Using a Neighbourhood Measure of School Readiness to Predict Academic Achievement in a Population of Children

by

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy

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Abstract

This study investigates whether academic achievement in individual children can be predicted by the proportion of children with school readiness vulnerabilities within the school neighbourhood. The data analyzed came from: 1) an extensive administrative database on the EDI (Early Development Instrument) (Janus & Offord, 2007), which provided the measure of school readiness vulnerability; and 2) a large study of academic achievement and associated factors conducted in Latin American and Caribbean countries (SERCE, UNESCO/LLECE, 2008), which provided the measure of individual child achievement and demographics at the school level. These data were collected in 2006 (SERCE) and 2008 (EDI) in Nuevo Leon, Mexico. A two-level Hierarchical Linear Modeling (HLM) approach was conducted to analyze the data, with individual SERCE student level predictors at level-1, and average EDI school neighbourhood vulnerability scores as predictors at level-2. The EDI records (n=50,400) were
nested within a total of 116 school neighbourhoods comprised of 151 schools. Results indicate that the level-2 predictors (EDI) accounted for a small but significant proportion of between school variance in third (13.8%) and sixth (17.2%) grade reading. However, the level-2 predictors (EDI) did not account for significant variance in third and sixth grade mathematics. These results provide further evidence for the influence that average school or neighbourhood readiness variations have on academic achievement. The study findings add to the conceptualization of the EDI as a marker of school and neighbourhood influences and suggest an enriched perspective on trajectories in learning for the UNESCO/LLECE research initiative.
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Dedication

To Mata Amritanandamayi Devi; and Ines Miketta.
List of Terms/Abbreviations

Level-1 and Level-2: This study adopts a two-level Hierarchical Linear Modeling (HLM) approach to analyze the data: level-1, which refers to child and family influences, as well as individual children's academic achievement scores; and level-2, which refers to global school neighbourhood influences.

PERCE: First Regional Study on Academic Achievement and Associated Factors conducted in 1997 by UNESCO/LLECE.

SERCE: Second Regional Study of Academic Achievement in Latin America and the Caribbean conducted by UNESCO/LLECE. The present study analyzes SERCE data which were collected in 2006 in the State of Nuevo Leon, Mexico. SERCE predictors and outcomes are analyzed at level-1.

LLECE: Latin American Laboratory for Assessment of the Quality of Education. LLECE is coordinated by UNESCO’s Regional Bureau for Education in Latin America and the Caribbean.

TEE: Total Environment Effect (TEE). The term TEE is used to encapsulate global school readiness influences associated to the geography of the school neighbourhood (postal code).

EDI: Early Development Instrument (EDI; Janus and Offord, 2007). The EDI is a school readiness population tool administered at kindergarten. The present study analyzes EDI data collected in the State of Nuevo Leon, Mexico, in 2008. EDI vulnerability scores are averaged at the school neighbourhood level to reflect global environmental influences at level-2.

School readiness: i) Ecological properties that make for ready schools, families, and communities; ii) a social construct and the product of the ecology within which a child is embedded; iii) a child’s developmental health status (physical health and well-being, social competence, emotional maturity, language and cognitive development, etc.).
CHAPTER ONE: INTRODUCTION

Background

At the individual level, the period from conception to age five is a critical stage for the programming of neurobiological pathways that can affect health, learning, and behaviour during the entire life cycle (Mustard, 2006; Shonkoff, 2012); as well as a foundation for school readiness, school achievement, and lifelong learning (Rebello Britto & Limlingan, 2012). At a societal level, the early years are seen as the underpinning for the establishment of egalitarian, competent, prosperous, healthy, tolerant, peaceful, stable, and democratic societies in a complex changing world (Mustard, 2006). Although there is abundant evidence on the importance of the early years and family determinants, there is a need to know more about how community influences in populations of children can affect healthy development (D’Angiulli, Warburton, Dahinten, & Hertzman, 2009). Gaining knowledge on these influences can add to our understanding of the necessary supports for healthy development.

This study links two databases, one featuring school readiness data and the other academic achievement data, collected in preschools and elementary schools matched by postal code. The purpose is to investigate whether academic achievement in individual children can be predicted by the proportion of children with vulnerabilities in readiness for school within school neighbourhoods, beyond the effect of demographic predictors for individual children. The objective is to provide empirical evidence for possible school-level neighbourhood effects on the development of individuals.

Throughout the literature review, this thesis discusses both individual and population level trajectories in learning as a theoretical framework, but emphasizes the population level. The examination of both is required because neither individual nor population developmental health
can be properly defined or studied without contextualization in terms of the other (Arah, 2009). This double perspective recognizes that individual and population factors are not associated randomly. In other words, populations are formed by individuals, and individuals are affected by population level factors such as neighbourhood environments.

A developmental trajectory refers to the course that development can take as a result of gene-environment (early experiences) interactions. In these interactions, epigenetic effects can play an important role. At the individual and group level, these trajectories can be affected by the global social environment made up by poverty/wealth, culture, biological and by psychosocial protective/risk factors present in families (e.g., attachment relationships, parenting practices) and communities (e.g., sanitation, nutrition) (Walker et al., 2007; see Figure 1). In this process of experience based brain development (Mustard, 2006), a combination of early biological embeddings and cumulative experiences come into play (Hertzman, 1999; Hertzman & Boyce, 2010). A biological embedding refers to the process by which experience gets under the skin altering human biology and development. This process can affect the central nervous system development and function and developmental domains closely related to school readiness (e.g., sensori-motor & physical health, social-emotional, cognitive-language).
From the perspective of the social determinants of health (SDH), the intersections and interactions among determinants affect life course patterns in health, learning, and behaviour (Beanlands & Betker, 2009). SDH are widely used as an important part of the population level approach to study human development. For instance, research initiatives in multiple countries have found a gradient between the level of education in a population (as an SDH) and its physical and mental health (CSDH, 2008; Kirsch, Jungeblut, Jenkins, & Kolstad, 2002; OECD, 2000). This particular gradient can be explained in terms of: 1) the association between the level of education and other SDH (e.g., place of residence, family income); and 2) the enhanced literacy and understanding capacity that education provides to promote one's own health (Mikkonen & Raphael, 2010). This is an example of how population trajectories in human development are affected by the social conditions that individuals experience and live within. SDH also include societal factors such as social status, gender, social support networks, social
exclusion, social safety net, food insecurity, health services, and housing (Mikkonen & Raphael, 2010); as well as early childhood development and the experiences that affect it (Irwin, Siddiqi, & Hertzman, 2007).

A theoretical perspective that helps with understanding how individual and population determinants affect child development comes from Bronfenbrenner's Bioecological Model (Bronfenbrenner, 1977; Bronfenbrenner, 1979). This model is useful in conceptualizing how school readiness levels and the social ecology of the neighbourhood are tied together, ultimately affecting trajectories in learning. The term social ecology refers to the constellation of environments and relationships in which individuals live (Earls & Carlson, 2001). Bronfenbrenner sees human development as taking place in interrelated ecological levels, conceived as nested systems. These levels are: the microsystem, mesosystem, exosystem, and macrosystem. To explain development, this model takes into consideration: 1) the biopsychosocial characteristics of the child; 2) the influence of the surrounding social contexts and their combined effects in the form of patterning environmental events, transitions, and socio-historical circumstances; and 3) the interaction between (1) and (2) that takes place over time (Bronfenbrenner & Morris, 2006).

Bronfenbrenner's notion of nested systems is commonly adopted by models that study the effect of ecological factors on child development. For example, the Ecological and Dynamic Model of Transition (Rimm-Kaufman & Pianta, 2000) sees school transition as being affected both directly and indirectly by the dynamic and organized network of interactions among child, home, school, neighbourhood settings, and institutions. These interactions form patterns of relationships across time (Rimm-Kaufman & Pianta, 2000), affecting development and learning. An example of a pattern of relationship that is instrumental to school readiness and school
transition is the one formed by children and their families through social relationships with peers, caregivers, teachers, parenting supports, and early education services (Patel, Corder, Pelletier, & Bertrand, 2016). Patterns of relationships that are established within communities can affect school readiness in the form of 'neighbourhood readiness' influences.

