A Multilevel Analysis of Reading Literacy Achievement: Comparisons of the Canadian National Sample, and its Highest, and Lowest Quartiles

by

Shawn W. Thomas
Bachelor of Arts, University of Winnipeg, 2005

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ABSTRACT

This study investigates the importance of demographic variables and the influence of teachers on the reading literacy performance of Canadian 15-year-olds in a multi-level analysis of the national population as well as its highest and lowest quartiles. A large-scale representative dataset was chosen for these purposes. Multi-level modeling was completed using Hierarchical Linear Modeling (v. 6.08) quantifying the variance present at the student- and school-levels as well as identifying statistically significant correlates for each of the three models examined. Results were consistent with prior research while the use of a quartile-split accessed subpopulations based on achievement that are otherwise not closely examined by national averages. Students' gender and schools' SES appear to be the most influential individual factors of those examined, while the positive influence of teachers is a conclusion to be gleaned from this research.

TABLE OF CONTENTS

LIST OF TABLES

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Chapter One: Introduction

"The foundation of every state is the education of its youth" - DiogenesLaertius

The foundation of democracy is the equality of a nation's citizens. Education is the tool used to ensure that a society transmits its culture and prepares its population for adult citizenship and participation in its economy. In this age of information, economies are now linked together more than ever before, and globalization has taken education from local transmission of customs and practices to the advancement of science, technology, and society itself (Spring, 2008). Education systems from around the globe now compete to produce resources in the form of human capital (Coleman, 1988) that can contend with a dynamic and fast-paced world of perpetual progress. Canada's place in the world economy is admirable, and the national pursuit of equitable education systems is essential to our continued success on the international stage.

Research can provide policy makers with up to date and thoughtful information about the issues for which they are required to make decisions (Gall, Gall, & Borg, 2010). This study will attempt to add to the existing body of literature with a description of the nature of Canadian students as a whole and then comparing our high and low achievers to see if there are policy recommendations that can raise the bar for all students.Potential issues of interest include variations in the demographic composition of the higher and lower achieving groups, school differences in group demographic make up, as well as differentially perceived relationships with teachers. These issues could inform policy debates concerning student placement and direct further research in the area of student-teacher relations to better understand this important relationship.

Overview

Academic achievement has been a highly researched topic for decades. The Coleman report (Coleman, Campbell, Hobson, McPartland, Mood, Weinfield, & York, 1966) brought great attention to the issue by concluding that family background and social context alone impact students' achievement free from the influence of schools and educational policy. Studies such as these spawned a litany of research ranging from influential support (Jencks, 1972) to an entire field contesting the notion that schools are unable to influence academic achievement. School Effectiveness Research (SER) is the field that has demonstrated the magnitude of the impact that schools have on students and their scholastic performance (Goldstein & Woodhouse, 2000). Few today would argue that schools do not influence the achievement of their students and modern research attempts to explore all factors associated with education. Advancements in computer processing have made data analysis techniques widely available that are capable of interpreting not only student and school level factors but also the relationship between those two levels of influence. Specifically, multilevel modeling using HLM software allows for the examination of student's traits related to achievement, school's traits related to achievement, while simultaneously examining the relationships between school traits and student traits that influence individual achievement.

Individuals vary in a plethora of ways beginning with their biologically inherited differences and subsequently their lived history and social interactions (Bornstein & Lamb, 2005). Individual differences related to achievement range from developmental issues, to quantifications of intelligence, to sex and gender differences. Traits of concern at the student level in the present research include gender differences and family background variables, specifically: socioeconomic status, family structure, and immigration status. Students'

perceptions of the school environment also contribute to the individual's motivation and performance (Anderson, 1982). Demographic variables have been selected at the student level in order to investigate similarities and differences between the highest and lowest achieving cohorts in the study with the intention of informing policy relating to supporting at-risk students.The final level-1 variables selected student-teacher relations. This variable shows the influence teachers have on their pupils from the perspective of the students, offering insight into the experiences of high and low achievers beyond insinuations derived from test scores.

Schools constitute the organizations in which these students are educated and are therefore the second level of this multilevel analysis. The influence schools have on children are wide-ranging and result in students of the same school, who share similar experiences, are more like each other than students from other schools who also share experiences. Schools vary on organizational characteristics such as public versus private schools, religious institutions, and language of instructions. These organizations consist of many individuals functioning in positions at a variety of levels creating cultures of their own with innumerable implications for the student population (Arum, 2000). This study attempts to focus on school factors that are hierarchically related to the student factors already indicated. These variables are the average socioeconomic status of the students in the school, proportion of female/male students, proportion of nuclear families, and proportion of students identified as immigrants. In order to examine the influence of teachers at the school level the following three variables were identified: average school student-teacher relations, teacher behaviour, and teacher participation. These variables will help to identify characteristics of the schools housing the highest and lowest achievers in the Canadian data, measure the influence these schools have on individual's

achievement, as well as examine potential differences in the relationships and experiences of teachers in the Canada's educational systems.

The data set chosen for analysis is the results of the 2009 version of the Organization for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA). PISA is an international assessment of sample populations of 15-year-old students from all OECD member countries (OECD, 2010). These assessments are accomplished not through the examination of curriculum-based performance measures, but rather, instruments PISA designs to assess the literacy students possess that are required by adults in a modern economy. It is for this reason that this population was chosen due to their nearing completion of compulsory education in most OECD countries.

PISA operates on a 3-year cycle shifting its focus across reading, mathematics, and science. The focus in 2009 was on reading literacy, considered by some the most important form of literacy due to its foundation for the other two (Norris & Phillips, 2003). Canadian students performed well in the international rankings (Statistics Canada, 2010), however, population averages do not alone provide information on how to improve the education of students who perform poorly relative to their peers. This study is designed to provide more detail on this issue with the hope of identifying student and school traits related to achievement, which willinform educational policy. This data set is suitable for the research design due to its focus on achievement results in combination with an extensive examination of student and school variables contributing to those results. Though only a limited number of the variables available at either level have been chosen for this study, the PISA data set offers a wide range of variables appealing to secondary research in many areas of the social sciences and is a rich resource for many researchers around the world.

Purpose

The purpose of this study was to examine Canadian data from the 2009 Programme for International Student Assessment and investigate the relationships between both student- and school-level factors on the reading achievement of 15-year-olds. The research question then became: how do demographic variables as well as teacher influences effect reading literacy scores when measured at the student- and school-levels on the Canadian national population as well as its highest and lowest quartiles? In order to focus attention on supporting Canada's lowest achieving students, Hierarchical Linear Modeling (Raudenbush &Bryk, 2002) was used to create a model for each of the three groups to be examined. Commonalities and differences that exist between high- and low-achievers in comparison to the Canadian average provided the basis for discussion. Results gained by splitting the data set were highlighted in the experiences of the top- and bottom- quartiles of students by verifying how the influencing factors identified at the national level would hold across the subpopulations. Focusing attention on the demographic realities of both groups of students and their schools will provided a descriptive analysis useful in further discussions of the influence of teachers on these subpopulations. Together, this adds to the body of literature with the goal of helping to inform policy and future research both in terms of where Canada's educational systems are effective and where further resources could be targeted to support those students who struggle behind their peers.

Summary of Chapter One

This introductory chapter has offered an overview of the topic of research and the methods to be used to satisfy the intent of supporting Canadian students to achieve their full potential. The next chapter consists of a literature review designed to situate this study in its field of research as well as to support its design and theory employed. Brief histories as well as

current description of the state of research in the significant areas will be pursued. The following chapter will then describe the methodology chosen and support the analysis of the data through evidence from prior research.

Chapter Two: Review of the Literature

This literature review outlines the areas of research covered by the research question, specifically, the influence of demographic variables on student achievement and the role schools play in the achievement of their students.The chapter will begin with an overview of achievement and its measurement and a discussion of literacy, the achievement type highlighted by the data set. Next, it will delve into each demographic variable: gender, family structure, socioeconomic status, and immigration; focusing on their relationship to student achievement. Finally, the chapter will conclude with a brief discussion of the influence schools have on individual achievement noting the criticism that exists regarding school effectiveness research while showcasing the important role teachers' relationships play in their students' education.

Achievement

Generally speaking, achievement is the outcome of a learning process. The measurement or evaluation of achievement is an important facet of the education process as competition derived from a global economy pervades classrooms around the world. Tests are the most common form of the assessment of learning or achievement in educational settings and are commonly found in the form of teacher written tests, standardized or norm-referenced tests, criterion-referenced tests, or portfolios (Gipps, 1999). Each method of testing has it merits and detractions, but their common goal of quantifying the achievement of students maintains their relevance and importance in education today.

The study of achievement is a complex and multifaceted area drawing attention from fields as diverse as education, psychology, philosophy, sociology, and economics (Coleman, 1988; Winne &Nesbitt, 2010). Winne and Nesbitt (2010), describe the task as ""Extensive" significantly understates the scope of research relevant to a psychology of academic

achievement" (p. 654). Within the field of psychology alone these authors discuss the impact of factors ranging from cognition, metacognitions, motivation, to the context of each individual learning scenario at every level of influence. A topic this complex can be difficult to study and interpret, however, advances in statistical analysis and the availability of specialized software has opened up the field to better evaluations (Ma, 2001). An excellent example of the use of advanced quantitative analysis is the work of Ma and Klinger in 2000.

In their study, Hierarchical Linear Modelling of Student and School Effects on Academic Achievement, Ma and Klinger examined data collected on the entire English speaking population of New Brunswick 6th graders in the 1995/96 school year. The total number of students was 6,883 from all 148 schools in the province educating 6th graders. Students were evaluated on their achievement in mathematics, science, reading and writing, with their results processed in conjunction with student and school questionnaires. The goal of this research was to examine the influence of student and school factors on the achievement of students in a range of academic topics. Hierarchical Linear Modelling (HLM) was used to separate the effects of schools on students who are nested in those 148 schools. A sample of the findings from this study includes gender differences within subject areas, variation in achievement residing mostly within rather than between schools, and low achievement amongst students self-identified as Native in ethnicity. Further, they found that school size did not influence achievement, students of single parents had similar achievement to students of two parent households when SES is controlled for, and the most interesting finding was that when SES was controlled for Native students' mathematics achievement was not significantly below average as it was for the other domains assessed.The results of this study were both significant and interesting, showing how useful

HLM can be in educational research and generally how research can inform policy directly related to education issues (Gall, Gall, & Borg, 2010).

Results from research utilizing this multilevel methodology provide a deeper understanding of the context of learning achievement. It is with this goal that this thesis will pursue similar objectives on the reading achievement of Canadian students at the national level from the results of the 2009 PISA assessment.

Reading Literacy

The literature provideslittle agreement on a single definition of the concept of literacy, with some authors arguing that the concept is so context specific that one can never be found (Bartlett, 2008). The field has adapted by operationalizing the term for individual studies. Examples of recent definitions include one from the International Association for the Evaluation of Educational Achievement (IEA): "ability to understand and use those written language forms that are required by society and/or valued by the individual" (Shiel & Cosgrove, 2002; p. 690). This definition addresses written language forms valued by the individual; in this study it is referring to the variety of media used by individuals that carry written language including printed text in the form of books, as well as electronic text such as text messages or online discussion forums. These forms of literacy can be highly valued by individuals and have the potential to produce more satisfaction than literacy used primarily in an economic context such as while an individual is at work. Forms of literacy vary depending on the individual's economic context, for example a delivery person may be required to read street signs and maps while an accountant may be required to read technical documents on tax codes. The OECD developed the original PISA definition for literacy as: "understanding, using and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society"

(OECD, 1999, p. 21). This definition refers to using literacy to develop an individual's knowledge and potential as a participant in society which is PISA's approach to applying literacy in an economic sense tying into their stated purpose of assessing youth towards the end of their compulsory education and just prior to entering their national economies. The focus here suggests a more economic perspective to their definition, which supports the goals of the organization (OECD) and the specific assessment (PISA). Examples of reading passages include news paper articles of varying difficulty designed to assess reading comprehension. These definitions are suitable for the purposes they serve, each demonstrating internal consistency within their assessment measures, and in the measurement of achievement data in their respective international contexts in the global economy.

