−15.79	23.36^	−25.55*
Sweden	84.78***	81.24***	74.81***	69.86***	59.62***	59.01***
Switzerland	49.97**	44.35**	56.26***	52.02**	31.79*	26.77*

High School * Country

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	Document Literacy		Quantitative Literacy		Prose Literacy	
	Model 1	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Belgium	−44.08*	−36.84*	−40.15^	−34.49^	−36.39*	−30.57^
Canada	−22.42	−16.24	−11.01	−7.13	−19.89	−14.22
Chile	−26.37^	−17.17	−6.21	2.01	−10.02	−4.08
Czech Republic	−38.25**	−29.40*	−29.09*	−20.33	−29.54*	−24.87*
Denmark	−39.30*	−31.07*	−35.40^	−28.38	−33.55*	−28.99*
Finland	−31.83*	−22.39	−30.83^	−22.89	−28.01*	−22.12^
Germany	−52.37***	−41.36**	−48.47**	−38.73*	−41.60**	−33.51*
Great Britain	−40.74*	−32.53*	−31.52^	−26.36	−31.84*	−24.21^
Hungary	−29.10^	−23.24	−9.02	−4.94	−22.23	−17.45
Ireland	−22.66	−15.82	−13.77	−8.13	−13.44	−9.19
Italy	−23.63	−15.85	−12.62	−5.69	−4.31	1.00
Netherlands	−38.02**	−31.04*	−34.54*	−28.64^	−25.66^	−20.80
New Zealand	−16.04	−8.43	−11.50	−4.59	−11.83	−8.19
Norway	−45.47**	−37.93**	−42.93*	−37.17*	−38.14**	−32.77*
Poland	−22.33	−13.78	−14.28	−6.42	−16.5	−11.07
Slovenia	−16.91	−9.97	−6.69	−0.66	−9.74	−4.50
Sweden	−43.18*	−33.57*	−40.05*	−30.97^	−27.28^	−22.13
Switzerland	−32.19^	−26.47	−36.97*	−33.11*	−27.81^	−21.77^
College * Country						
Belgium	−49.21**	−44.56**	−42.05*	−37.49*	−33.88*	−29.54^
Canada	−24.87	−20.98	−24.39	−21.56	−28.82	−24.17
Chile	−28.67*	−22.22	−0.32	5.87	−11.48	−5.92
Czech Republic	−49.51***	−41.57**	−44.93**	−36.66*	−45.63***	−39.41**
Denmark	−54.23**	−45.15**	−60.86**	−52.61**	−50.12***	−43.60**
Finland	−45.30**	−35.61*	−52.43**	−43.62*	−43.36**	−35.90*
Germany	−63.43***	−55.12***	−67.13***	−59.28**	−48.83***	−42.28**

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	Document Literacy		Quantitative Literacy		Prose Literacy	
	Model 1	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Great Britain	−47.04***	−39.94**	−41.07**	−35.71*	−38.58***	−31.11**
Hungary	−26.32	−23.47	−11.38	−8.95	−31.99*	−29.53^
Ireland	−44.23**	−39.96**	−40.13*	−36.10*	−36.46**	−32.68*
Italy	−42.00**	−35.44*	−36.77*	−29.31^	−23.12^	−18.05
Netherlands	−59.39***	−53.30***	−54.65**	−49.49**	−43.24***	−37.23**
New Zealand	−41.88**	−34.80**	−42.90**	−36.74*	−37.91**	−32.18**
Norway	−50.90**	−43.51**	−50.11**	−43.33*	−46.11***	−40.97**
Poland	−36.11*	−29.38^	−35.94*	−28.19	−28.65*	−25.13^
Slovenia	−14.37	−8.23	−7.70	−0.33	−7.76	−3.59
Sweden	−54.83***	−47.48**	−52.95**	−45.06**	−35.80**	−31.65*
Switzerland	−47.92**	−42.25**	−62.45***	−59.65***	−46.98**	−37.59*
Female		2.42		−3.89^		11.40***
Employed		13.40***		14.23***		9.27**
Parental Education (reference = < high school)						
High school		14.77***		10.35**		9.22*
College		13.39**		10.88**		14.59***
Missing		13.85*		−12.39^		−10.1
R^2	.32	0.35	.33	0.35	.32	0.34