Another model that explains the effect of ecological factors on early human development is the Total Environment Assessment Model of Early Child Development (TEAM-ECD). This model was envisioned by the World Health Organization's Commission on Social Determinants of Health (Siddiqi & Hertzman, 2007). It takes elements from ecologically oriented system theories to illustrate how the SDH operate at different levels of influence, which ultimately affect trajectories in human development and learning. Figure 2 presents a graphic representation of the TEAM-ECD and an overview of the environments and their interrelations that matter most for children. As shown, the model features interrelated nested systems (e.g., families, family and community supports, primary health care services), which are part of a neighbourhood, regional, national and global context. At the centre of the graph are children, whose pathways to developmental outcomes can be affected by SDH and the mechanisms represented in Figure 1.
The TEAM-ECD approach is helpful in contextualizing school readiness as a social construct. In the past decades, the conceptualization of school readiness has partially shifted, at least at a conceptual level, from a child-centred perspective to a society-centred perspective (Meisels 1988; Meisels, 1999; Pelletier & Corter, 2002). A society-centred perspective conceptualizes, investigates, and promotes school readiness taking into consideration the multidimensional contexts in which children develop, and the interconnections between these contexts (Arimura et al., 2011; Kagan, 1992). In this perspective, school readiness is seen as the result of ecological/synergistic processes of influence between the child, contextual factors (Sameroff, 1995), and organized networks of interactions (Mashburn & Pianta, 2006; Rimm-Kaufman & Pianta, 2000).

The TEAM-ECD is also helpful in explaining the influence of the multilevel contexts
affecting school readiness, and the interactions among these contexts and their SDH, which give rise to 'neighbourhood readiness influences'. For example, neighbourhoods cluster institutions, families from similar background, social networks, and levels of crime and violence. These SDH contribute to neighbourhood level variations in the experiences affecting childhood development, including educational segregation, the effect of which is explained in more detail later in the document. 'Neighbourhood readiness influences' are relevant; in the present study school readiness vulnerability scores are averaged at the school neighbourhood level (postal code), and therefore represent neighbourhood school-level influences affecting development.

This study uses the term Total Environment Effect (TEE) to encapsulate neighbourhood readiness influences associated with the geography (postal code) of the preschool/school. TEE has a meaning similar to TEAM-ECD; however, TEE circumscribes its focus to the preschool/school neighbourhood sphere of influence, encompassing all the SDH present in the geographical area, including individual and group level determinants of early development. It is argued here that the TEE constitutes both a collective experience and an individual/family level experience whose influence is reflected in the proportion of children with school readiness vulnerabilities at the school neighbourhood level.

**Data Used in the Present Study**

This study includes the analysis of two large data sets collected in 2006 and 2008 in the State of Nuevo Leon, Mexico. The first comes from an EDI (Janus & Offord, 2007) data collection conducted in preschools across the state that evaluated children 3.67 to 7.5 years of age. The second comes from academic achievement scores on the SERCE - Second Regional
Study of Academic Achievement in Latin America and the Caribbean (UNESCO/LLECE\(^1\), 2010), which measured the reading and mathematics skills of children in the third and sixth grade.

The EDI is a teacher rated measure of children’s early development administered at kindergarten (Janus & Offord, 2007). This tool is commonly used to measure average vulnerability levels for the under-5 population in a given geographical area (e.g., school districts, neighbourhoods). This instrument is being increasingly used across Canada (Janus & Duku, 2007) and Australia (Chittleborough, Searle, Smithers, Brinkman, & Lynch, 2016) to monitor the developmental status of populations of children, and also to investigate the influence of context level factors on their development. The SERCE was part of a research initiative lead by UNESCO that measured academic achievement and the factors affecting it. SERCE included questionnaires on 'associated factors' (e.g., mother's educational level) that were completed by students, parents, teachers, and school principals. The present research study uses the 'proportion of school neighbourhood children with vulnerability on two or more domains of the EDI’ as a measure of school readiness that reflects the influence of the TEE on SERCE measures of academic achievement. The purpose of using this definition is to provide the analysis with a more extreme measure of vulnerability. Note that this criterion to define *school readiness vulnerability* differs from the standard criterion used by the Offord Centre for Child Studies, which uses the benchmark ‘vulnerable in one or more domain’.

\(^1\) LLECE: *Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación* (Latin American Laboratory for Assessment of the Quality of Education). LLECE is the network of quality assessment systems for education in Latin America. It is coordinated by UNESCO’s Regional Bureau for Education in Latin America and the Caribbean with headquarters in Santiago, Chile.
Rationale

Schools and preschools from the two databases were paired at the school neighbourhood level, determined by postal code (from now on called school neighbourhood level). School neighbourhoods are conceived as circumscribed geographical areas that cluster institutions and people from similar sociocultural backgrounds, whose exchanges enable TEEs to emerge. A two-level Hierarchical Linear Modeling (HLM) analysis was conducted to analyse the data, with SERCE individual-level achievement and SERCE individual student related predictors at level-1, and the proportion of EDI school neighbourhood vulnerabilities as predictors at level-2. In the analysis, the proportion of EDI school neighbourhood vulnerabilities represent the nesting of schools within school neighbourhoods, and are used as aggregated markers of between school neighbourhood influences affecting academic achievement. Results on the dependent variable are interpreted at the level of the individual child within a school.

Several large-scale studies using the EDI have investigated the association between school readiness and academic achievement at the neighbourhood level (Lloyd & Hertzman, 2009; Lloyd, Li, & Hertzman, 2010). In most of these studies, data from the same children have been linked across time to examine trajectories in learning. However, a search of the literature found no studies that have attempted to use school readiness scores as a measure of the TEE to predict academic achievement in school-aged children in the same neighbourhood at the same point in time.

A search of the literature also indicates that the SERCE data have never been linked for research purposes with early child development administrative databases. The linkage of these two sets of data offers the unique opportunity to investigate whether the proportion of children with EDI vulnerability scores in school neighbourhoods explains SERCE academic achievement scores at
the individual child level. The working hypothesis is that population school readiness scores reflect the Total Environment Effect: individual/global environmental influences and children's developmental health status in the geography of the preschool/school; and therefore can predict individual academic achievement in a population of children whose preschool/school are located in the same postal code area.

**Objective**

The objective of this study is to examine if the proportion of EDI vulnerability scores across school neighbourhoods adds to the prediction of individual-level SERCE academic achievement scores, beyond that of the SERCE predictors alone. In this multilevel analysis, individual children are nested within schools, and preschools and schools are linked by postal code areas. In the HLM methodology used in the analysis, EDI vulnerability scores are averaged at the school neighbourhood level and therefore there is no variation in the EDI within schools at level-2. Thus, the focus of the present study is on between school neighbourhood effects and the influence of the TEE on individual learning differences among schools.

**Hypothesis**

It is expected that the combined effect of the proportion of EDI vulnerabilities (level-2 average school neighbourhood) plus SERCE predictors (level-1 individual child) will have a stronger effect on SERCE individual children reading and mathematics scores within a school than SERCE predictors alone.
CHAPTER TWO: REVIEW OF THE LITERATURE

Background

The purpose of this literature review is to examine evidence in support of the proposition that the TEE (Total Environment Effect) at the school neighbourhood level can affect life course trajectories in learning at a population level. As explained earlier, the term TEE is used in the present study to encapsulate the influence of nested contexts and shared neighbourhood experiences on school readiness. The literature review is divided into three parts: (1) the development of the notions of school readiness and trajectories in learning; (2) the evidence for effects on school readiness associated with family SES, home learning environment, early education, and neighbourhood characteristics; and (3) the evidence from the EDI and SERCE literature linking area level environmental effects with school readiness and academic achievement.

An additional purpose of the literature review is to provide a multilevel contextualization to the themes being discussed. In the HLM methodology adopted in this study, individual/family factors correspond to level-1, while population/community factors correspond to level-2. Accordingly themes were examined throughout the review at both levels of analysis. This multilevel approach facilitated the conceptualization of the TEE, which it is argued encompasses level-1 (SERCE) and level-2 (school neighbourhood EDI vulnerability) factors.

Defining School Readiness

Historically, school readiness has been defined in terms of the individual child's ability to meet the requirements of the school. Such requirements include being comfortable exploring and asking questions, having the ability to hold a pencil, playing and working with other children, remembering and following rules (Janus et al., 2007), and sitting quietly and listening to the
teacher (Kagan, 1992). School readiness can be seen as encompassing five different domains: physical well-being and appropriate motor development; emotional health and a positive approach to new experiences; age-appropriate social knowledge and competence; age-appropriate language skills; and age-appropriate general knowledge and cognitive skills (Kagan, Moore, & Bredekamp, 1995).

Over the years the above definitions of school readiness were enriched from debates centred around two conceptually competing terms: readiness to learn and readiness for school (Kagan, 1992). Readiness to learn refers to the level of development at which a child is ready to undertake the learning of specific material, and to comprehend and respond to instruction. These capacities are influenced by the child's past and present experiences. In contrast, readiness for school refers to the child's acquisition of specific cognitive and linguistic skills thought to be necessary for success in school and assimilate the curriculum content (Kagan, 1992). In readiness for school, the onus for early success is placed on the child (Lapointe, 2006).

In response to the debate around readiness to learn and readiness for school, another perspective - maturationist readiness - was proposed (Kagan, 1992). Taking elements from both views, this new perspective sees readiness as the unfolding of biological development that cannot be altered (Meisels, 1998; Meisels, 1999). Maturationist readiness positions argue that children be allowed to develop according to their own timetables, and that children should attain a fixed entry standard prior to school entry (Kagan, 1992).