The importance of reading literacy is potentially the only notion agreed upon in the literature, with support wide ranging from economics (Bechger, van Schooten, De Glopper, & Hox; 1998), to politics (Bartlett, 2008), to the essential literacy for science and technology (Norris & Phillips, 2002). Regardless of contextual implications of literacy, its place as a foundation for knowledge-based economies is the reason that the OECD focuses attention on it in their PISA studies (OECD, 2010). With the current direction of world economies and the global society in mind, trends towards online reading have become a focus in the study of literacy. The trend of online reading and the challenges it presents were recognized in the early 1990's (Smith, 1990), and PISA has recognized the growing issue with the addition of adigital reading assessment (DRA) (OECD, 2010). The DRA was optional in PISA 2009 and was completed by 20 countries not including Canada, and will therefore not be a focus of this work. However, its mention is noteworthy in the context of recent research in this field of literature.

Leu, McVerry, O'Byrne, Kiili, Zawilinski, Everett-Cocapardo, Kennedy, & Forzani(2011) examined the differences between online reading and traditional sources of reading material. They found that due to the vast amounts of information available from sources with unknown quality or bias, online reading requires skills and techniques not required by "offline" reading (Leu, et al. 2011). Online reading is self-directed and there is more of a focus on critically evaluating the source of the information along with the content itself. This leads to the challenges for school and students of low socioeconomic status where access to the internet is not available outside of school. The authors contend that schools with unlimited internet access incorporate online reading into their curriculum and homework. They argue that this disparity in internet access will lead to a gap in literacy skills as school children age enter the job market with the potential for lower SES job seekers at a disadvantage in terms of online literacy; though they may be equal in offline reading literacy. Another interesting factor is the impact online reading has on offline literacy. Lee and Wu(2012) looked at this question using 2009 PISA data and found that students with positive attitudes towards information and communication technology (ICT) were more likely to have home access to the internet and also score lower on "offline" reading achievement (Lee & Wu, 2012). These results become significant in light of Leu et al.'s discussion of low SES students having less access to online reading. Though Lee and Wu suggest that offline reading is negatively impacted indirectly by positive attitudes towards ICT, this does not favour low SES students with less access to ICT because of the progressive incorporation of online reading in the workplace (Lee & Wu, 2012).

This field of literature is currently shifting towards an incorporation of online reading into the more traditional assessments of reading literacy. The differences as well as the relationship between these two forms of reading literacy appear to be influential in the direction

this field is heading. PISA included a digital reading assessment (DRA) as an option in the 2009 study and could potentially include it in all countries to be tested in the following reading cycle scheduled in 2018.

The Impact of Demographics

Gender Differences

The discussion of demographic issues in achievement must recognize the possibility that findings have the potential to lead to the blaming of demographic groups rather than the identification of social inequalities. Halpern (1997) opens her article with this cautionary note and states that when it comes to gender differences, many researchers that identify real differences face the dilemma of whether or not to report their results due to the fear of supporting the misogynist agenda of others (Halpern, 1997). However sociopolitical the issue may be, Halpern argues that science is the best method of finding valid conclusions on sensitive issues and highlights that science does not create stereotypes but rather misunderstandings do. It therefore becomes the responsibility of researchers to ensure their work focuses on the clarity of its language and results, the limitations of its methodology, and the transparency of its agenda. This work will strive to meet these expectations.

Biological sex differences in science inevitably lead to a discussion of terminology, i.e. sex versus gender. Haig (2004) describes the shift in scientific literature from the use of 'sex' to the contemporarily more popular use of 'gender' in terms of differences between males and females. His account shows the influence of feminist literature in the 1970's leading to the eventual adoption by the majority of researchers in the majority of fields by the early 2000's. The reason for the distinction is that many differences are socially constructed rather than

biologically determined and this warrants acknowledgement through the use of the term gender in scientific literature (Haig, 2004).

Many gender differences in psychological abilities have been found in research though none have garnered unanimous support (Halpern, 1997). Some areas have been identified where females have an advantage and include: accessing phonological and semantic information, production and comprehension of complex prose, perceptual speed, and fine motor skills (Halpern, 1997). They have also been found to achieve higher grades, perform better on writing tasks, and have a higher post-secondary completion rate (Buchmann, 2006; Halpern, 2004). Males tend to perform better in tasks requiring visual-spatial working memory, fluid reasoning, and motor skills involved in aiming (Halpern, 1997) and have a tendency to score higher on standardized tests in mathematics and science, judgments of velocity and navigation, as well as knowledge of geography and politics (Halpern, 2004; Ma, 2008). On the negative side males are more likely to be found in low-ability groups including mental retardation, attention disorders, dyslexia and speech disorders (Halpern, 1997).

The discussion of a gender gap in academic performance began with the first review of the literature by Maccoby and Jacklin in 1974 (Hyde & Linn, 1988). Buchmann, (2008), provides a thorough review of the literature and highlights major issues the field has identified beginning in the late 1950's until the present. The performance gaps identified were in favour of females in reading, and males in mathematics and science. Interestingly, the gaps only became measureable around the age of 11 and grew larger as students made their way into adolescence (Buchmann, 2008). While later research found a narrowing in these academic gaps (Hyde & Linn, 1988), others have found that patterns in these gender gaps may vary by country (Ma, 2008), with one possible explanation for a narrowing gap in the United States is the intentional

removal of questions from standardized tests that produce significant gaps by gender (Halpern, 1997).

Theories for the causes of differential performance by gender follow a general dichotomy along the lines of the nature-nurture debate (Halpern, 1997). McBurney, Gaulin, Devineni, and Adams (1997) looked at theories on Environment of Evolutionary Adoptedness (EAA) theories of gender differences and found support for male superiority in spatial ability and navigational tasks could be linked to polygynous mammals. Gaulin's previous works had found that species where females stayed relatively localized but males benefited from reproductive encounters outside of their regular territory had larger sex differences in spatial abilities, even demonstrating this point in the laboratory with comparisons of polygynous and monogamous voles. Then with their 1997 article, McBurney et al., provided more evidence for EAA in that women had superior spatial memory due to their gathering past (McBurney, et al., 1997).

Socially mediated theories are based upon the social learning theories inspired by the work of Albert Bandura (Halpern, 1997), and look at differences in values and attitudes between the genders that lead to academic choices. Eccles, 2011, outlines the application of the Eccles Expectancy Value Model of Achievement-Related Task Choices in order to understand the psychological processes involved in the educational and occupational choices of males and females. Eccles summarized the impact of subjective task value in terms of short and long-term goals, intrinsic interest, attainment value, and cost of engagement on the choices students make (Eccles, 2011). This model attempts to explain the changes seen in gender patterns over the previous decades as well as identify the complexity of achievement-related choices that are the current academic and economic reality. Eccles lists issues such as low proportions of females in traditionally male occupations as a factor influencing female students' expectations when

considering educational and economic choices. She discusses how 'old boys' clubs' create obstacles to entry into fields and success within them. Females may also have priorities not recognized by men in male-dominated fields and require extra effort and resources by individual females in order to assert their desires and needs. Eccles discusses the social formulation of these issues within the expectations of individuals, and suggests that families and schools can reinforce these expectations sometimes without intention. Schools therefore have a role to play in shaping the expectations of their students with the potential to steer females and males towards their aptitudes in areas traditionally dominated by the opposite gender.

A further issue regarding the relationship between gender and achievement is the differing academic achievement by gender and is discussed in the literature in the context of achievement 'gaps.' Ma (2008) sought to identify the role schools play in achievement gaps between the genders. Looking at international PISA data, Ma, compared 41 countries from the 2000 data set. Findings showed achievement gaps as expected in most, though not all, countries as well as little influence from schools. Ma concluded that an absence of school effects on achievement gaps supports cognitive differences between the genders, but cautioned that because these differences were not universal, i.e. not every country showed gender differences, other factors related to socialization could be influential.

Another attempt to identify the influence of schools in gender-related achievement differences was the 2006 work of Van der gaer, Pustjens, Van Damme and De Munter(2006). Van der gaer et al., looked at the language achievement of adolescents based on group attitudes of classrooms. Examining teacher's perceptions by the students at the individual and class level showed that males performed worse in classes where their fellow students possessed negative views of the teacher. Essentially, if the class as a whole had a positive view of the teacher then

males performed as expected, however, if the class as a whole had a negative view of the teacher then males would perform worse in assessments than would be expected. This result becomes more interesting when taking into consideration the cases of females in these same classes who's performance remained steady regardless of class attitudes towards their teachers. Additional results showed that lower grades for males only arose in situations where teachers had poor relationships with the students, students lacked motivation, and when students felt poorly integrated (Van de gaer, et al., 2006). This study highlights the roles played by peers and teachers and how the influence of each group can be realized in individual achievement.

Identifying gender differences at the individual and school level on high- and low-achievers will promote clearer recommendations than studies that look at group averages. Understanding the gender composition of these groups will lead to a focused approach that can target students most in need of extra resources.

Family Structure

Family structure attempts to describe the living arrangements of families and how and why varying living arrangements affect the family members involved. The traditional two biological parent, or nuclear, family is not the norm in many countries, with estimates that half of all children will spend at least some time outside of this family structure (Astone, 1991; Teachman, 2008). Alternatives to the traditional households are numerous and include: single parents, step-parents or blended families, never married single mothers, teen parents/teen mothers, families with biological siblings only, and families with step- and half-siblings. Families with adopted and foster children are generally studied in their own field of research. For this context, the impact of family structure on academic achievement is considered with findings from the research offering both predictable and surprising results.

Teachman (2008) discusses research that indicates a strong relationship between living arrangements and students' likelihood of high school graduation, years of schooling completed, scores on standardized tests, and grade point average (GPA). Findings suggests that students who do not live with their married biological parents are less likely to graduate, attain fewer years of school, and score lower on both standardized tests and have lower GPA's (Teachman, 2008), while Bankston found similar results and suggests that these results are valid even after controlling for SES (Bankston, 1998). Pong and Ju (2000) emphasize the impact of family structure on the completion of secondary education and caution that dropping out is potentially "the most serious consequence for children's future" (Pong & Ju, 2000; p.148). Dropping out is strongly associated with economic hardship including unemployment, low earnings potential, and the risk of criminal activity and drug use (Pong & Ju, 2000). Other findings suggest that divorce has more of an effect on boys than girls (Downey, 1995; Krein, 1988; Teachman, 1987), and that step-siblings in the household are correlated with lower academic achievement not seen in households with half-siblings (Tillman, 2008).

Factors resulting from unstable family structure impact family members through three general theoretical avenues: turbulence, economic resources, and parenting context (Pong, 2000; Teachman, 2008; Teachman, 1987). Turbulence refers to the stress families experience due to the causes and process of divorce, and include factors inside and outside of the home. Economic resources are examined through the dilution model proposed by McLanahan in 1985 (Pong, 2000), which shows how resources are stretched and depleted when the economic realities of single parenthood are realized. Other examples of resource depletion include time with parents which is strongly linked to parental involvement (Astone, 1991), and economic resources tied to the size of family, finding that larger families have fewer resources available for each member

(Downey, 1995). Parenting context is potentially the most intriguing variable due to findings that show that positive parent-child relationships can mediate the negative effects associated with family structure (McNair, 2009; Phillips, 2012; Tillman, 2008).

Pong (1998) looked at the impact that single parenthood had on mathematics and reading achievements amongst grade 10 students on the National Education Longitudinal Study (NELS). Fifteen percent of the sample population of 10,399 students from 654 schools showed that the school composition had an effect over and above individual students' backgrounds. Specifically, a negative impact on achievement was found on all students attending schools with higher proportions of low SES students and high proportions of children of single parents.