N = 12,346

^ p < .10

* p < .05

** p < .01

*** p < .001 (two-tailed tests)

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Table 4

Hierarchical Linear Modeling Estimates of Between-School Inequality Effects on Quantitative Literacy Gaps by Educational Attainment

	Country's degree of between-school inequality in:				
	Instructional Resources[a]	**Class Size[a]**	**Teachers' Experience[a]**	**Teachers' Certification[b]**	**Amount of Curriculum Taught[c]**
Student-Level Equation (effects of other student-level variables are not shown)					
Intercept	254.201 (3.338)***	255.683 (5.093)***	255.823 (4.254)***	260.496 (4.080)***	255.777 (4.663)***
College	57.259 (2.984)***	56.463 (3.083)***	56.267 (2.718)***	52.774 (2.878)***	56.243 (2.951)***
High school	35.137 (2.039)***	34.680 (2.521)***	34.539 (2.222)***	32.386 (2.554)***	34.573 (2.389)***
Country-Level Equation					
Effects on the Intercept					
Instructional resources	−20.893 (7.146)*				
Class size		−1.898 (1.425)			
Teachers' experience			−7.687 (2.969)*		
Teachers' certification				−15.202 (2.037)***	
Amount of curriculum					−24.030 (13.718)^
Odds ratio of receiving training (< high school vs. high school or higher)	12.190 (4.421)*	17.442 (4.411)**	16.094 (3.986)**	12.512 (3.363)**	15.550 (3.902)**
Effects on the Slope of College					
Instructional resources	10.428 (4.604)*				
Class size		2.806 (1.122)*			
Teachers' experience			5.293 (1.872)*		
Teachers' certification				7.689 (1.517)***	
Amount of curriculum					16.893 (8.541)^
Odds ratio of receiving training (< high school vs. high school or higher)	−7.144 (3.132)*	−9.864 (3.138)**	−9.249 (2.938)**	−6.790 (2.474)*	−8.830 (2.886)**
Effects on the Slope of High School					
Instructional resources	10.820 (2.623)**				
Class size		0.787 (1.335)			
Teachers' experience			3.635 (1.397)*		

	Country's degree of between-school inequality in:				
	Instructional Resources[a]	**Class Size**[a]	**Teachers' Experience**[a]	**Teachers' Certification**[b]	**Amount of Curriculum Taught**[c]
Teachers' certification				5.350 (0.923)***	
Amount of curriculum					11.385 (6.051)^
Odds ratio of receiving training (< high school vs. high school or higher)	−3.579 (2.158)	−6.640 (1.936)**	−6.028 (2.059)*	−4.679 (1.784)*	−5.730 (1.791)**
Variance Components					
Intercept	370.0	607.1	402.8	322.7	495.1
% of Variance explained	63	38	59	67	50
College	188.1	222.4	134.5	128.2	180.0
% of Variance explained	46	38	62	58	50
High School	64.3	128.6	83.9	99.9	105.3
% of Variance explained	64	26	52	42	40

Note: Denmark is excluded from the analysis of instructional resources. Three countries – Canada, Hungary and Slovenia – are excluded from the analysis of teachers' certification. Values in parentheses are robust standard errors.

[a] The coefficient indicates change in the dependent variable per .01 unit change in the Theil index.

[b] The coefficient indicates change in the dependent variable per .1 unit change in the Theil index.

[c] This is a dichotomous variable that distinguishes Chile, Great Britain, Hungary, New Zealand and the United States from the rest of the countries.

^ p < .10

* p < .05

** p < .01

*** p < .001 (two-tailed tests)