The maturationist view is giving way to a more contemporary perspective that contends that learning nourishes development and highlights the importance of placing children in rich early learning situations as a means to enhance readiness. This perspective is rooted in Vygotskian theory, which emphasizes a child's active role in the generation of knowledge based
learning (Derry, 1999), as well as the influence of culture and context in supporting children's development. In Vygostkian theory, children develop as a result of the interaction between a natural line (e.g., biological maturation) and a cultural line. For proper development to occur, children must be exposed to culture and stimulation (Vygotsky & Luria, 1930/1993). This view represented a shift from readiness for school to the readiness to learn perspective, in which schools must adapt educational styles, resources, and goals to be ready for children.

Meisels’ interactionist approach helped to integrate some of the above views about readiness, which is defined as the product of the “…interaction between children’s prior experiences, their genetic endowment, their maturational status, and the whole range of environmental and cultural experiences that they encounter” (Meisels, 1996, p. 409). The interactionist approach integrates: 1) idealist/nativist perspectives (children are ready to start school when they reach a certain level of maturity); 2) social constructivist views (readiness must be defined in social and cultural terms); 3) and empiricist/environmental notions (readiness must be defined in terms of the practical characteristics of the child’s behaviours and the external evidence of learning). The interactionist view helped to conceive readiness in terms of information from children’s current skills, knowledge, and abilities and the conditions of the environment in which children are reared and taught (Meisels, 1998).

The definition of readiness evolved further thanks to new perspectives introduced by ecologically oriented system theories. These theories see readiness as based on reciprocal/transactional interactions between the child, contextual factors (Sameroff, 1995), contextual systems (Pianta & Walsh, 1996), and organized system of relationships among people, settings and institutions (Rimm-Kaufman & Pianta, 2000). Increasingly, there has been a realization among child development specialists that school readiness is the product of the ecology within
which a child is embedded, and therefore it must be contextualized in relation to the child's ecological system (Arimura et al., 2011; Guhn & Hertzman, 2016; Mashburn & Pianta, 2006). This approach to school readiness underlines the need to favour the mutual influence and partnerships among parents, teachers, neighbourhoods, public and private services, as well as local governments with the purpose of enhancing the child's social and learning experiences (Doherty, 1997; Janus & Offord, 2007; Kagan, 1992; Mashburn & Pianta, 2006; Meisels, 1999; Patel et al., 2001; Pelletier & Corter, 2002; Pelletier & Corter, 2006). Thus, the ecologically oriented system theories have contributed to define school readiness in terms of the ecological properties that make for ready schools, families, and communities (Arimura et al., 2011; Pelletier & Corter, 2006; Pianta, 2000; Pianta & Laparo, 2003; Rimm-Kaufman, Mashburn & Pianta, 2006).

A case study on Cuba provides evidence of the learning benefits associated with society readiness. The PERCE study (UNESCO/LLECE, 1998), conducted in 1997, found that the median average values for Cuban students in third and fourth grade language and mathematics scores were about two standard deviations above the regional mean (Willms & Somers, 2001). The SERCE study conducted in 2006 replicated these findings. These outcomes created interest in the study of the Cuban regional academic advantage (Carnoy, Gove, & Marshall, 2007; Senate of Canada, 2008). Tinajero (2009) and Tinajero and Mustard (2011) investigated these results from the perspective of universal health and education ECD programs delivered on the island. At the beginning of the 1990's, all Cuban children under 5 years of age participated in an early education program, and their development was closely monitored to ensure an appropriate growth of language, cognitive, socio-emotional, and motor skills. This comprehensive education program was part of a universal developmental health program including health, nutrition, and
sanitation, which paid close attention to the well being of pregnant mothers, newborns, and young children. By 1997 (year of the PERCE evaluation), developmental health indicators in Cuba were significantly better than those from Latin America and the Caribbean, in terms of maternal mortality rate, mortality rate of infants and children under the age of 5, low birth weight, high school completion, and adult literacy rates (Tinajero, 2009). The high scores obtained by Cuba in academic achievement are compatible with the evidence that early experiences set trajectories in physical health, mental health, learning and behaviour (Tinajero & Mustard, 2011).

The Cuban academic advantage can be explained in terms of the island's universal early human development program, the influence of which permeates all layers of the ecological system, including schools, neighbourhoods, and society in general. Key elements of this system are: 1) a management principle that education is everybody's responsibility (Gasperini, 2000); and 2) the reinforcement of values and practices of collective social capital ("relationships and networks that enhance individual's productivity or academic achievement..."; (Carnoy et al., 2007, p.51). The above arguments speak of a 'society readiness' effect that arguably gives Cuban children an academic advantage. Measuring and understanding community readiness is an important step for developing strategic approaches to support children to succeed in school (Kershaw, Irwin, Trafford, & Hertzman, 2005).

The Early Development Instrument (EDI), created by Janus and Offord (2007), is a school readiness measurement tool positioned in the context of the social constructivist approach (Janus & Offord, 2007). The EDI is a population measure that undertakes a community-level approach to evaluate children's skills in their own social context (Janus & Offord, 2007). This rating scale instrument is typically completed by teachers in the second half of the kindergarten
year. Assessing children within the context of their place of residence, the tool allows mapping of the ‘geography of opportunity’ for early child development (Kershaw et al., 2005).

‘Geography of opportunity’ refers to the effect on human development that arises from the place of living, as defined through quality of local educational, health and social services, quality of recreational resources, social interactional effects, socio-economic status, physical infrastructure, and green areas available to the population. EDI data are particularly helpful to designing local plans for enhancing child development (Kershaw et al., 2005). The present study uses the EDI as a measure of the TEE and a proxy to the 'geography of opportunity' in school readiness and academic achievement.

**Defining Trajectories in Learning**

Trajectories refer to life course developmental health patterns\(^2\), as well as life course exposure to social determinants of health, environments, and experiences (Hertzman & Boyce, 2010). A learning trajectory can be conceived as having two components: a predictive one and an outcome one. For example, a measure of child's school readiness represents a developmental course that can predict school achievement, and at the same time, a developmental outcome of early experiences.

An important notion related to trajectories in learning is that the individual and collective ecological contexts affecting them are connected in largely inseparable ways. In this way, what affects an individual can affect the collective, and what affects the collective, can affect an individual (Arah, 2012). For example, early experiences related to the family environment can affect children’s developmental health status, developmental health pathways, life course

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\(^2\) Understood as the programming of brain and body functions, as well as ways of interaction among the different domains comprising development
circumstances, and the type of groups they will belong to during their life cycle. In this way, individual trajectories are linked to collective trajectories and their associated group effects. Synergistic effects and the dynamics of this connection make neighbourhoods greater than the sum of individual trajectories (Arah, 2012). In the present research study the term TEE is used to encapsulate individual (level-1) and collective (level-2) school neighbourhood influences affecting trajectories in learning. The hypothesis under examination is that EDI scores reflect these influences, and therefore can be used to predict later cross school neighbourhood variations in academic achievement at the child level within a school.

Differences in the quality of individual and group level experiences can give rise to population gradients in human development and learning. In association with measures of SES, ‘gradient’ refers to commonly observed population patterns of monotonic increase or decrease in human development outcome variables (Keating & Hertzman, 1999). The term also refers to gaps in education and health outcomes between majority groups, minority groups (Kirsch et al., 2002), area levels (e.g., school districts) (Kershaw et al., 2005), and countries (Irwin et al., 2007). Gradients are affected by the cumulative effect of impoverished life circumstances that are commonly shared by individuals at the lower end of the socioeconomic ladder (Duarte, Bos, & Moreno, 2010; Hertzman, 1999). Thus, these gradients are a source of variation in the quality of experiences associated to the TEE. During the early years of life, adverse experiences can get 'under the skin' creating population gaps and steeper gradients in human development and learning (Hertzman & Boyce, 2010).

Evidence in support of trajectories in learning can be found in longitudinal studies measuring school readiness levels, academic achievement in primary and secondary school, and literacy levels in adulthood. For example, reading and numeracy skills (Duncan et al., 2007;
Rebello Britto, & Limlingan, 2012), attention skills (Duncan et al., 2007), and behavioural self-regulation at school entry (McClelland, Acock, & Morrison, 2006) have been found to be associated with later reading and math achievement in elementary school. Children who enter formal education with poor school readiness skills generally do not do well in the school system (Lloyd & Hertzman, 2009; Rouse, Brooks-Gunn, & McLanahan, 2005).