Multilevel modeling can be used to describe the influences of a variety of factors on individual achievement. The family structure of students as well as their peers in the form of school composition will be examined for their impact on achievement.

Socioeconomic Status

Generally speaking, socioeconomic status (SES) is considered a social construct comprised of various levels of educational attainment, income, and status of occupation to form a multidimensional factor that influences many aspects of life (Brooks, Wesler, Hogan, & Titsworth, 2011). The origin of the construct lies in research in status attainment and social stratification (Nonoyama-Tarumi, 2008). Prior to this, data collected on populations by governments and insurance corporations were generally restricted to individuals' age and gender (Entwistle & Astone, 1994). It was not until the 1930's that sociologists and psychologists began to survey participants on their income, possessions, and education in attempts to better understand how individuals and groups differ in their status, and how that relates to their behaviour (Edwards-Hewitt & Gray, 1995). It was not until 1960 that the United States National

Center for Health Statistics as well as the Bureau of the Census began including SES as a variable in their research (Stockwell, 1966).

A theoretical shift in SES research was initiated by Coleman in 1988, and transferred the emphasis in the field from measuring household occupations, education, and income towards individual and family access to resources. The idea came from economics (Coleman, 1988), and likened the possession of economic resources to the possession of human resources. In economics, resources or assets can be thought of as tools that can be used when required and the access to and collection of tools increases an individual's or group's economic capital. Essentially, they are more prepared and therefore more valuable. Coleman incorporated these ideas into his sociological theory resulting in his work *Social Capital in the Creation of Human Capital*, where he describes resources such as education and more specifically, social connections, as forms of human capital that are no different from the possession of assets in the economic sense. This interdisciplinary theory changed the course of SES research, and with additions from others, has transformed modern thinking on SES and its measurement (Entwistle & Astone, 1994). While revolutionary in its impact, Coleman's focus on social capital has not proven itself in the literature (Brooks, et al., 2011; Schultz, 2005). Instead the field has transitioned to studying a wider range of forms of human capital as will be described next.

Socioeconomic status conceptualized as the access to or possession of human capital was the starting point for additional work in theory and the incorporation of other forms of capital. Potentially the most influential capital addition to the current model is based on the work of Bourdieu and his concept of cultural capital (Yang & Gustafsson, 2004). Cultural capital, defined by PISA as the possession of items related to "classical" culture in the home (OECD, 2012) as described by Marks, Cresswell and Ainley (2007), has the prospective ability to explain

differences within households that are not captured by traditional measures of SES. Marks et al. key in on 'academic climate' within the home suggesting that families that value education and discuss its importance with children outperform students from households that do not focus on the value of education. The authors suggest the incorporation of a construct that captures the value of education in the household as having the potential to be more meaningful than PISA's current method of indirectly measuring this value through possessions. Further, the incorporation of Bourdieau's notion that one form of capital can lead to greater access to other forms of capital, allows SES theory to explain more than the influence of poverty on individuals and groups, but also a greater range of the SES spectrum. Today, capital-based theories of SES, including PISA's use of Economic Social and Cultural Status (ESCS), are being applied in research around the world and are explaining more variance between participants than traditional measures alone (Schulz, 2005; Sirin, 2005).

The relationship between SES and achievement is varied in the literature both in its measurement and the resulting strength of the correlation coefficients (White, 1982). Two meta-analyses have been conducted on the subject, first by White in 1982 reviewing literature published prior to 1980, then a replication study by Sirin (2005) examined the literature between 1990 and 2000. Conclusions were similar for each researcher, finding that at the student level a weak ($r = .22$) but statistically significant relationship between SES and achievement accounting for approximately 5% of the variance between students (Sirin, 2005). Aggregated measures of SES at the school level were found to have stronger correlation coefficients but may fall victim to the atomistic fallacy of attributing group characteristics to all members of that group (Sirin, 2005). Sirin addressed this in the context of studies that did not attempt to measure SES at the individual level and instead used indirect methods such as aggregate data collected on the

community via zip codes in research performed in the United States. Variations in SES measurement are attributed to differing types of SES measured, student and group characteristics (Sirin, 2005), and research design of the data collected (Entwistle & Astone, 1994). In addition, each researcher noted a great deal of variation across countries as well as achievement domains. As with all meta-analysis, results are in aggregate form and may not capture the variability in the literature with composite descriptors.

The impact of socioeconomic status extends beyond academic achievement with the field of literature attending to other factors influenced by SES, with evidence suggestingthat it is equally important to success in early adult life as individual intelligence or grade point average (GPA)(Strenze, 2007). Another issue in the field is examined by Entwistle and Alexander (1994),who explored the concept of summer setback. Summer setbackdescribes how low SES children are found to perform at similar levels while school is in session but consistently score lower at the beginning of the next school year. The issue becomes less about what is lost over the summer by low SES students, but rather what their higher SES classmates gain over the summer. They state, "…it is not race or family status that controls summer gains – it is economic status" (Enwistle & Alexander, 1992, p.82). This cumulative effect develops as students develop; initially only modest differences are stratified by individual SES with a stable impact found between ages 7 to 11, followed by a widening gap as children enter adolescence (Caro, 2009).

An issue effecting low SES students as they progress through the education system, as discussed by Trusty and Harris (1999),is the impact of SES on talent development and the issue of lost talent. Specifically, Trust and Harris identified students who indicated in the 8th grade that they would like to attain at least a bachelor's degree, and scored above the median in

mathematics and reading, who did not eventually pursue postsecondary education.They found that lower SES, defined as one standard deviation below the mean, doubled the chances for lost talent in females, and tripled the chances in males (Trusty & Harris, 1999). Another study that focused on post-secondary success and its relationship to SES as the work of Frempong, Ma, and Mensah (2011) whoinvestigated the influence schools have on access to postsecondary education in Canada. They conducted a multilevel analysis using the Canadian PISA sample from the 2000 assessment in conjunctions with the Youth in Transition Survey (YITS). The sample was of 29, 687 students age 15 who participated in both studies. The findings suggest that schools do make a difference regarding whether students access postsecondary education. Specifically, academic pressure and student-teacher relationships were the most important school-level factors contributing to students' decision to continue their educations. One encouraging result was that student and parent expectations, in combination with high GPA's, led to postsecondary education regardless of SES.

This brief review of the SES literature shows the importance of the subject and why explorations of the impact of the construct at both the individual and school level can produce valuable and informative results, making these the reasons for the inclusion of this concept in this analysis.

Immigration

PISA defines immigration status in terms of native and non-native students, referring only to the immigration status of the students and not to their ethnicity. The specific definition is as follows: "'Native' students are those students who reported in the Programme for International Student Assessment (PISA) that they were born in the country of assessment and who had at least one parent born in that country" (OECD, 2008, p. 352). In terms of

achievement, immigration is a factor effecting students who have moved to a new country, or are the children of parents who moved to a new country. Either way the assimilation to a new culture and potentially a new language are obstacles for students to overcome in addition to the traditional education experience. Canada's population continues to grow as of the 2011 census, mostly due to the immigration of temporary and permanent residents (Statscan, 2012). In fact, Canada's population growth wasthe highest in the G8at 5.9% (Statscan, 2012), an issue demanding attention from education systems across the nation.

The hurdles faced by immigrant students include a combination of learning a new language, situations leading to emigration, and adjusting to a new culture (Covington-Clarkson, 2008). Researchers interested in studying this phenomenon have their own difficulties in gathering suitable data due to the diversity of the immigrant population. Covington-Clarkson (2008) describes the realities of studying immigration in education and highlights the ineffectual categorization of immigrant students into one category, often ignoring diverse heritages, languages spoken, immigration trends, and unrepresentative sample sizes. PISA includes a category in their student questionnaire in order to identify students as either native or non-native to their testing country (OECD, 2012). (This variable specifically refers to immigration status and not to ethnicity.) However, as Covington-Clarkson states, "the success of immigrant student groups will remain untold if data disaggregation remains…general" (Covington-Clarkson, 2008, p.25).

Theoretical issues in the literature often examine the process of assimilation for immigrants from one culture into another, or ethnic performance orientations. Kao and Tienda (1995) discuss two theories of assimilation termed straight-line assimilation and segmented assimilation. Both theories explore the effects of generational status on achievement with

straight-line assimilation assuming a linear or chronological assimilation process that will lead to improved academic achievement upon successful acclimatization to the new culture. The segmented theory of assimilation does not regard the process as unidirectional, but rather dependent upon the degree of assimilation pursued by the individual, family, or community. Theories of performance orientations survey academic outcomes without delving into assimilation statuses. Generally speaking, when discussing performance orientations amongst immigrants the level being discussed is the group or ethnic performance orientation and not individuals' or families'. Kao and Thompson (2003) review the roles played by cultural orientations and the structural position of the ethnic group, concluding that group categorization oversimplifies the issue and does little to further the understanding of the reality of these individuals.

The education of immigrant students is not the same in every country. Schnepf (2007) reviewed the data from three international studies and found that immigrants in English-speaking countries outperformed immigrants of non-English speaking countries. Schleicher (2006) explored the 2003 PISA data set and found that non-native students in countries with high levels of immigration were not at a disadvantage. The study found that countries with high levels of immigration were quite adept at incorporating the needs of immigrant students into their education systems and achievement results were similar to native students in these countries. Regarding the Canadian context, immigrants performed as well as native students in general and were not at a disadvantage in mathematics as was seen in other countries (Schleicher, 2006).

Though the research on immigrant achievement is inconclusive, and little additional information is to be gained from aggregated cross-sectional data (Covington-Clarkson, 2008; Marks, 2010), PISA's inclusion of native status with respect to immigration is still useful in a

descriptive sense when attempting to describe the demographic makeup of achievement at the student and school levels.The literature to this point has identified the influence of demographic variables on achievement in education (Halpern, 1997; Pong, 2008; Sirin, 2005; & Schleicher, 2006) and the next logical level of analysis would be schools and how they impact the achievement of their students.

School Impact Student Achievement

School Effectiveness Research (SER) emerged in support of the argument that schools had differing influences on similar student populations and that those differences could impact achievement (Goldstein & Woodhouse, 2000). SER has been criticized for searching for a simple combination of factors that will produce effective schools, and no such formula has yet to be revealed in research. Some argue that longitudinal research into the tracking of school improvement and decline would be more valuable than cross-sectional research that lists the characteristics of model schools (Anderson, 1982; Goldstein & Woodhouse, 2000). Nevertheless, schools do influence students in many ways and the multilevel analysis of data sets such as PISA can describe and separate those influences into their component parts (Creemers & Kyriakides, 2006). Analysis of previous PISA data sets has consistently found the influence of schools on individual achievement in Canada to be below 20% between the highest and lowest achieving schools in the country, results lower than other countries examined the articles reviewed (Anderson, Milford, & Ross, 2009). This indicates that the majority of the differences in test scores reside in the differences between test-takers within schools. This relative consistency between schools across the nation indicates that school operations are likely not the primary target of reform, though further information on areas that do impact student achievement are always welcome information to inform policy.

One of the major research topics on how schools influence their students is known as school climate. One useful way to think of school climate is that "Personality is to the individual what 'climate' is to the organization" (Halpin & Croft, 1963, as cited in Anderson, 1982). Or as PISA describes school climate it: "school climate… covers different aspects of a school's culture, including the disciplinary climate, how well students and teachers get along, how strongly students identify with their school and how motivated and committed the school's teachers are" (OECD, 2009, p. 25)Battistich, Solomon, Kim, Watson, & Schaps (1995) found that schoolsthat promote a caring and supportive environment are more likely to have students accept the organization's norms and values and better incorporate students into the school culture.A positive school climate can improve students' attitudes and self-perceptions (Loukas & Robinson, 2004), as well as increase levels of motivation and achievement (McEvoy & Welker, 2000). Schools can positively influence their students by engaging them and motivating them to achieve the goals set by their educators. The influence of school climate has been found to be more important than school context (Ma, 2003) and to have its most profound impact on students from disadvantaged backgrounds (Battistich et al., 1995).