Evidence in support of trajectories in learning also comes from other studies that track children's development at the neighbourhood or district level (Kohen, Oliver, & Pierre, 2009; Lloyd & Hertzman, 2009; Lloyd, Li, & Hertzman, 2010). For instance, Lloyd and Hertzman (2009) created a Community Index of Child Development (CICD) by linking at the aggregate level EDI and grade 4 academic achievement scores. The data analyzed came from 63 neighbourhoods nested within 4 school districts in British Columbia. Results showed the existence of wide variations in CICD scores across the children's districts of residence in kindergarten, possibly originating from demographic and socioeconomic variations across neighbourhoods. The study results suggested that CICD can be used as a neighbourhood level descriptor to track trajectories in learning. The aggregate level data generated by the index highlight the notion of neighbourhood readiness, in which child development is the product of the ecology in which the child is embedded. These findings are relevant, as the present research study uses the TEE to reflect area level influences affecting academic achievement. It should be noted that even though the notions of TEE and CICD have common elements, TEE is more conceptually inclusive of community influences affecting development. This is because the TEE encapsulates global school readiness influences, including individual and group level determinants.

Further support for the notion of trajectories in learning can be found in country-level
population studies. For example, Merry (2013) examined the origins of the academic achievement gap that exists between Canadian and U.S. 15- to 16-year-olds' PISA\(^3\) scores (a gap that favours Canadian reading, mathematical and scientific literacy scores). The author hypothesised that this gap was already in place when these children entered the school system. To investigate this, two sources of data were linked: 1) PISA (2009) scores; and 2) vocabulary tests results (Peabody Vocabulary Test-Revised) from the NLSY National Longitudinal Study (Canada), and the NLSCY-79 (U.S.). The NLSCY and NLSY-79 data came from the 1994, 1996, and 1998 cycles administered to children ages 48 to 71 months - roughly corresponding to the age at which youth took PISA in 2009. The study samples were nationally representative and demographically similar\(^4\). Results indicated that the academic achievement gap between U.S. and Canadian children was already in place before the start of formal schooling, and that this gap was more prominent in the bottom 50 percent portion of the PISA scoring distribution. According to the author, this gap originates from differences between the two countries (favouring Canada) in terms of their absolute living conditions (e.g., infant mortality rate, life expectancy); relative living conditions (e.g., income based inequalities); poverty; mentalities and ideologies towards culture, policies, and institutions; and health and social welfare systems. This study provides evidence that population gaps in school achievement can originate early in life, and that SDH (as a society readiness effect) sets trajectories in learning.

In the past few years the Inter-American Development Bank (IDB) conducted a comprehensive review of child development studies in Latin American and Caribbean countries. This review has shown that once children in the region begin school, on average they present

\(^3\) Programme for International Student Assessment  
\(^4\) According to the author the two countries hold similarities in their demographics, living standards, occupational structures, educational attainment, decentralization, and expansive geographies.
significant deficiencies in reading and mathematics skills. This poor progress is attributed in part to deficits in language and cognitive skills these children have upon entering school, and also to the low quality education they receive in the school system (Berlinski & Schady, 2015). To come to this conclusion, the IDB examined evidence from the PERCE (First Regional Study on Academic Achievement and Associated Factors conducted in 1996) and SERCE initiatives (Cruz-Aguayo & Schady, 2015), PISA (OECD) results in LA/C countries (Cruz-Aguayo & Schady, 2015), census information from UNICEF’s Multiple Indicator Cluster Survey and the Demographic and Health Survey (Berlinski, López Boo, Pérez Expósito, & Schady, 2015), and randomized control studies conducted across the region (Berlinski, et al., 2015). Particularly in the language and cognitive domains, the review found a socioeconomic gradient in early childhood development. This gradient becomes larger as children grow older, at least until the age when they begin formal schooling (Berlinski & Schady, 2015). These findings align with evidence that SES disparities in verbal skills of children at age 3 are affected by the degree of language exposure from age 1 to age 3 (Hart and Risley, 1995); and also with evidence that population trajectories in learning can be established before children enter the school system.

**School Readiness, Achievement and Contributing Factors**

There is strong evidence that individual, family, school, and neighbourhood level factors predict early child development and school readiness. For example, school readiness can be affected by the child's gender, age, and suboptimal health (Janus & Duku, 2007); quality of the home learning environment (Melhuish, Phan, Sylva, Siraj-Blatchford, & Taggart, 2008); family socioeconomic status (SES) (Janus & Duku, 2007; Kohen, 2009; Noble, Tottenham, & Case, 2005); neighbourhood SES (Jones & Shen, 2014); neighbourhood social capital (e.g., social
cohesiveness) (Jones & Shen, 2014); concentrated neighbourhood affluence/disadvantage ('mixed communities') (Carpiano, Lloyd, & Hertzman, 2009); and the socio-demography of the school and the neighbourhood (Kohen et al., 2009). Of the above references, the ones by Janus and Duku (2007), Kohen et al. (2009), and Carpiano, Lloyd, & Hertzman (2009) are population studies conducted with the EDI.

In a similar way, a large number of other studies have shown the significant role played by individual and context level factors on academic achievement. For example, in relation to the child's age (Siddiqi, Kawachi, Berkman, Hertzman, & Subramanian, 2012) and gender (OECD, 2014); quality of the home learning environment (Bradley, Caldwell, & Rock, 1988); school readiness at school entry (Brinkman et al., 2013; Chittleborough et al., 2016; D'Angiulli et al., 2009; Davies, Janus, Duku, & Gaskin, 2016; Duncan et al., 2007); prior academic achievement (Chiu, 2010; Hattie, 2009); family SES (Chiu, 2010; Duncan, Morris, & Rodrigues, 2011); classroom climate (Treviño, Place, & Gempp, 2013; Willms & Somers, 2001); curriculum and teacher approaches associated with student learning (Hattie, 2009; Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2011); school educational resources (Alacaci & Erbas, 2010; Chiu, 2010; UNESCO/LLECE, 2010; Willms & Somers, 2001); school family structure (Caldas & Bankston, 1999); school SES (Willms, 2006); neighbourhood SES (Leventhal & Brooks-Gunn, 2004); neighbourhood social environment (Bowen & Bowen, 1999; Woolley et al., 2012); and early childhood neighbourhood concentrated disadvantage (Lloyd, Li, & Hertzman, 2010). In the above references, those by D'Angiulli et al. (2009), Lloyd, Li, & Hertzman (2010), Brinkman et al. (2013), Davies et al. (2016), and Chittleborough et al. (2016) correspond to population studies conducted with the EDI; while those by Willms & Somers (2001), UNESCO/LLECE (2010), Treviño, Place, & Gempp (2013), Chiu (2010), Alacaci & Erbas (2010), and Willms
(2006) correspond to population studies conducted within either the PISA or UNESCO/LLECE research initiatives.

The evidence provided by these studies is explored in more detail throughout the thesis. At this point, it is important to mention that many of the above research initiatives adopted an HLM methodology, which is appropriate to analyzing nested data. HLM allows disaggregating the effect of the independent variable(s) on the dependent variable by level of influence (e.g., individual, family, school). In two of the EDI studies, individual and family socio-demographic factors were aggregated at the neighbourhood level, to examine their effect on school readiness (Kohen et al., 2009) and academic achievement (Lloyd, Li, & Hertzman, 2010). Similarly, in the SERCE study an index of the home learning environment was aggregated at the school level to determine its influence on reading and mathematics scores. The evidence derived from these studies supports the notion that group effects such as neighbourhood SES can influence school readiness and academic achievement, even after taking account of the same factor(s) at the individual level.

To better understand the link between individual and group effects, Willms (2006) further analyses the influence of compositional and contextual effects on learning. The former results from the aggregation of individual and demographic factors, while the latter refers to the teaching and learning environment of the school that result from the demographic characteristics of the schools’ composition (e.g., physical features of the learning environment, norms of academic success)\(^5\). Compositional effects explain why students attending high SES schools tend to have higher academic achievement scores than those attending low SES schools, even after

\(^5\) In other words, contextual effects refer to a global school effect on academic achievement in individual children, beyond the effect of any individual level influence.
taking into account the students’ SES at the individual level. This difference in academic achievement is attributed to the capacity of high SES schools in high SES neighbourhoods to attract and retain talented and motivated teachers, have smaller class sizes, better teaching resources, more peer support conducive to learning, greater involvement from parents, fewer disciplinary problems, and an atmosphere more conducive to learning (Willms, 2006)\(^6\).

According to the author, compositional effects such as those deriving from SES can have a triple jeopardy influence on academic achievement. This result from the child’s own family experience; the child being segregated into a school with peers from similar SES; and by the interaction between the SES of the student’s family and the SES makeup of the school (Willms, 2006). The notions behind compositional and contextual effects are important to understand the TEE.