The effects of school climate are dependent upon the educational professionals who create the climate of the school, and for whom any successful intervention is based upon (Forman, Olin, Eaton Hoagwood, Crowe, & Saka, 2009). The support of a caring teacher can have many positive influences on the outcomes of students in their classrooms. Teacher support has the potential to reduce problem behaviour as well as improve students' perceptions of school meaningfulness (Brewster & Bowen, 2004), improve students engagement (Klem & Connell, 2004), reduce the number of friendships with risky peers as well as reduce the use of drugs and the occurrence of mental health symptoms (LaRusso, Romer, & Selman, 2008), and

improvehelp-seeking on the part of the student (Ryan, Gheen, & Midgley, 1998). Teachers clearly have the potential to strongly influence their students, though too often teachers focus their positive attention mostly on students who demonstrate academic effort (Muller, 2001). Additionally, the supportive relationship must be bi-directional for it to work, where a student who remains disengaged will not benefit from increased support (Klem & Connell, 2004).

In terms of achievement, support exists for the influence of the teacher-student relationship and achievement, though the relationship is indirect through engagement (Klem & Connell, 2004). Cornelius-White (2007) performed a meta-analysis on research relating teacher-student relationships and learning. He examined 119 studies with a student sample of 355, 325 looking at 9 independent, 18 dependent, and 39 moderator variables. The author used the definition that, "Students desire authentic relationships where they aretrusted, given responsibility, spoken to honestly and warmly, and treated withdignity" (Cornelius-White, 2007, p.116) in his selection of studies in order to examine positive teacher-student relationships. Results included increased student participation ($r = .55$), motivation to learn ($r = .32$), and self-esteem ($r = .35$), as well as decreases in dropout rates ($r = .35$), disruptive behaviour ($r = .25$), and school absences ($r = .25$). Teacher characteristics supporting this type of supportive relationship include empathy, respect, nondirectivity (supporting autonomy), encouraging learning and thinking, and adapting to differences. Perhaps the most notable finding came from research that included and controlled for IQ and prior achievement which found that the correlation between person-centered variables and students outcomes to be $r = .46$ or approximately 21% of the remaining variance could be accounted for by the positive teacher-student relationship. This study shows the profound effect that teachers can potentially have on their students that their influence is a factor ripe for investigation in general but also within the

Canadian PISA data set.

Teachers and schools influence their students in many direct and indirect ways. Large educational data sets such as PISA allow researchers to identify these influences and account for their variance at both the student- and school-levels. The primary method of investigation these influences will be the composite variables found in the student and school questionnaires of the PISA data set (See Appendix A).

Summary of Chapter Two

Chapter Two has reviewed the literature of the fields covered by the variables included in the forthcoming HLM analysis. Student background variables were discussed as well as the impact other students and teachers can have on the educational outcomes of individuals. The next chapter will review the methodology to be employed in order to account for the varying levels of influence each factor of the analysis contributes.

Chapter Three: Methodology

This chapter details the research design selected for this study. The selected methods will be reviewed with a summary of their benefits and limitations. Topics to be discussed are secondary data analysis (SDA), hierarchical linear modeling (HLM), and the use of a quartile-split of the data. Following this is a look at the Programme for International Student Assessment (PISA) and a discussion of the sampling procedures, instrumentation, and weighting of the research design. Finally, the analytic models used will be introduced prior to moving to chapter four and the results of the analysis.

Research Design

The general approach of this study is a quantitative correlational study seeking to identify co-relationships between variables of interest in the context of educational achievement. Correlational research cannot attribute causality to the findings, however, it does benefit from researching phenomenon in realistic situations that laboratories cannot imitate producing results that have the potential to be replicated in the real world.

Secondary Data Analysis (SDA)

The secondary analysis of data provides the opportunity for more researchers to examine large sample datasets than would not otherwise be possible if every researcher collected their own data individually. Large data sets with many participants are resource intensive in terms of both money and time. With these concerns in mind, many researchers choose to analyze data previously collected by others when data sets are appropriate in terms of sample population and the operationalization of the variables included. Value can be found in both the primary collection of data as well as the auxiliary analysis of data sources by other researchers (Rogers,

Anderson, Klinger & Dawber, 2006), with some data sets designed with the purpose of secondary analysis (Atkinson & Brandolini, 2001).

Some of the benefits of SDA are that the selected data sets are generally larger than most researchers could collect on their own. In addition to large sample sizes, the standardization of items and indices provide a common framework to the discussions of subsequent researchers utilizing identical variables. Also, SDA is particularly well suited for trend, cohort, time-series, and comparative analyses (Kiecolt & Nathan, 1985).

The limitations of SDA are a result of researchers having to use the data without input on its collection. Kiecolt and Nathan (1985) discuss the difficulties of finding a data set that targets both the ideal target population and includes the necessary variables of interest. Subsequent to this are issues related to the operationalization of those variables and their measurement. Poorly operationalized variables or inadequate measures can lead to biased or inconclusive results. It is very important for secondary researchers to understand how the data was collected and the original researchers' intentions for the research design (Atkinson & Brandolini, 2001). Additionally, accessing subpopulations can be a challenge if samples sizes large enough to yield significant resultsdistort the distribution of subpopulations within the dataset(Thomas & Heck, 2001). Lastly, documentation provided by the original researchers can be incomplete or inadequate for the purposes of identifying errors made in the interviewing process, coding, or data entry (Rutkowski, Gonzalez, Joncas, & Davier, 2010).

Hierarchical Linear Modeling

HLM is a software package designed for multilevel regression analysis of quantitative data. Simple regression analyses examine relationships between variables. Generally, the goal is to identify the influence that 'predictor' or independent variables have on a specific 'outcome' or

dependent variable. Relationships vary in direction and magnitude resulting in variables that increase or decrease together or in opposition to each other, and to varying degrees. Complications result from collecting data on variables at multiple levels, such as students in classrooms or different schools. The purpose of multilevel analyses is to correct for the nested effect of data collected at multiple levels. When students are in the same classroom they are more similar to each other in terms of educational outcomes than students in other classes (with other teachers, etc.) and they are considered nested in those classrooms. Multilevel analysis is better able to account for those shared experiences at the individual level than are single level regression equations that aggregate all participants without recognizing environmental similarities (Raudenbush & Bryk, 2002). This allows researchers to identify both individual differences and group membership differences that influence the individual.

Though theoretically any number of levels of analysis is possible, two-level analyses are the most widely reported and yield reliable results, with larger and larger data sets required for every additional level to maintain statistical power (Spybrook, 2008). The benefits of HLM include the ability to simultaneously model multiple levels of data while avoiding aggregation bias, misestimating standard errors, as well as the heterogeneity of regression (Lee, 2000).

Quartile-split

A quartile-split was selected for this analysis in order to access the subpopulations of high- and low-achievers in the Canadian data set. The benefit of the splitting the data set, i.e. quartile-split, selected for this study isthe ability to access subpopulations overlooked by national averages, with the intention of identifying potential areas for further research held within the data set that would otherwise go unexamined (McConney & Perry, 2010). This design will identify questions such as whether schools have an equal impact on low versus high achievers in Canada,

and how do students' experiences with teachers vary by group? Simultaneously an examination of the separate demographic realities of these two groups will be revealed. The primary limitation of this method is the reduced variance and the resulting inflation of standard errors accompanying the smaller sample populations. However, sample sizes of approximately 5,800 individuals will still yield statistical results with suitable power for comparative purposes seeking to outline fundamental differences between groups. The reader must be aware that due to the constrained variance the resulting coefficients will also be constrained limiting the impact of the results. With this information in mind, the goal remains to identify interesting results in order to inform discussions of policy and future research.

Overview of PISA

The Programme for International Student Assessment was first implemented in 2000 in all Organization for Economic Co-operation and Development (OECD) countries and is open to non-member countries choosing to participate. Assessments occur on a three-year cycle with each implementation focusing on one of three literacies. In 2000, the focus was on reading, mathematics in 2003, science in 2006, and 2009 began the second cycle with reading again being the focus. The purpose of PISA is to measure the readiness of students for adult life who are nearing the end of their compulsory education. This measurement philosophy attempts to assess problem solving in 'authentic' situations experienced in everyday life rather than measuring curriculum-based performance (OECD, 2010).

Procedure

The PISA framework for assessment is designed by the PISA Governing Board, which includes senior policy officials from every participating country. Their responsibility is to determine policy priorities and to develop standards for indicators, assessment instruments, and

the reporting of results. Each country presents a National Project Manager (NPM) for the purposes of facilitating the assessment in that nation. NPM's work with Subject Matter Expert Groups (SMEGs) to ensure the validity of the assessment in their country, the inclusion of culturally and educationally relevant materials, and the appropriateness and authenticity of measurement materials. Translations are implemented at the national level with source material provided by PISA in both English and French. NPMs were also responsible for the implementation of the assessment in their countries including the hiring and training of personnel for the purposes of school coordination and test administration.

Sampling

The target population is 15 year olds who are in at least the 7th grade and are enrolled in full- or part-time studies in all OECD countries. The probability of a school being selected is proportional to the institution's size based on the number of eligible 15 year olds, with at least 150 schools per country. PISA provided NPMs with a School Sampling Preparation Manual, which outlined the framework for selection of schools based on considerations such as size and homogeneity of the student population. The NPMs then provided a list of eligible schools to the international organizing consortium who then completed the selection process for the purposes of consistency across nations. Once the school sample was identified, the list was provided to the NPM who contacted each school requesting the identification of eligible students. Using PISA-designed software, the NPM then selected individual students to be included in the assessment (OECD, 2012).

Instrumentation

Assessment development consisted of a multilevel process instituted over several years. After reviewing the initial PISA 2000 framework, the international organizing consortium

produced new items for potential inclusion. Following local item paneling and pilot testing on local target sample populations, each nation was provided with the items for review and pilot testing. The consortium reviewed the feedback from each nation and considered the items submitted by nations for their own assessments before producing the source versions of the items in English and French (English only for the DRA), and returning the final assessments to each country for field trials prior to the full-scale implementation.

Literacy Framework

The PISA framework is based on literacy and not curriculum. The goal of this perspective is to focus on students' applications of their knowledge and skills by assessing how well they can understand and interpret written material they are likely to encounter in their everyday lives. This concept extends to their abilities to overcome mathematical and spatial challenges and to overcome scientific problems common in the lives of adults. PISA promotes a mastery emphasis based on the understanding of concepts and ability to function in a variety of scenarios. The three literacies are defined as follows:

> ***Reading literacy:*** An individual's capacity to: understand, use, reflect on and engage with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society.
>
> ***Mathematical literacy:*** An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.

> ***Scientific literacy:*** An individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence- based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.
>
> (OECD, 2012)

Reading Literacy Assessment

The assessment or reading literacy was divided by the students' performance on three broad aspect categories designed to evaluate the complex nature of reading. The three categories are a students ability to a) access and retrieve, b) integrate and interpret, and c) reflect and evaluate. These aspects were evaluated on printed and electronic texts; which were divided into authored and message-based categories; in formats that ranged from continuous, non-continuous, mixed, and multiple; and covered texts defined as description, narration, exposition, argumentation, instruction, and transaction.

Item Construction Process

The 2009 PISA assessment utilized Item Response Theory (IRT) methodology to create a bank of questions to assess each form of literacy. Test materials were constructed based on item clusters, comprised of standardized series of questions, designed for completion within 30 minutes. Due to the focus on reading literacy in 2009, two clusters were including for reading with one cluster each for mathematics and science. Questions were in the form of multiple choice or constructed response.