The sections that follow deepen the arguments on how the social determinants of health (SDH) can affect child development through different levels of social aggregation. The focus of this review is on four factors affecting school readiness and academic achievement at the area level: family socioeconomic status (SES), home learning environment, early education, and characteristics of the neighbourhood. This review is important in order to understand the mechanisms by which these factors can affect the TEE (as measured by the EDI) at the place level. Individual and population level studies, in majority and minority world countries\(^7\), are included in the analysis.

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\(^6\) The author used PISA 2000 and 2002 data to investigate the influence of compositional effects on students’ reading skills. He found that the compositional effect was statistically significant in every country in PISA, although the magnitude of the effect varied considerably across countries.

\(^7\) The term 'majority world' or 'majority countries' is used throughout the document to refer to those nations where the majority of the world's population lives. These terms are often used nowadays instead of 'developing world' or 'developing country', which are avoided because they suggest a hierarchy among rich and poor nations.
Family Socioeconomic Status (SES)

In every society, rich or poor, SES differences (e.g., family income, parental education) among its members translate into early human development gaps (Hertzman et al., 2010). Poverty is a SDH encompassing low SES and associated adverse factors. The effect of poverty on development can be multidimensional in that low-income individuals and populations are simultaneously exposed to segregation and deprivations related to health, education, social isolation, voice, and security (Hulme, Moore, & Shepherd, 2001). Segregation refers to the policy, practice or condition of individuals from low SES backgrounds being concentrated in schools and neighbourhoods (Jenkins, Micklewright, & Schnepf, 2008). In scenarios marked by segregation, learning can be affected by the mere concentration of parents, teachers, and peers with similar backgrounds (e.g., levels of preparation, standards of performance, expectations), which can affect the quality of the learning/educational experience (Caldas & Bankston, 1999). Conversely, the integration of children from families with socio-demographic risks into mixed-income schools/communities appears to reduce the negative effect these determinants can have on learning (Hertzman, McLean, Kohen, Dunn, & Evans, 2002). Social integration can also benefit affluent children. For example, school readiness studies have found EDI scores to be higher in mixed communities than in concentrated affluent communities, in part because children residing in mixed communities may benefit from the ECD services aimed at assisting lower SES residents (Carpiano, Lloyd, & Hertzman, 2009). These considerations make SES relevant to studies involving multilevel data, because the effects associated to SES can permeate the entire ecological system.

The association between family SES and child development is complex, and there is still speculation on how the various components of SES interact synergistically at multiple levels of
influence to affect development (Bradley & Corwyn, 2002; Janus & Duku, 2007). However, the evidence of this association is strong across the literature, including the EDI literature. Research has shown that, on average, children from low SES families do significantly worse than children from high SES families in school readiness (Janus & Duku, 2007; Janus, 2011; Leventhal & Brooks-Gunn, 2000), school enrolment (Leventhal & Brooks-Gunn 2000; Smith, Brooks-Gunn, & Klebanov, 1997), school completion (Smith et al., 1997), school achievement (Duarte, Bos, & Moreno, 2010; Duncan, Morris, & Rodrigues, 2011; Willingham, 2012), executive function (e.g., working memory) (Blair & Diamond, 2008), and intelligence tests (Bradley & Corwyn, 2002).

Studies in the U.S. and the minority world have provided evidence that low SES children are more likely to be exposed to less stimulating home learning environments (Bradley & Corwyn, 2002; NICHD Early Child CARE Research Network, 2005; Smith et al., 1997; Willingham, 2012), and to more ambient noise, residential crowding, food insecurity, job insecurity, and high stress levels that arise from these living conditions (Bradley & Corwyn, 2002; Evans, 2004; Willingham, 2012). In particular, research has found that environmental stressors can alter a child’s biological system in the form of an elevated allostatic load (e.g., arousal level across the physiological response system) (Evans & Kim, 2012; Shonkoff & Garner, 2012). In addition, environmental stressors and cumulative risk exposure can undermine the parents' physical health, mental health, and their capacity to maximally support their children's development (Bornstein & Bradley, 2003). All these factors combined put low SES children at heightened risk for poor school readiness and academic achievement.

The association between family SES with children's academic achievement is in part mediated by the home learning environment (Davis-Kean, 2005; Jeon, Buettner, & Hur, 2014). In the early years, this association is stronger for maternal education than for family income, but
as children grow older the association between family income and academic achievement may become stronger (Melhuish et al., 2008). More highly educated parents may offer their children more stimulating learning environments by providing fostering independent thinking, problem solving, enriched language and literacy experiences, and getting involved in school related activities (Magnuson, 2007).

In the majority and minority world SES is usually defined in terms of family income, and parents' occupation and education level (Fotso & Kuate-Defo, 2015). SES is also defined in terms of level of community development\(^8\), and family assets such as land, and durable household goods (Fotso & Kuate-Defo, 2015). Asset ownership predicts children's health conditions, school-enrolment, -attendance, and -completion, as well as child labour (Chowa, Ansong, & Masa, 2010). Poor household flooring, poor roofing, and lack of running water, are other dimensions commonly used as indicators of low SES; they reflect a level of deprivation of basic human needs (Gordon, 2005), which is closely associated to increased illness, malnutrition (Bradley & Putnick, 2012; UNICEF & CEPAL, 2010), and delays in neurodevelopment (Wehby & McCarthy, 2013). The SERCE study used some of the above definitions of SES (e.g., parents' educational level, household flooring, home services, home assets) to create a Socioeconomic and Cultural Status Index. The purpose was to investigate the influence of SES on academic achievement at the individual child and school aggregate levels. Results from Nuevo Leon indicated the existence of a large SES gradient in academic achievement, which was more prevalent at the aggregate school level than at the individual/family level. The above considerations of SES are important to contextualize the TEE (UNESCO/LLECE, 2010).

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\(^8\) For example: proportion of households having access to electricity, telephone, as well as safe drinking water.
Home Learning Environment

While the effect of family SES is important, evidence from the Effective Pre-school and Primary Education project in Great Britain indicated that the Home Learning Environment (HLE) exerts a powerful independent influence on educational outcomes at school entry, over and above SES\(^9\) (Melhuish et al., 2008; Siraj-Blatchford, Taggart, Sylva, Sammons, & Melhuish, 2008), and maintains its influence on academic achievement at age 11 (Sylva et al., 2013). A study using data from the Canada NLSY (National Longitudinal Survey of Youth; years 1979 to 1992) found that among the predictors that were examined HLE is the most important factor mediating the effect of poverty on cognitive development (Guo & Harris, 2000). In this study poverty was measured by the proportion of the years since the child's birth in which the family lived below the poverty line. The outcome from Guo and Harris (2000) can in part be explained in terms of the multiple factors that are at play in poverty; however, the result highlights the important role played by the HLE on school readiness.

The quality of the HLE is typically defined in terms of the children's use of learning-oriented toys, availability of reading materials, and the frequency with which adults read to the children (Caldwell & Bradley, 1984). Other factors defining HLE include motivational aspects of child development (e.g., supporting learning to learn) (Melhuish et al., 2008), quality of parent-child interactions and parental warmth (NICHD, 2005), and the child's internalization of parental values and expectations (Melhuish et al., 2008).

In the U.S., measures of the home environment (Home Observation for Measurement of the Environment Inventory) of children 2 years or older, were found to significantly predict IQ

\(^9\) This finding reflects the fact that SES is a proxy for many factors influencing development, whereas HLE is a direct measure of child development.
scores obtained throughout infancy and childhood (Bradley et al., 1988). HOME scores also predicted cognitive and social skills at fifty-four months (NICHD, 2004). Additionally, results on the HOME scale Availability of Play Materials at age 2 years were related to language achievement at age 11, irrespective of the quality of the latter environment (Bradley et al., 1988).

The quality of the home learning environment has also been studied through family surveys. UNICEF's Multiple Indicator Cluster Survey (MICS 3) 2005-2007 data, from 28 middle and low income countries, showed that there are significant shortfalls in home environment conditions for many families (Bradley & Putnick, 2012). These deficits are particularly noticeable in children's accessibility and engagement with formal learning resources, informal learning resources, caregivers' cognitive interactions (e.g., tell stories, read books, name, count, draw), and socioemotional interactions (e.g., play, sing songs, not leave child alone; Bornstein & Putnick, 2012). For example, in the countries included within the UNICEF study, only about 10%-41% of parents provide cognitively stimulating materials to their children and only about 11-33% of parents actively involve their children in cognitively stimulating activities (Walker et al., 2007). The MICS 3 data also revealed an association between family income and two aspects of the home environment: quality of housing (drinking water, toilet facilities, household flooring, cooking, and refrigeration) and asset ownership (Bradley & Putnick, 2012). Poor quality of housing constitutes a risk factor for malnutrition and poor physical health, which in turn can affect cognitive and socio-emotional development (Bornstein et al., 2012).