An international consortium of experts is organized who design the framework for each PISA assessment. Once the framework is complete, individual items are produced to meet the requirements agreed upon. Experts from each country conduct a qualitative analysis of every item with each item reviewed at the national and international levels prior to selection. Multiple versions of each item are developed and final selection completed on the basis of an analysis using item response theory software.

Context Questionnaire

Context questionnaires are designed as a collaborative effort by international experts prior to field-testing, and are to be completed by each student as well as the principal of each school. Topics covered include information on their social, economic, cultural, and educational factors associated with student achievement. Questions to students cover individual characteristics, family background, perceptions of school climate, self-related cognitions, as well as learning strategies and preferences. Information collected on schools comprises descriptions of scholastic systems, the individual schools, instruction, and learning environments and activities. Questions posed to principals examine school characteristics, admittance policies, school resources, administrative structure, and school climate. The context questionnaires are the sources of all of the examined independent variables and were extrapolated by PISA from the student and school questionnaires resulting in the composite variables found in the analysis and defined in Appendix A.

Weighting

Weighting refers to the adjustment of a score based on the likelihood of its inclusion and the magnitude of its impact relative to other scores in the data set (Thomas & Heck, 2001). In the case of PISA, small and large schools are selected and the data must take into account the

likelihood of the student selected representing their school. Weighting is used to correct sample data in order to more accurately describe the greater population variance used in the calculations of means and standard deviations. A limitation appears when subpopulations are focused upon, because there is the tendency to oversample small populations and to under sample larger populations (Thomas & Heck, 2001). A real world example of this flaw is Canadian data that treats each province equally in the computation of a national average, giving equal weight to a province as small as P.E.I. as one as large as Quebec. Survey design weights are used to reduce bias, calculate statistical estimates, and make valid statistical inferences (Thomas & Heck, 2001; Willms & Smith, 2005). However, their use is not required in this study due to the research design, which does not compare populations assigned weightings, i.e. provinces (Willms & Smith, 2005).

Analytic Models

Null Model

The null model is the simplest analysis in HLM and is essentially a one-way ANOVA with random effects (Raudenbush & Bryk, 2002). It offers the ability to separate the variability of the outcome into within- and between-school components, and the calculation of the intra-class correlation, which describes the amount of variance contributed by the second level of analysis. This calculation will be performed on the national data, as well as each of the quartiles. Any variation in level-2 influence seen in the subpopulations would be an interesting finding due to a differing level of influence schools could have on each population.

Random Intercepts and Slopes Models

The final models allow intercepts and slopes to vary, which, following the removal of nonsignificant correlates constitutes the final model for each of the population groups. This

model allows student- and school-level variables to vary and is used in the calculation of variance reductions used to assess the effect sizes of variables in each model. Any differences in the influence of demographic variables between the subpopulations and the national average will surely lead to a noteworthy discussion. Additionally, the existence of varying influence of teachers in terms of student perception or the second-level influence on individual achievement outcomes will be results worth discussing.

The model building process was completed in conjunction with guidelines presented by Raudenbush & Bryk (2002) and was acceptable for the research design based on its parameters, specifically the size of the sample and the number of variables selected. The process followed the 'saturation' model of model design where all variables are added at once followed by the removal of statistically non-significant correlates. This process was first conducted at the student-level, followed next by the intercept at the school-level, then each student-level slope in succession. If a correlate was removed due to a lack of statistical significance, the model was re-run without the correlate and compared to the saturated model, which included the non-significant correlate. This process did not produce any dramatic shifts in the results and was maintained throughout the analysis. Finally, the methodology employed included all significant correlates regardless of effect size maintaining the importance of all factors influencing individual achievement in the analysis.

Summary of Chapter Three

This chapter discussed the benefits and limitations of the research design selected for this study. The data set provided by PISA was discussed with attention paid to the original research design and how it informs the present analysis. Finally, a discussion of HLM analysis and

analytic models was reviewed prior to moving into the next section, which will report on the results of this analysis.

Chapter Four: Results

The aim of this analysis is to develop three models: a Canadian national model, and one each for its lowest and highest achievers allowing for the comparison of the correlates of the three groups. The final models used for comparison will be of the order of random intercepts and slopes as was discussed in the previous chapter. A quartile-split will be used in order to access the subgroups of the Canadian data set describing the results of the highest and lowest achievers in terms of reading achievement. The statistical analysis software by IBM, SPSS v. 21, was used to analyze and report descriptive statistics and correlations between variables and prepare the data set for entry into the multilevel analysis software. The multilevel analysis was completed using the software program Hierarchical Linear Modeling (HLM 6.08). This chapter will recount the descriptive statistics and correlations for the student- and school-level variables, as well as the models produced by the HLM analysis for the data set covering each group of students.

The Sample

Due to the use of a quartile-split in the research methodology each group of students have differing sample characteristics. The national sample consists of all 23,207 Canadian students who completed the reading achievement test for the 2009 PISA survey, while each quartile (upper and lower) consists of 5,802 students who's achievements scores in reading placed them in their relative grouping.

Table 1
Sample Sizes in National, Higher Quartile, and Lower Quartile Data Sets

Variables	National	Higher Quartile	Lower Quartile
Total Sample	23,207	5,802	5,802
Female Sample	11,776	3,545	2,102
Male Sample	11,431	2,257	3,700
School Sample	978	879	897

Missing values are a prominent concern in multilevel analyses (Raudenbush & Bryk, 2002; Snijders & Bosker, 2012) and a variety of methods have been developed to handle the issues that arise. The method employed in this HLM analysis was a list-wise deletion during model analysis (Raudenbush & Bryk, 2002). Table 2 indicates the number of missing values sorted for each group and variable respectively. Note the relatively increase in missing values for the Lower Quartile grouping over the other groups.

Table 2

Missing Data in Level-1 for National, Higher Quartile, and Lower Quartile Data Sets

Variables	National	Higher Quartile	Lower Quartile
Gender	0(0%)	0(0%)	0(0%)
Family Structure	668(2.9%)	82(1.4%)	327(5.6%)
Immigration Status	803(3.5%)	78(1.3%)	425(7.3%)
SES	591(2.5%)	59(1%)	294(5.1%)
Student-Teacher Relations	595(2.6%)	72(1.2%)	281(4.8%)[1]

[1] The missing values found in the lower quartile are substantially higher than the national average of those found in the higher quartile. This does have the potential to influence the analysis of the true population.

Missing Data in Level-2 for the School Data Set

Variables	School File
Proportion of Female Students	47(4.8%)
Teacher Participation	6(0.01%)
Teacher Behaviour	9(0.92%)
School SES	94(9.6%)
School Student-Teacher Relations	94(9.6%)
Proportion of Students Non-Nuclear Family Structure	94(9.6%)
Proportion of Students Non-Native Immigration Status	94(9.6%)

Student-Level Variables

Descriptive Statistics for Student-Level Variables

The descriptive statistics for each group are presented in Table 3. The achievement scores in reading, mathematics, and science are expectedly highest in the higher quartile data set, lowest in the lower quartile data set, and somewhere in between in the national data set.

Standard deviations for the achievement variables are largest for the national data set, indicating a larger spread or range of scores. The higher quartile data set has the, relatively, smallest standard deviations, and the lower quartile has relatively smaller standard deviations than the national data set.

In terms of gender, the national gender proportions are nearly equal with slightly more female test takers, as was seen in Table 1. The higher quartile has significantly more females than males while the lower quartile has significantly more males than females, an artifact of mean performance in reading literacy by gender. The variables for family structure and immigration status are relatively consistent across the groups with proportions indicated in Table 4.

Socioeconomic status (SES) follows a similar pattern as the distribution seen in the achievement variables, i.e. highest in the highest quartile, etc., a result that is consistent with the literature. The standard deviations for SES (Educational, Social and Economic Status or ESCS is the PISA index of SES) are nearly consistent across the groups, however, the range shows the lowest value from the national sample residing in the lower quartile data set, and yet the highest value in the national data set does not reside in the higher quartile data set. Also noteworthy is that the range is lower for both the minimum and maximum for the lower quartile group than the higher quartile. Finally, the student perceived student-teacher relations also follows the pattern seen in achievement and SES with the higher quartile students reporting the highest perceived levels in terms of those relationships.

Table 3
Descriptive Statistics of Student-Level Variables in National, Higher Quartile, and Lower Quartile Data Sets

Variable	Data Set	Mean	Standard Deviation	Minimum	Maximum
Reading	National	511.53	93.56	45.82	871.12
	Higher	627.00	39.53	577.41	871.12
	Lower	389.32	51.00	45.82	449.71
Mathematics	National	516.39	87.52	85.54	846.09
	Higher	606.21	57.37	389.32	846.09
	Lower	422.87	64.25	85.54	620.67
Science	National	518.12	90.66	130.12	861.10
	Higher	617.36	39.53	431.50	861.10
	Lower	413.79	61.05	130.12	635.71
Gender[1]	National	1.49	.50	1	2
	Higher	1.39	.49	1	2
	Lower	1.64	.48	1	2
Family Structure[2]	National	1.85	.40	1	3
	Higher	1.88	.34	1	3
	Lower	1.83	.46	1	3
Immigration Status[3]	National	1.23	.57	1	3
	Higher	1.24	.58	1	3
	Lower	1.24	.58	1	3
ESCS	National	.46	.82	-4.77	3.10
	Higher	.77	.76	-2.68	3.04
	Lower	.18	.82	-4.77	2.75
Student-Teacher Relations	National	.32	1.05	-2.90	2.45
	Higher	.57	1.00	-2.90	2.45
	Lower	.06	1.10	-2.90	2.45

[1] The mean value for Gender of 1.49 indicates that there are slightly more females in this population than males due to the coding of the variable: Female = 1, Male = 2.
[2] The mean value for Family Structure of 1.85 indicates that on average the students are slightly more likely to lived in a household with one parent rather than two due to the coding of the variable: Single Parent = 1, Nuclear Family = 2, Mixed Family = 3.
[3] The mean value for Immigration Status of 1.23 indicates that on average a student is more likely to be identified as Native than as 1st or 2nd generation immigrants due to the coding: Native = 1, 2nd generation = 2, 1st generation =3.

Table 4
Sample Statistics describing the within group distribution of Family Structure and Immigration Status

Variable	National	Higher Quartile	Lower Quartile
Family Structure			
Nuclear Family	18501(79.7%)[1]	4959(85.5%)	4173(71.9%)
Non-Nuclear Family	4038(20.3%)	761 (14.5%)	1302(28.1%)
Total	22539(100%)	5720(100%)	5475(100%)
Immigration Status			
Native	18851(81.2%)	4771(82.2%)	4530(78.1%)
Non-Native	3854(18.8%)	953(17.8%)	847(21.9%)
Total	22404(100%)	5724(100%)	5377(100%)

[1] This table indicates the distribution of these variables within each grouping as opposed to Table 3 which displayed mean values for each variable listed by group.

Table 4 indicates the percentage of each population split between the subgroups of each variable for each population examined. This information shows differences in the composition of each student grouping in terms of their family and immigration statuses. Note how the Lower Quartile has fewer students who identify belonging to Nuclear Families, while Immigration status is more consistent across the groups.

Correlations Matrix for Student-Level Data

The correlations matrix for the three student groups are presented in Table 5, with significant correlations denoted with an asterisk if the p-value <0.05. Cohen (1988), describes benchmarks for relative value of correlations in educational research defining small, medium, and large effect sizes as ± .1, ± .3, and ± .5 respectively (Cohen, 1988). These recommendations will be used in this section discussing the bivariate correlations between variables.

Low correlationswith significant p-values are seen between ESCS and family structure in addition to a relationship between immigrant students and SES. Low to medium correlations are seen between ESCS and the achievement variables suggesting a relationship where higher levels of SES result in higher achievement scores in all three subjects tested. Student-teacher relations also displayed low effect sizes regarding its relationship with achievement scores within the

national and lower quartile groups. In contrast, the higher quartile group does not seem to have as strong of a relationship between these variables.

In terms of the correlations between the achievement variables, it is noteworthy to point out that the strongest relationships between variables are seen between the achievement variables, and yet the range of the correlations indicates differing degrees of relationship between these variables for each of the groups. The strongest correlations are seen within the national data set while the lowest are within the higher quartile data set. This indicates that the highest achievers in reading have the largest variability between their reading score and their results in the other two achievement domains (mathematics and science), and thus, this population is more heterogeneous in nature. The relatively larger amount of variability (as compared to the national correlations) of the lower quartile group also indicates less of a relationship between the reading scores for this group, which shows the national group having the most consistency between the categories of achievement tested.

Table 5
Correlation Matrix for Student-Level Variables in the Student Data Sets

Variable	Family Structure	Immigration Status	ESCS	Student-Teacher Relations	Mathematics	Reading	Science
Family Structure							
National	1.0						
Higher	1.0						
Lower	1.0						
Immigration Status							
National	.01	1.0					
Higher	.01	1.0					
Lower	.00	1.0					
ESCS							
National	.15*	.03*	1.0				
Higher	.18*	.05*	1.0				
Lower	.08*	.00	1.0				
Student- Teacher Relations							
National	.03*	.09*	1.0				
Higher	.05*	-.01	.08*	1.0			
Lower	.02	.07*	.02	1.0			
Mathematics							
National	.07*	.01	.31*	.17*	1.0		
Higher	.08*	.06*	.22*	.08*	1.0		
Lower	.03*	-.04*	.16*	.06*	1.0		
Reading							
National	.05*	.00	.28*	.19*	.82*	1.0	
Higher	.04*	.04*	.17*	.06*	.52*	1.0	
Lower	.01	-.03*	.10*	.11*	.59*	1.0	
Science							
National	.06*	-.03*	.29*	.16*	.87*	.88*	1.0
Higher	.06*	.00	.17*	.06*	.68*	.62*	1.0
Lower	.01	-.10*	.14*	.06*	.72*	.70*	1.0

* Correlation is significant at the 0.05 alpha level (2-tailed)

School-Level Variables

Descriptive Statistics for School-Level Variables

The descriptive statistics for the school data set are presented in Table 6. All values presented are on standardized scales that PISA uses in the comparison of national data sets. The proportion of females students in Canadian schools is close to 50% even when taking into account one-gender schools, as is indicated by the corresponding minimum and maximum values. Teacher participation is a composite variable derived from principal-reported perceptions of the teachers' participation in a variety of factors related to school decisions (see AppendixA), while teacher behaviour refers to teacher-related factors associated with school climate. The mean for these variables are close to zero but negative, indicating that Canadian principals perceive their teachers to be slightly less involved than the OECD average in terms of their influence on schools' decisions and their contribution to school climate.

Mean ESCS in Canadian schools is nearly half of one standard deviation above the OECD average (0.45), with a standard deviation of 0.39 and a range from a minimum of -1.01 to a maximum of 1.72. Mean student-teacher relations are also above the OECD average as reported by students (0.30), as are the proportion of students in the school from non-nuclear families (0.18) and the proportion of students identified as immigrants (0.16). This translates into schools that are comprised of more families that are not intact and relatively more students who were either not born in Canada or their parents were not born in Canada than the average OECD country reported on these variables correspondingly.

Table 6
Descriptive Statistics of School-Level Variables in the School Data Set

Variable	Mean	Standard Deviation	Minimum	Maximum
Proportion of Girls in the School	49.37	8.12	.00	1.00
Teacher Participation	-.03	1.00	-2.07	2.81
Teacher Behaviour	-.02	.85	-3.00	2.12
Mean School ESCS	.45	.39	-1.01	1.72
Mean School Student-Teacher Relations	.30	.31	-1.04	1.27
Proportion of Students with Non-Nuclear Families	.18	.10	.00	.73
Proportion of Students with Non-Native Immigration Status	.16	.22	.00	.97

Correlations Matrix for School-Level Data

The correlations matrix for the school data set is presented in Table 7. Low to medium effect sizes are indicated for the correlations between school ESCS and teacherparticipation (0.1) and teacher behaviour (0.22), implying that teachers are more involved in higher SES schools. Mean school ESCS is also correlated with mean school student-teacher relations (0.12).

Negative relationships appear when the proportion of non-nuclear families in a school rises, indicating poorer relationships with Teacher Behaviour (-0.09), Mean School SES (-0.34), and Mean School Student-Teacher Relations (-0.11). The relationship between Mean School SES and non-nuclear families is particularly interesting showing the relationship between the economic realities of single-parenthood.

Finally, there appears to be relationships between schools with higher numbers of immigrant students and Mean School SES (0.18) and Mean Student-Teacher Relations (0.07) signifying the potential for more immigrants in a school raising the mean SES and also slightly raising student-teacher relations.

Table 7
Correlation Matrix for School-Level Variables in the School Data Set

Variable	Proportion of Girls in the School	Teacher Participation	Teacher Behaviour	Mean School ESCS	Mean School Student-Teacher Relations	Proportion of Students with Non-Nuclear Families	Proportion of Students with Non-Native Immigration Status
Proportion of Girls in the School	1.00						
Teacher Participation	.21	1.00					
Teacher Behaviour	.03	-.02	1.00				
Mean School ESCS	.04	.10*	.22*	1.00			
Mean School Student-Teacher Relations	.05	.00	.08*	.12*	1.00		
Proportion of Students with Non-Nuclear Families	-.02	.01	-.09*	-.34*	-.11*	1.00	
Proportion of Students with Non-Native Immigration Status	-.04	.04	.03	.18*	.07*	-.01	1.00

* Correlation is significant at the 0.05 alpha level (2-tailed

Hierarchical Linear Modeling

Two-level HLM models were generated for each student data set using HLM 6.08 (Raudenbush & Bryk, 2002) to analyze the multilevel relationships between the student- and school-level variables. HLM estimates are based on the PV1 plausible values onlywithout further incorporation of other plausible values provided in the dataset, in accordance with the recommendations of Rutkowski et al. (2010). This is done in order to avoid underestimating standard errors. The full data set collected by PISA has multiple plausible values (PV's) designed to facilitate the comparison of scores across nations. Weighting was not employed in this analysis as it is most advantageously utilized in research methodology involving comparisons of international results and not required for the examination of individual nations.

First, the null model is analyzed which is an unconditioned model without student- or school-level variables loaded. This model provides an indication of the amount of overall variance as well as the variance residing at the second-level of the analysis. The null model facilitates the calculation of the intra-class correlation coefficient which defines the amount of overall variance located in the second-level of the analysis, revealing the amount of influence schools have on the individual achievement results of their students in reading.

Final HLM models were derived by removing non-significant correlates (intercepts) on student-level variables and non-significant correlates (coefficients) and/or error terms at the school-level. Only significant variables were retained and reported in the following tables.

National Model

The intra-class correlation for the national data set equals 0.21 indicating that slightly over 20% of the variation in students' reading achievement is directly influenced by the schools in which they are educated.

Table 8
Null Model for National Data Set: Reading Achievement Intercept and Student and School Variance Components

Fixed Effects		Coefficient	P-value
Reading Achievement		513.07	< .001
Random Effects		**Variance Components**	**P-value**
School-Level Effect	r_{ij}	1849.42	< .001
Student-Level Effect	μ_{0j}	6989.86	

Reliability coefficient for National Data Set is 0.86. Intra-class correlation is 0.21.

Final Model for National Data Set:

$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}) + \beta_{2j}(\text{Immigration}) + \beta_{3j}(\text{SES}) + \beta_{4j}(\text{Student-Teacher Relations}) + r_{ij}$

$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{School SES}) + \mu_{0j}$

$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Proportion Non-Native}) + \mu_{1j}$

$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{Proportion Non-Nuclear}) + \gamma_{22}(\text{Proportion Non-Native})$

$\beta_{3j} = \gamma_{30} + \mu_{3j}$

$\beta_{4j} = \gamma_{40} + \gamma_{41}(\text{School Student-Teacher Relations}) + \mu_{4j}$

Results of the analysis of the final model for the national data set are presented in Table 9. The intercept for the average school achievement in the national data set is 543.49 ($p<.000$), a value higher than the mean reading achievement score reported earlier and a result of the inclusion of other variables in this multilevel model. Females outperformed males by an average of 37.10 points on reading achievement or over one-third of a standard deviation on this test. SES also had a substantial impact with a one-unit increase in SES translating into an increase of 21.90 points in reading. Student-teacher relations are also a factor with the potential to raise reading scores by 15.56 points with a one-unit increase in the student-reported measure.

School-level influences were found on average school performance (β_{0j}), the influence of gender (β_{1j}), the influence of student immigration status (β_{2j}), the influence of student

immigration status(β_{2j}), and the influence of student-teacher relations (β_{4j}). A one-unit increase in school ses (γ_{01}) raised average school scores by 42.19 points after conditioning and schools still varied significantly with school SES factored in (τ_{00} = 1001.49, p<.000). An increase in the school's proportion of non-native students (1st or 2nd generation immigrants) affected the gender slope by increasing scores by 21.90 points. Students' immigration status was affected by the proportion of non-native students as well as the proportion of non-nuclear families in the schools. These factors decreased average scores by 35.07 and 6.79 points respectively for every one unit increase in the school-level predictor.

Student-level SES was not influenced by any of the examined school-level factors and did not vary significantly between schools (μ_{3j} did not load on the final model) indicating that in terms of this sample student-level SES is a level-1 predictor not influenced by schools. Student-teacher relations shifted with a one-unit increase of school average student-teacher relations and lowered scores by an average of 7.61 points. An interesting HLM result that suggests that students with high perceptions of their teachers in schools where teachers are perceived highly, fair slightly worse than students who perceive their teachers highly in schools where average student-teacher relations are lower.

The final model reduced variance in the error terms by approximately 14.9% at the student-level and 45.8% school-level. These error reductions translate into an explanation of the relative percentage of between student and school variation explained by the final model and suggests how much resulting variation is unexplained by the variables examined.

Table 9
Final Model for National Data Set: Slopes and Intercepts

Fixed Effects (Student Level)	Coefficient	P-value
Intercept	543.49	< .001
School SES (School Level)	42.19	< .001
Gender	-37.10	< .001
Prop Non-Native (School Level)	21.90	< .001
Immigration Status		
Prop Non-Nuclear (School Level)	-35.07	< .001
Prop Non-Native (School Level)	-6.79	.039
ESCS	20.29	< .001
Student-Teacher Relations	15.56	< .001
School Mean Student-Teacher Relations (School Level)	-7.61	< .001

Random Effects(School Level)	Variance Components	P-value
School-Level Effect	1001.49	< .001
Gender	188.29	.003
Immigration Status	130.49	< .001
Student-Teacher Relations	24.69	.036
Student-Level Effect	5947.38	

Higher Quartile Model

The intra-class correlation for the national data set equals 0.08 indicating that only 8% of the variation in students reading achievement is directly influenced by schools for this subgroup of the population, or less than half of the influence seen for all Canadian students combined.

Table 10
Null Model for Higher Quartile Data Set: Reading Achievement Intercept and Student and School Variance Components

Fixed Effects	Coefficient	P-value
Reading Achievement	625.64	< .001

Random Effects	Variance Components	P-value
School-Level Effect	122.58	< .001
Student-Level Effect	1444.30	

Reliability coefficient for National Data Set is 0.33. Intra-class correlation is 0.08.