School readiness can also be affected by risk factors present in the home environment. A study in Manitoba using the EDI and data from the Population Health Research Data Repository found that the key driver affecting EDI language and cognitive domains correspond to family risk factors, the influence of which goes above and beyond prenatal risk factors and birth
outcomes (Brownell, Ekuma, Nickel, Chartier, Koseva, & Santos, 2016). This study used a life course perspective and an ecological model of development as frameworks for understanding how early experience can shape development. The family risk factors investigated were: teen mother, child welfare involvement, family receipt of income assistance, family with more than four children, maternal depression. This study also reported that family risk factors are strongly influenced by neighbourhood SES, as measured by employment rate, average household income, and average school completion (Brownell, et al., 2016).

One question that has been addressed in multilevel studies has to do with the influence of individual and family factors on school level effects. In particular, this question has focused on individual and family factors shared within a school community (e.g., family structure, low SES). To investigate this type of effect, Caldas & Bankston (1999) compared the academic scores of individuals coming from single parent families against the average academic score of school communities with a majority of families having this same kind of family structure. The study examined the data from 42,000 tenth graders completing the Louisiana Graduation Exit Examination (GEE). Results revealed that: (1) the percentage of single parent families at the school level is a much stronger predictor of academic achievement than the student's own family structure; and (2) between school variations in academic achievement among schools and school districts are closely associated with the family structure that prevails in the schools and districts. These outcomes provide evidence on the synergistic effect of shared family factors on academic achievement at the school and district levels. These findings are significant, as the present research study also investigates the influence of shared group experiences (proportion of school neighbourhood children with EDI vulnerabilities) on academic achievement.

The SERCE study in Latin American and Caribbean countries (UNESCO/LLECE, 2008;
UNESCO/LLECE, 2010) undertook a similar line of investigation that compared individual family effects against school-average family effects. One factor examined was a measure of home education level, a Home Education Index (HEI), which was composed of: parents' educational status, parental involvement in school activities, whether parents read to child when little, and whether the child attended a preschool when little. One finding of the study was that the effect of the HEI on school achievement was significantly stronger at the average school level than at the individual family level (UNESCO/LLECE, 2010). Additionally, the HEI was found to be a stronger predictor of academic achievement than the Socioeconomic and Cultural Status Index (e.g., family SES measures), at both the individual and aggregate school levels. These results, and those from Caldas and Bankston (1999), speak to the crucial role of the school community in transmitting individual and family influences that affect learning. The question in relation to the hypothesis being tested is: Can readiness at the group level, measured by aggregated EDI scores, have an additive effect (positive or negative) on individual readiness in children within the same school neighbourhood? And more specifically in relation to the literature review: how is this magnifying effect explained?

**Early Education**

One question that arises from the delivery of early educational programs is whether the initial gains in school readiness translate into an academic advantage during the later school years. Reviewing early education is important because of its role as part of the TEE, and because in the adopted HLM methodology preschool attendance is used as one of SERCE's level-1 factors potentially affecting academic achievement.

Longitudinal studies conducted on the Head Start, Abecedarian, Project CARE, EPPE (The Effective Pre-school and Primary Education), NICHD (National Institute of Child Health
and Human Development), and CQOS (Cost, Quality, and Outcomes Study) programs have provided evidence for the benefits of participating in high-quality early educational interventions. For example, evidence shows that adults from control groups who participated in the Head Start (Schweinhart et al., 2005), Abecedarian (Pungello et al., 2010), and CARE (Campbell et al., 2008) programs have higher occupational and educational outcomes than adults from control groups who did not participate in these projects. Further evidence from a large meta-analysis study indicates that participation in early educational programs leads to a reduction in special education placement, grade retention, and high school dropout (McCoy, Yoshikawa, & Ziol-Guest et al., 2017).

Although there is strong evidence of positive occupational/educational long-term outcomes being associated with early educational programs as noted above, the evidence on their effect in elementary school achievement has been somewhat mixed and is not conclusive (Borraz & Cid, 2013). Longitudinal findings from the NICHD indicate that quality early educational interventions predict children’s cognitive and language development at 24 and 54 months of age (NICHD, 2006). Additionally, findings from the CQOS indicate that this program has a positive influence on preschool children’s receptive language, pre-academic abilities (e.g., pre-reading) (Peisner-Feinberg & Burchinal, 1997), and grade 2 receptive vocabulary, math, and reading skills (Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002). Furthermore, a meta-analysis study of 22 high-quality experimental and quasi-experimental studies found that on average, participation in ECE leads to statistically significant increases in high school graduation, and reductions in grade retention and special education placement (McCoy, Yoshikawa, Ziol-Guest, et al., 2017). However, the majority of studies report that the initial gains in literacy, language, and cognitive development vanish during the elementary school ("wash out" effect) (OPRE,
2012). Indeed, this early academic advantage has been proven to be rather small, after controlling for background factors (Peisner-Feinberg & Burchinal, 1997; NICHD, 2006; Burchinal et al., 2009). In a meta-analysis of 20 studies, Burchinal, Kainz, & Cai (2011) found that with some notable exceptions, the effect of quality early educational interventions on child development tends to be small by statistical standards. The EPPE (Effective Pre-school and Primary Education) project in Great Britain is one of the few research initiatives reporting sustained gains in academic achievement through grade 6 (Sylva et al., 2013).

The lack of success of most studies, in finding an influence of early education on sustained gains in academic achievement, has been attributed to limitations in the research methodologies that were used to measure program outcomes (Sylva et al., 2006). For example, the majority of studies on child care effects have failed to simultaneously assess quantity, quality, and childcare type (NICHD, 2006; Sylva et al., 2006; Sylva et al., 2011). This lack of consistency in the findings has also been attributed to differences between the programs in terms of target populations and the socio-cultural context in which children, families, and communities are situated (Barnett & Ackerman, 2006; Barnett & Masse, 2007).

The EPPE project is a longitudinal study that has contributed significantly to the understanding of quality early education and its role in achieving sustained gains in academic achievement (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004; Sylva et al., 2007; Sylva, Siraj-Blatchford, & Taggart, 2010). In its investigative approach EPPE differentiated process elements (e.g., pedagogical practices, the nature of adult-child interactions that facilitate learning) from structural elements (e.g., adult-child ratio, teacher education, personal care routine) (Sylva et al., 2006). EPPE studies have found that medium/high quality preschool provision (as measured by process elements) has a positive impact on English and mathematic
achievement scores at age 11. Children in this study who attended a low-quality preschool did better than a control group of children with no preschool experience; however, the initial beneficial effects of low-quality preschool faded by age 11 (Sylva, et al., 2008). This evidence is the first linking early education with late-elementary school academic achievement (Sylva et al., 2013).

The effect of early education on school achievement has also been studied in relation to preschool participation, where influence has been found to be largest for the most disadvantaged children. This has been corroborated in both small scale high quality intervention programs (Barnett, 1995; Duncan & Magnuson, 2013); and in population studies such as SERCE, TERCE\textsuperscript{10} (UNESCO/LLECE, 2015), and PISA 2012 (OECD, 2013). In SERCE, for example, preschool attendance (yes/no) had a positive effect on third and sixth grade mathematics achievement. These findings suggest that preschool participation can serve as an equalizer of between-family disparities in learning (Tucker-Drob, 2012). At first glance this seems paradoxical: how can preschool participation improve achievement, when in most population studies the quality of education is not controlled? The answer to this question seems to arise from the fact that low SES children are more likely to attend poor quality preschools (Meyers, 2004), and on average live in less stimulating home learning environments (Bradley & Corwyn, 2002; NICHD, 2005; Smith et al., 1997). Thus, it is possible that low SES children may benefit from low quality early educational services, in cases where the learning experiences provided by the educational services are richer than those from the home environment (Barnett, 1995). At first glance this speculation seems reasonable; however, it seems to disagree with EPPE’s findings that sustainability in academic achievement is limited to medium/high quality preschool

\textsuperscript{10} Third Regional Comparative and Exploratory Study on academic achievement in Latin America and the Caribbean.
education programs (Sylva et al., 2008).

**The Neighbourhood**

In this thesis, the term ‘neighbourhood’ refers to a geographic space, which can be defined in terms of named community areas and their physical boundaries (e.g., streets, parks), census tracts, block groups, streets (Sampson, 1999), and administrative agencies (e.g., school districts, police districts) (Sampson, Morenoff, & Gannon-Rowley, 2002). Neighbourhoods are conceived to cluster institutions and people from similar sociocultural backgrounds, whose exchanges enable neighbourhood effects to emerge (Sampson et al., 2002). This study examined group effects at the school-neighbourhood level. The term TEE is used to encapsulate level-1 (e.g., family SES), level-2 (e.g., average school neighbourhood EDI vulnerabilities), and other unmeasured influences affecting academic achievement.

From a sociological and ecological point of view, the evidence has shown that neighbourhood effects: (1) originate from clusters of behaviours and protective/risk factors (SDH) that characterize the geographic area of living; (2) are likely to operate through more proximal variables, which act as mediators and moderators of community influences; and (3) affect school readiness and academic achievement as part of a multilevel system made up also by families, schools, and other spheres of influence (Leventhal & Brooks-Gunn, 2000).

As mentioned above, families, peers, and schools can function as mediators and moderators of neighbourhood influences on child development (Leventhal & Brooks-Gunn, 2000). The close examination of mediators and moderators allows for understanding the potential pathways through which more distal variables operate. In particular, parental behaviour can play the role of a mediator through which neighbourhood influences come into action. For instance, parents' collective socialization variables (e.g., educational expectations and
involvement in supporting homework) are strong mediators of neighbourhood effect on math and reading academic achievement among tenth graders (Ainsworth, 2002). Additionally, perceiving the neighbourhood as unsafe might cause psychological distress and lead parents to act aggressively towards their children (Shumow, Vandell, & Posner, 1998). Parental behaviour can also play the role of a moderator that regulates the strength and direction of neighbourhood effects (Leventhal & Brooks-Gunn, 2000). For example, self-perceived neighbourhood dangerousness can moderate the link between harsh parenting and children’s internalizing problems (in other words, self-perceived neighbourhood dangerousness can affect the association between harsh parenting and internalizing problems) (Callahan, Scaramella, Laird, & Sohr-Preston, 2012).

Neighbourhoods can also affect child development directly, independent of the participation of other factors (Jones & Shen, 2014; Kohen et al., 2009). For example, living in a low SES neighbourhood, can affect children's early cognitive and behavioural development, above and beyond the influence of family- and individual-level factors (Vaden-Kiernan et al., 2010). These findings come from the Head Start Family and Child Experiences Survey (FACES) and Census 2000 data, which comprised 2,113 neighbourhoods. The authors argued that the direct effect associated with the area of living derive from neighbourhood structural (e.g., physical infrastructure) and social organizational factors (e.g., social cohesion); the authors further argue that social organizational factors may also affect child development indirectly, acting as a mediators of more structural aspects of neighbourhoods.\(^{11}\)

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\(^{11}\) The process by which neighbourhood influences affect child development has not been robustly verified empirically using HLM techniques (Vaden-Kiernan et al., 2010). For this reason, this and other studies have not been able to determine the individual effect of the factors comprising neighbourhood influences.
Neighbourhood effects on school readiness and academic achievement

The EDI has been widely used to investigate neighbourhood effects on school readiness and academic achievement. An extended literature review on this measurement tool is presented later. In general, findings on the EDI have contributed significantly to demonstrating the effect of the area of living on child development (Hertzman et al., 2002; Kohen et al., 2009). In one study in British Columbia, Kershaw et al. (2005) found, via multiple regression analysis, an association between 19 neighbourhood-level SES indicators (e.g., median family income) with at least one EDI domain. In a separate study, also in British Columbia, Lapointe, Ford, & Zumbo (2007) examined the relation between 13 neighbourhood environment contextual factors and EDI scores in children living in the same district. Some of the factors analyzed included: proportions of low income status (e.g., family income), multiple family households, aboriginal status residents, and university level residents. Results from an HLM analysis found that all neighbourhood contextual factors had statistically significant associations with at least one EDI domain. Results indicated that the EDI domain physical health and well being was predicted by 8 of the 13 factors that were examined, communication skills and general knowledge by 6, language and cognitive development by 4, and the rest of the domains by three or fewer factors. The community factors predicting at least three EDI domains were proportion of aboriginal status residents, proportion of residents with no knowledge of an official language, and proportion of male residents in management positions. An HLM analysis examined the proportion reduction in variance statistics for the EDI outcomes that was accounted by all 13 neighbourhood contextual factors (the study did not report the variance explained by each factor). The percent reduction in variance was larger for the domain communication and general knowledge (40%), followed by physical health and well-being (38%), language and cognitive development (23%), emotional
maturity (18%), and social competence (9%). These findings raise the issue of neighbourhood influences showing variations across developmental domains.

In a separate research initiative using a school readiness measure other than the EDI, Leventhal and Brooks-Gunn (2004) investigated the influence of neighbourhoods on school performance. To this end, the authors conducted a randomized control trial study that compared families who moved from high- to low-poverty neighbourhoods, against those who did not move. The data analyzed came from the Moving to Opportunity for Fair Housing Demonstrations program in the U.S. Results indicated that moving from high- to low-poverty neighbourhoods reduces grade retention in children 6-10 year-old, and improves academic achievement in 11-18-year-old boys. Results of the study were mediated by the parents’ satisfaction with the school in the 6-10 year old group, and by school level factors in the 11-18-year-old boys group (Leventhal & Brooks-Gunn, 2004).

In nearly all research studies conducted in the majority and minority world, neighbourhood effects have been investigated primarily in relation to the SES of the population (Ferguson, Cassells, MacAllister, & Evans, 2013). This research bias towards neighbourhood SES has left little room for the analysis of other social interactional mechanisms (e.g., social capital, social networks) present in the area of living. These social features, in combination with the neighbourhood's SES, health/education services, and physical infrastructure, contribute to neighbourhood-level variations in behaviour and learning experiences affecting school readiness and academic achievement. These SDH can operate at different levels of influence within the ecological system. It is argued here that the TEE encapsulates these and other SDH, and therefore can be used as a measure of area level influences affecting academic achievement.

The work of Jencks and Mayer helped to shift the focus of analysis from community SES
factors to community interactional factors affecting child development. In their book *The social consequences of growing up in a poor neighbourhood* (Jencks & Mayer, 1990), the authors provided a taxonomy of models through which neighbourhoods might affect child development. These models explain the dynamic of social interactional mechanisms affecting neighbourhood influences, and therefore can contribute to better understanding of these influences as part of the TEE. The proposed taxonomy includes: (1) contagion models (e.g., problem behaviour of neighbours and peers is contagious and easily spreads); (2) collective socialization models (e.g., social interaction, adult role models, supervision, and monitoring); (3) models of competition (e.g., neighbours compete for scarce community resources); (4) relative deprivation models (e.g., neighbourhood characteristics affect individuals by means of the comparisons they make of their own condition against the situation of others in the vicinity); and (5) neighbourhood institutional resource models (e.g. presence of health, education, recreation services). These models can be useful in explaining how neighbourhood experiences can affect children differently. For example, the first two models predict that an affluent neighbour can benefit all children in the area of living, while the relative deprivation and competition models predict that having an affluent neighbour can negatively affect some children.

More recently, Sampson et al. (2002) investigated the salience of social-interactional mechanisms within neighbourhoods that may account for residential-community variations in child and adolescent development. After examining 40 neighbourhood-effect studies, they identified four classes of neighbourhood social-interactional and institutional mechanisms: (1) social ties/interaction (e.g., frequency of social interaction); (2) institutional resources (e.g., quality, quantity, and diversity of institutions in the community that address the needs of children); (3) routine activities (e.g., daily routine activities that translate into children's well-
being); and (4) norms and collective efficacy (e.g., shared willingness to intervene for the public good). The contribution of this model was that it moved beyond so called "negative" neighbourhood characteristics (e.g., poverty, deprivation) to emphasize neighbourhood ties, social control, mutual trust, institutional resources, and routine activity patterns (Sampson et al., 2002).

The study of social interactional effects and their influence on school readiness and academic achievement has been examined over the years by different authors. Part of this evidence is summarized below; Appendix A presents the literature review in greater depth. Evidence from these studies has shown that: children from neighbourhoods with higher levels of social capital (e.g., networks, norms, cooperation values) and/or collective efficacy (e.g., achievement of collective goals) scored higher on receptive vocabulary skills (Jones & Shen, 2014); low levels of neighbourhood bonding social capital (e.g., neighbours do favours for each other) predict poor school achievement in grades 1 to 6 (Woolley et al., 2012); and parents’ perceived neighbourhood social networks are positively associated with the home literacy environment (e.g., number of children’s books in the home), which in turn is positively related to children’s vocabulary skills (Froiland et al., 2014). The reviewed studies also indicated that neighbourhood exposure to different forms of crime and violence has a negative impact on school attendance, school trouble avoidance/discipline, and academic achievement (Bowen & Bowen, 1999).

Beyond the effects of social characteristics of neighbourhoods, studies in the majority and minority world have linked cognitive and social-emotional development with at least four neighbourhood physical conditions: exposure to toxins, sanitation, mobility, and air and water pollution (Ferguson et al., 2013). Other demonstrated forms of neighbourhood influences
affecting development include inadequate collection of household waste and poor drainage (Ferguson et al., 2013). Substandard physical infrastructure contributes further to the high indices of morbidity and mortality in low income countries (WHO, 2011), and raised lead and arsenic levels that affect 40% of children in low-income countries (Walker et al., 2007).