Final Model for Higher Quartile Data Set:

$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}) + \beta_{2j}(\text{Family Structure}) + \beta_{3j}(\text{Student-Teacher Relations}) + r_{ij}$

$\beta_{0j} = \gamma_{00}$

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

$\beta_{3j} = \gamma_{30}$

Results of the analysis of the final model for the higher quartile data set are presented in Table 11. This model represents only the significant correlates after removing all non-significant variables from the model. The coefficient for gender was a negative value indicating that males performed 5.05 points on average below their female peers. While students from nuclear families scored an average of 4.85 points higher and good student-teacher relations project improvements of 2.47 points for every one-unit increase.

The final model for the higher quartile of students did not have significant error terms at the second-level indicating that this subgroup is not influenced by schools on the level-1 variables examined. As was previously noted in the section on the null model for this group, only 8% of the variation in students scores is attributable to differences in schools, and the variables examined in this study do not explain any significant amount of that error with the included correlates.

Table 11
Final Model for Higher Quartile Data Set: Slopes and Intercepts

Fixed Effects	Coefficient	P-value
Intercept	623.91	< .001
Gender	-5.05	< .001
Family Structure	4.85	.002
Student-Teacher Relations	2.47	< .001

Lower Quartile Model

The intra-class correlation for the national data set equals 0.13 indicating that 13% of the variation in students reading achievement is directly influenced by schools for this subgroup, an influence lesser than the national average, but also greater than the higher quartile subgroup.

Table 12
Null Model for Lower Quartile Data Set: Reading Achievement Intercept and Student and School Variance Components

Fixed Effects	Coefficient	P-value
Reading Achievement	392.93	< .001

Random Effects	Variance Components	P-value
School-Level Effect	319.03	< .001
Student-Level Effect	2232.78	

Reliability coefficient for National Data Set is 0.43. Intra-class correlation is 0.13.

Final Model for Lower Quartile Data Set:

$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}) + \beta_{2j}(\text{Immigration}) + \beta_{3j}(\text{SES}) + \beta_{4j}(\text{Student-Teacher Relations}) + r_{ij}$

$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Teacher Behaviour}) + \gamma_{02}(\text{School SES}) + \gamma_{03}(\text{School Student-Teacher Relations}) + \mu_{0j}$

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

$\beta_{3j} = \gamma_{30}$

$\beta_{4j} = \gamma_{40}$

The analysis of the final model for the higher quartile data set is presented in Table 13. Females had average reading scores of 16.14 points abovetheir male peers and immigrants averaged 4.41 points lower than native students. Students' SES had a small influence on scores raising them by 3.87 points for every one standard deviation increase in the ESCS scale. Good student-teacher relations project improvements of 3.81 points for every one unit increase.

School-level influences were only found on the intercept indicating that school averages vary by school-level variables but that the student-level variables just described are not influenced by the school for lower quartile students. This indicates that lower-quartile students are more difficult to support through school interventions. Teacher behaviour resulted in an increase of 3.61 points, school SES could increase reading scores by 14.60 points for every 1 unit increase, and school student-teacher relations also have the power to increase scores by as much as 8.52 points.

The final model reduced variance in the error terms by approximately 10.9% at the student-level and 48% at the school-level.

Table 13
Final Model for Lower Quartile Data Set: Slopes and Intercepts

Fixed Effects	Coefficient	P-value
Intercept	418.63	< .001
Teacher Behaviour (School Level)	3.61	< .001
School SES (School Level)	14.60	< .001
School Student-Teacher Relations (School Level)	8.52	.004
Gender	-16.14	< .001
Immigration Status	-4.41	.001
ESCS	3.87	< .001
Student-Teacher Relations	3.81	< .001

Random Effects	Variance Components	P-value	d.f.
School-Level Effect	204.35	.000	777
Student-Level Effect	1989.75		

Summary of Chapter Four

This chapter presented the results of the HLM models depicting the influence of demographic factors and teachers' influence on reading achievement for Canadian students on average as well as the highest and lowest scoring students on PISA's 2009 assessment. Variation between the groups was evidenced and will be considered further in the next chapter's discussion section.

Chapter Five: Discussion and Conclusion

The previous chapter reported the results of the statistical analysis in terms of the descriptive statistics and HLM models describing the relationships between the level-1 and level-2 variables on the reading achievement of Canadian students. This chapter will further discuss these results as well as comment on the limitations of the research methodology, recommendations for future research, and implications for educational policy.

Discussion

Schools

School-level correlates displayed interesting relationships to reading achievement both in the correlations matrix and in the final HLM models. Specifically, the correlations seen between School SES and Teacher Participation (r= 0.1*) as well as with Teacher Behaviour (r = 0.22*), indicate differences in higher SES schools and the performance of their teachers. It appears that higher SES schools report more favourable measurements of Teacher Participation and Bevhaiour, suggesting superior teacher support for the higher SES students. Also correlated with School SES was School Student-Teacher Relations, suggesting differing relationships between teachers in higher SES schools and their students than is seen in lower SES schools. This finding is supported in the literature by Klem & Connell (2004) who emphasize a bi-directional relationship as necessary for the influence of teachers to impact students, which is more often seen in high SES schools. This point is further discussed by the authors in the context of low SES students where the authors report that though those strong student-teacher relationships are less common in low SES schools, they have the potential to have significant results on achievement when good relationships exist for low SES students.

The other notable school-level relationships identified in the results are the impact of the school proportions of students from non-nuclear families as well as the proportion of non-native students. The data indicates that non-nuclear families score lower on the SES scale (ESCS), at least in terms of the economic capital (Coleman, 1988; Parcel, Dufur, & Zito, 2010), a result consistent with the literature (Krein & Beller, 1988; Mulkey et al., 1992). Immigration status appears to be related to SES in schools with a positive relationship between the two, a conclusion supported by Canadian immigration policy favouring the selection of qualified professionals over immigrants from other careers (Schleicher, 2006). Another association with schools with more immigrant students is that those schools show higher School Student-Teacher Relations, possibly suggesting that immigrants may have better relationships with their teachers than Canadian-born students. Potential explanations for this include cultural influences affecting respect and authority figures as well as home-supplied emphasis on success in education that influence these students interactions with their teachers. These factors could lead to non-native students finding a way to overcome their challenges and make the most of their educational experiences (Grayson, 2007). Overall, the results pertaining immigrant students in Canada are positive and reward its inclusion in this analysis.

HLM Models for the Student Groups

National Model

The national model highlights the importance of Gender and SES on the average Canadian student. Females scored higher in reading achievement suggesting that the average male at age 15 under-performs their female peers in reading literacy in Canada, a relationship that holds across the quartiles examined as will be evidenced later. SES is also a major issue for Canadian schools. An interesting result of this analysis is that School SES has more than twice

the effect on reading achievement as the student's own individual SES (42.19 vs. 20.29). Literature supports the proposition that low SES students perform better in high SES schools (Sirin, 2005) and further advocates for policy that does not support grouping low SES students together separate from the greater population (Crosnoe, 2009) regardless of geography. The final noteworthy result of the final model for the national data set is an inverse relationship between student-level Student-Teacher Relations and school-level Student-Teacher Relations. Essentially, good Student-Teacher Relations enhances scores for individuals but only if their school is not above average in School Student-Teacher Relations measurements. One explanation is that higher average relations come at the cost of teachers supporting all of their students, while the students requiring the most assistance may not receive the support they require because their teachers' time is spread amongst all of the students and not just those with the highest needs.

Higher Quartile Model

A total of three correlates loaded on the student-level of the model, however, the highest associated coefficient was only 5.05. Of these correlates the variable (Gender) represents an impact of less than 1% of the total achievement score for this group (5.05/627 x 100 = 0.81%). The remaining two correlates that were statistically significant for this group were Family Structure and Student-Teacher Relations. However, with such a small effect size associated with these variables it is hard to argue that much, at least in the terms of the variables examined, impacts the performance of these students. Effectively, these students are thriving in Canada's educational systems and do not require further levels of resources or support related to reading literacy. To add to this point, none of the included level-2 correlates loaded onto the final model meaning that schools are functioning well for these students and the fact that the error term on

the intercept was not significant indicates that school do not vary in the achievement of higher quartile students.

Lower Quartile

For lower quartile students the most significant factor appears to be Gender, with males outnumbering females in the sample as well as performing below their female peers who also occupy the subgroup. Schools in this group vary which can be shown by the significant level-2 variance on the intercept (β_{0j}). This variation represents differences in how schools and teachers impact their lower performing students' achievement in reading, and shows that schools support these students differently. This differential success indicates that there is room for improvement that can be realized through the application of further resources and policy implementations. Finally, immigrants scored slightly worse than their peers in the lower quartile, potentially pointing towards language issues as the exacerbating factor in reading achievement for non-native students (Schnepf, 2007). However, in general immigrant students performed well in this analysis highlighting a positive facet of Canada's education systems.

Similarities and Differences between the Models

Females outperformed males in each group examined in this analysis. This was the most common trait amongst the models that proposes fundamental achievement differences between the genders in terms of reading literacy. This study did not delve further into the reasons for this relationship, however, further research should be pursued in order to best support males in reading. The influence schools have, in terms of the proportion of variance residing at the school-level, on both high and low achieving students is also similar, in that the national influence is above 20%, while the higher quartile was 8% and the lower quartile was rounded up to 13%. This indicates that these groups are more individually homogenous than the Canadian

average in terms student achievement. Neither group is particularly amenable to intervention from schools (based on their ICC), largely leaving lower quartile students at a disadvantage due to the demographic realities of their family background and largely outside of the realm of educational policy. Finally, another indication that these groups are homogenous is the standard deviations on their mean performance displayed in the descriptive statistics (National = 93.56, versus Higher Quartile = 39.53, versus Lower Quartile = 51.00). These groups vary less around their means than do the national sample, despite their increased potential for extreme values, suggesting that these groups are similar enough to each other to support the quartile split in the research methodology.

Though the relative underperformance of males is common between the two subgroups, the magnitude of the impact on scores was not directly comparable. Males' scored lower by more than one third of a standard deviation for lower achievers while higher achievers scored lower by less than one percent (0.81%). The variable gender shows results are lower for males yet the impact between these groups is dissimilar. SES was more influential in the achievement of lower quartile students, however, the range reported in the descriptive statistics showed great variability in terms of SES within each quartile. Finally, though there were differences in the impact of Student-Teacher Relations for these groups the amounts of variation within the groups (standard deviations) again indicates the homogenous nature of these subgroups in a variety of ways.

Limitations

Limitations pertaining to the general research methodology concern issues relating to correlational research, secondary data analysis, international achievement testing, and missing data. All correlational research is non-experimental and therefore does not have control over the

variables examined in order to imply causation (Gall, Gall, & Borg, 2010). Correlational research such as regression analysis and multilevel regression analysis are correspondingly restricted to identifying relationships without the ability to further describe the nature of those relationships. Results therefore should be considered to be best for directing future research and informing policy without suggesting full understanding of these relationships prior to further examination using other research methodologies more appropriate for defining causality.

Secondary data analysis suffers from a number of limitations including a lack of control for subsequent researchers to design measures or measurement schemes, requiring full understanding of the original researchers conceptions and framework for analysis. Reliability is another concern removed from the influence of secondary researchers putting some degree of faith in the original researchers, leaving inquiry into data sets and associated methodology the only recourse for these researchers.

International achievement tests generally suffer due to their inability to be comprehensive. When data is gathered on samples sizes as large as are seen in PISA it is inevitable that compromises must be made during the design of the study. One weakness of this type of data set is the restrictions posed on the questionnaires by time restraints and issues related to full disclosure and subsequent missing data. For example, students and principals complete questionnaires, yet no surveys are issued to teachers or parents (except for the parental option chosen by some countries but not all OECD members). These are two groups, which have a tremendous influence in the achievement of students, yet do not have data collected on them and hence do not have a voice. Another point of concern regarding the questionnaires is that all of the data describing schools is collected from a single source: the principal. This may not be the most accurate way to describe the reality of each school and could be vulnerable to bias in the

opinions of the principal regarding the schools and its teachers and students. Questionnaire items may also be too general for in-depth analysis of any topic. Though this is still used advantageously in order to direct future research towards a number of areas for which there are not enough resources to study in-depth during every cycle of PISA. Another comment on PISA is that their target population is 15-year-olds with sound justification; however, the sample they study is not presented independently. The study of 15-year-old students is a study of the cumulative experiences of those students and not an accurate portrayal of these individuals or their current school. Finally, without a measure of ethnicity PISA is not able to use its resources to the benefit of population subgroups that may be the most disadvantaged in any given country.

Limitations directly related to this study include issues of missing data, the amount of variance accounted for by the HLM models, and generalizability. Missing data is an issue in all regression analyses and methods are developed in order to deal with the ever-present situation. Lee (2000) discusses the inherent superiority of multilevel analysis when it comes to the issues related to misestimating standard errors, the issue that arises from missing data. Concerns point to the statistical power resulting from these analyses, however, in this case, sample sizes were relatively large. Quartile sample sizes were still larger following the list-wise deletion of data than is seen in the data sets of some countries with larger populations than Canada. This is due to decisions by Canadian representatives for PISA choosing sample sizes in each province large enough to be representative, resulting in Canada's overall sample being oversampled. The amount of variance accounted for by the final HLM models ranges from 14 to 15% at the student-level and 46 to 54% at the school-level. These results are influenced by the variables examined, and it is important to note that even incorporating all variables into the analyses would not explain 100% of the variation between students or schools due to limitations of measurement

in all areas. Generalizability is the final limitation to be discussed and pertains to the national models and quartile models respectively. The results of the national models are more likely to generalize to the population due to the full sample being incorporated. The quartiles consist of reduced sample sizes taken from the larger sample which result in non-normal distributions. The national sample therefore is more balanced due to the inclusion of all of the data. Further, the direct comparison of the national sample and the quartiles is hindered by differing sample sizes and the standard errors they reflect. These comparisons taken in the context of a direct one-to-one comparison due to this issue, though comparisons are still usefulin the context of informing and furthering the field of literature.

Future Research

This section will address recommendations for future research in two ways, firstly, with recommendations for future secondary research using the current PISA framework, and secondly,recommendations that could improve PISA in its goals in international assessments.

Potential studies related to this work relate to the current methodology being applied in other contexts. One suggestion is to address the issues of all quartiles in the Canadian data set in one study that look at how the national averages are composed of the quartiles representing all of the students in the sample. This would be a comprehensive review of the Canadian data set based on the current methodology with all of the associated advantages and disadvantages plus new ones of its own. For example, the added benefit of introducing the middle two quartiles will produce a holistic examination of the sample but will extend the limitation of this study regarding the comparison of quartiles with an unequal distribution of extreme scores or outliers. Another future study could use the exact same methodology, or the previously suggested methodology, while comparing the Canadian provinces. Each province samples enough students

to be representative statistically. The major caution here would be to accurately monitor weightings for the comparison and include a full explanation of statistical power in the analysis of samples sizes much smaller than were seen in the current study. Also, a comparison between nations using quartile-splits on achievement would provide a deeper understanding of international comparison research not captured by national averages. Here the concern would be selecting nations with sample sizes large enough to retain power in the analysis of the quartiles. Lastly, Canadian trends could be explored by following this methodology while examining the PISA data sets from all of the cycles beginning in 2000.

Suggestions to improve future PISA data sets are mostly directed towards increasing questionnaire data and less focused on achievement measures. More data to work with is the goal of most researchers, however, resources are usually the determining factor in this regard. More data on students' home environments (Marks, et al., 2007) including parent questionnaires (Kao, 2004; Schulz, 2005) would have the potential to explain more level-1 error in future analyses. Teacher questionnaires in combination with the principal's questionnaire would provide a more representative understanding of schools and all of their complicated influences at the second-level. More demographic information on students would also be beneficial. This study made good use of the available demographic variables, however, information on ethnicity, wealth, and the home environment and culture would hypothetically strengthen student background understanding and again reduce error. Lastly, the influence of gender at the student-level suggests that the gender of school staff such as teachers and administrators may also factor into the relationships that are currently measured gender-free (Lee, Kushner, & Cho, 2007). Even if only a principal supplied gender ratio of teachers were added to the current framework,

potential relationships could be identified to further the understanding of student-teacher relations.

Policy Implications

Implications for educational policy mainly concern identifying groups for matters of resource allocation. This study has shown that demographic differences in student background influence the reading achievement of students in Canada. Educators and administrators profit from information guiding them towards helping those who would benefit most from extra resources, and supporting those students as they proceed towards post-secondary education or the workforce. Helping males with reading is the most obvious result of this study (Halpern, 1997). Interventions for lower achievers and low SES schools (Luke, Dooley, & Woods, 2011) should focus as much as possible on improving males' reading scores as long as these students remain in the education system. Other courses and priorities should be secondary to ensuring adequate reading literacy levels before these students leave their education system and potentially never return to education again in their lifetime. Another group to support are students from non-nuclear families, with perhaps less direct reading assistance is the answer for this group and more help in areas such as stress-management and coping-skills required for their individual circumstances (Weiser & Riggio, 2010). Family turmoil can distract students from achieving their potential in all subject areas and emotional and affective guidance such as resiliency training could be an answer to improving students' self-efficacy in their educational pursuits. Immigrant students in Canadian schools fair quite well when compared to native-born students, however, if language barriers are affecting results, continued support in this area is constructive. Student SES is largely out of the realm of educational policy, however, any support for these students that is available such as meal programs on school days or over the

weekends as well as productive extra-curricular activities, designed to provide positive modeling as well as inspire lower SES students, would help them prepare for their future. In terms of school SES, some academics are calling for the de-segregation of schools along SES lines with the goal of incorporating all levels of SES into all schools, hypothetically leveling the playing field for all students, but whether this is a realistic policy implementation is yet to be seen. Lastly, regarding the influential impact of teachers (Klem & Connell, 2004), the most promising results from the HLM models showed that high SES schools benefitted from superior Teacher Behaviour, improved Teacher Participation, and higher Student-Teacher Relations. This could be an artifact describing the differences between private and public schoolsor it could be an indication that teachers value autonomyand when given the opportunity, results will be positive in other areas of their influence (Dondero, 1997).

Concluding Comments

Even in light of a relative lack of level-2 loadings in the HLM models, results from this study have been abundant and fruitful. Any study seeking statistically significant results pursuing the support of youth achieving below their potential is compelling, however, successfully realizing outcomes that have the potential to help is even better and more satisfying. Additionally, the homogeneity seen within the subgroups supports the use of quartile splits in research methodology with sample sizes large enough to maintain sufficient statistical power.

Overall, the message to be taken away from this research is that the education systems of Canada work well in supporting their students, though more support of disadvantaged groups is necessary before true equality can be realized. Demographics are still an important predictor of student achievement and until all groups are properly supported our system will require further refinement. Individual differences as well as the composition of our schools have an impact on

achievement than can be influenced by educational policy and resource allocation in order to pursue the equality of all students. Finally, teachers play a big role in the education of our youth and supporting teachers will translate into enhanced student-teacher relations and improve achievement scores for students currently not reaching their full potential.

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APPENDIX A

Description of Student-Level and School-Level Variables

Variable Name	Variable Label	Format Value Label or Description
ESCS	Index of economic, social, and cultural status (WLE)	The components comprising *ESCS* for PISA 2009 are home possessions, *HOMEPOS* (which comprises all items on the *WEALTH*, *CULTPOS* and *HEDRES* scales, as well as books in the home (ST22Q01) recoded into a four-level categorical variable (less than or equal to 25 books, 26-100 books, 100-500 books, more than 500 books), the higher parental occupation (*HISEI*) and the higher parental education expressed as years of schooling (*PARED*). However, the home possessions scale for PISA 2009 is computed differently than in the previous cycles for the purpose of enabling a trends study.
Family Structure	FAMSTRUC	1 Single parent (natural or otherwise) 2 Two parents (natural or otherwise) 3 Other 7 N/A 9 Missing
Gender (renamed from Sex)	ST04Q01	1 Female 2 Male 9 Miss
Immigration Status	IMMIG	1 Native 2 Second-Generation 3 First-Generation 7 N/A 9 Missing The index on immigrant background (*IMMIG*) is

		calculated from these variables, and has the following categories: (1) native students (those students who had at least one parent born in the country), (2) second generation' students (those born in the country of assessment but whose parent(s) were born in another country) and (3) first-generation students (those students born outside the country of assessment and whose parents were also born in another country). Students with missing responses for either the student or for both parents have been given missing values for this variable.
Teacher-Student Relations	STUDREL	This scale provides information on disciplinary climate in the classroom. There are five items in this scale. There are four response categories varying from "strongly disagree", "disagree", "agree" to "strongly agree". The items in this scale were reverse coded i.e. higher WLE's on this scale indicate a better disciplinary climate and lower WLE's a poorer disciplinary climate. Similarly, positive item difficulties indicate aspects of disciplinary climate that are less likely to be found in the classroom environment. The item difficulties (deltas) for all the items in this scale are all negative which means that the items are relatively easier to endorse.
Proportion of Female Students	PCGIRLS	The PISA 2009 index on the

		proportion of girls at school (*PCGIRLS*) is based on the enrolment data provided by the school principal, dividing the number of girls by the total of girls and boys at a school.
Proportion of Students Non-Native Immigration Status	Same	This is a composite variable derived from the mean value of each school in the data set using the original level-1 variable: IMMIG.
Proportion of Students Non-Nuclear Family Structure	Same	This is a composite variable derived from the mean value of each school in the data set using the original level-1 variable: FAMSTRUC.
School ESCS	Same	This is a composite variable derived from the mean value of each school in the data set using the original level-1 variable: ESCS.
School Teacher-Student Relations	Same	This is a composite variable derived from the mean value of each school in the data set using the original level-1 variable: STUDREL.
Teacher Behaviour	TEACBEHA	The question on student related aspects of school climate has appeared before in PISA 2003 is used for the index on the Student-related aspects of school climate. This question is reverse coded, *i.e.* higher WLE estimates on this scale represent a positive student behaviour. Similarly, positive item difficulties indicate student related aspects of school climate that are less likely to be present. Table 16.49 shows the item wording and the international parameters used for IRT scaling. The distribution of item and step difficulties for this scale is reasonable and

		appropriate.
Teacher Participation	TCHPARTI	The question on teacher related factors affecting school climate has appeared before in PISA 2003 and is used for the index on the Teacher-related factors affecting school climate. All items were reverse coded for IRT scaling and positive WLE scores indicate positive teacher behaviour. Similarly, positive item difficulties indicate aspects of teacher related factors affecting school climate that are less likely to be present. Table 16.48 shows the item wording and the international parameters used for IRT scaling. The item difficulties for all the items in this scale are all negative which means that the items are relatively easier to endorse.

APPENDIX B

Approval of Ethics Waiver

University of Victoria

Human Research Ethics Board
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Certificate of Approval of Waiver

PRINCIPAL INVESTIGATOR	**Shawn Thomas**	**ETHICS PROTOCOL NUMBER**	**13-037**
UVic STATUS:	**Master's Student**	ORIGINAL APPROVAL DATE:	04-Feb-13
UVic DEPARTMENT:	**EPLS**	APPROVED ON:	04-Feb-13
SUPERVISOR:	**Dr. John Anderson; Dr. Wanda Boyer**	APPROVAL EXPIRY DATE:	03-Feb-14

PROJECT TITLE: **A Multilevel Analysis of Reading Literacy Achievement: Comparison of the Canadian National Sample, and its Highest and Lowest Quartiles**

RESEARCH TEAM MEMBERS: None

DECLARED PROJECT FUNDING: **None**

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

Rachael Scarth

Dr. Rachael Scarth
Associate Vice-President, Research

Certificate Issued On: 05-Feb-13

13-037 Thomas, Shawn