In the present research study household flooring, utilities, and other SES measures are used as level-1 predictors, while the EDI is used as a level-2 predictor.

**Neighbourhood stability across time.** One question commonly asked about neighbourhoods is how stable they are across time. This question is relevant because, in the present study, the SERCE and EDI data were collected two years apart (SERCE in 2006 and EDI in 2008). Delmelle (2015) used U.S. Census data corresponding to the years 1970-2010 to examine demographic and spatio-temporal trajectories in neighbourhoods (Census Tracts). The cities studied were: Buffalo, New York; Chicago, Illinois; Charlotte, North Carolina; and Portland, Oregon. The study consisted of examining neighbourhood transitions through five different neighbourhood types: suburban, stable (e.g., characterized by an older population structure residing in their homes for a long period of time), blue collar (characterized by a population living in home values below the city mean, but with an income above the average poverty line), struggling (characterized by their large percentage of residents living below the poverty line), and new start (comprised by the highest educated residents, living in the highest home values, in areas with a high concentration of multiunit structures). Results indicated that in the 50 year period, about 20% of struggling neighbourhoods in Buffalo, Chicago, and Charlotte transitioned out of this group. Likewise, in Portland 22% of stable, 28% of blue collar, and 43%

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12 These neighbourhood types were developed through a partitioning clustering technique; therefore, the types are not mutually exclusive.
of struggling neighbourhoods also transitioned out of these groups. These results suggest that there is a great degree of diversity in longitudinal trajectories across cities and neighbourhood types. In addition, these results indicate that neighbourhood changes over time are rather slow (Delmelle, 2015). This latter finding is corroborated by the evidence of a 20-year study in the Montreal Census Metropolitan Area (census years 1986, 1991, 1996, 2001, and 2006). This study showed that radical changes in the geography of poverty are an exception, and even a ten year period may be too brief to detect significant transformations (Séguin, Apparicio, & Riva, 2012). From the above evidence, the findings from Delmelle (2015) and Séguin et al. (2012) suggest that the two year gap in the collection of SERCE and EDI data does not represent a limitation to the methodology of the present study.

**Measuring Multilevel Effects on Learning.** As noted above, the neighbourhood context affects learning through the quality of the surrounding environment in spheres of individual, family, school, and social organizations, and by the interaction between the determinants found in the neighbourhood and the regional, national and global context (e.g., collective values and practices towards child development) (Arimura et al., 2011; Mashburn & Pianta, 2006; Rimm-Kaufman & Pianta, 2000). Is it possible to measure how much the family, school, and neighbourhood context contribute separately to school readiness and academic achievement?

The evidence has shown that the strongest effect on learning comes from individual and family factors, with school and neighbourhood effects also becoming influential as children grow older (Kershaw et al., 2005; Kohen et al., 2009; Leventhal & Brooks-Gunn, 2000). The strength of these multilevel influences on school readiness and academic achievement can be estimated by the effect sizes and by the percentage of variance these dimensions account for. Knowing the magnitude of these effects is important for the formulation of education policy.
Effect sizes are defined as a value of a statistic that provides a common expression of the magnitude of an effect (e.g., family SES) associated with an outcome variable (e.g., academic achievement). An effect size of $d=1.0$ corresponds to an increase of 1 standard deviation in the outcome variable. Hattie (2009) conducted a meta-analysis of over 800 studies of effect sizes related to school achievement. In this analysis, $d=0.2$ was considered small, $d=0.4$ medium, and $d=0.6$ large. Some of the reported effect sizes with scores above $d=0.50$ were: classroom behaviour ($d=0.80$), teacher-student relationship ($d=0.72$), prior achievement ($d=0.67$), parental education ($d=0.60$), parental income ($d=0.58$), home environment ($d=0.57$), parental occupation ($d=0.56$), pre-term birth weight ($d=0.54$), classroom cohesion ($d=0.53$), peer influence ($d=0.53$), and parental involvement ($d=0.51$). The effect size related to preschool attendance was $d=0.45$, and to school-effect (e.g., climate of classroom, peer influences) was $d=0.48$. As seen, the above effect sizes were related to student, home, and school level factors.

To investigate the magnitude of family, school, and community effects, Duncan, Boisjoly, & Harris (2001) compared the statistical correlations in vocabulary and delinquency measures between four groups: siblings within a family, schoolmates who live close to each other, grademates within a school, and peers as defined by a set of “best friend” nominations. The study used data from a nationally representative sample of siblings, peers, neighbours, and grademates. The measures used were the Add Health Picture Vocabulary Test (a computerized version of the PPVT - Peabody Picture Vocabulary Test- Revised) and a delinquency scale. Results consistently showed much higher correlations for family context than for school and neighbourhood contexts. For the PPVT, the non-twin sibling correlations were much higher ($r=0.46$) than the SES-adjusted neighbour ($r=0.057$) and the grademate ($r=0.037$) correlations,
and doubled the SES-adjusted best-friend ($r=0.247$) correlations. These results align with other evidence that families, and not neighbourhood and school contexts, are the primary sources of inequality in academic achievement (Kershaw et al., 2005; Kohen et al., 2009; Leventhal & Brooks-Gunn, 2000). However, it is worth noting that in this study the family effects examined were not exclusively environmental, as they comprised also genetic similarities. Therefore, the results should be interpreted with caution and do not imply that neighbourhood effects are unimportant. In any case, the larger academic achievement effect attributed to families over schools and communities has also been reported elsewhere in the literature (Leventhal & Brooks-Gunn, 2000).

Literature reviews have found that individual/family effects account for approximately 80% of the variability in academic achievement scores, while school effects explain about 20% of this variability (Marzano, 2000). Literature reviews also indicate that there are considerable differences in the reported school effects, in some cases from 5% to about 30%, in part as a result of sample bias that arises from the use of different random sampling techniques (Sellstrom & Bremberg, 2006). These large variations were also found in the PERCE and SERCE studies in Latin America and the Caribbean.

The evidence also indicates that neighbourhood effects are small to modest, and explain between 5% to 10% of the variance in child and adolescent academic outcomes (Leventhal & Brooks-Gunn, 2000). However, the magnitude of these effects also varies according to what sort of outcome is being considered, the age and other attributes of the person being affected, and how neighbourhood is measured (Friedrichs, Galster, & Musterd, 2003). The magnitude of neighbourhood effects, although small as compared to family and school effects, can be

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13 All these correlations correspond to boys. For girls the magnitude of the correlation differences was about the same.
considered reasonably powerful, particularly the effect of affluent neighbours on children's IQ, teenage births, and school dropout (Brooks-Gunn, Duncan, Klebanov, & Sealand, 1993). A study on a nationally representative sample of middle and high school students conducted in the U.S. found that neighbourhood and school experiences with different forms of crime and violence explain about 5% of the variance in academic achievement (Bowen & Bowen, 1999).

The magnitude of neighbourhood effects has also been studied in relation to school readiness. Kohen et al. (2009) investigated the contribution of child/family (e.g., parent education), school (e.g., proportion of students in the school for whom English is not the first language), and neighbourhood (e.g., unemployment rate) disadvantage level on children’s preschool outcomes. In this study, kindergarten units and schools were nested within the same neighbourhood (e.g., census tract). The data analyzed came from the 2001 Census Canada and Understanding the Early Years Initiative. One question examined was whether school outcomes at the census tract level can predict levels of school readiness; the school readiness data corresponded to measures from the PPVT-R (Peabody Picture Vocabulary Test-Revised and the EDI (for both measures, the average child age was 70.1 months with a standard deviation of 4). Results showed that a higher proportion of non-native English speaker students within the school was associated with lower levels on the PPVT-R and EDI (Social Knowledge and Competence, Emotional Maturity, and Language and Cognitive Development domains). In addition, a higher proportion of adults with incomplete secondary education, and a higher proportion of immigrants in the neighbourhood, were both associated with lower PPVT-R scores. Finally, the child/family factors explain about 78% of the PPVT-R outcome variability, while school effects account for 17%, and neighbourhood effects for 5%. More information on this study is presented in Appendix B. These results are particularly relevant to the present research study, as they
demonstrate an association between the demography of the school and school readiness, specific to children attending schools in the same census tract area.

**Population Investigations on the EDI and PERCE/SERCE**

The previous section discussed how environmental influences at the area level can affect trajectories in learning. Thus far, the analysis has centred on the effects of socioeconomic status, home learning environment, neighbourhood influences, and early education on school readiness and academic achievement.

What is presented next is a literature review of the EDI (Janus & Offord, 2007) and the PERCE/SERCE (Willms & Somers, 2001; UNESCO/LLECE, 2010) academic achievement studies in Latin America and the Caribbean. The questions this review intends to answer are: (1) can the EDI be used to reflect the geography of opportunity and be used to predict trajectories in school readiness and academic achievement at the area level? and (2) to what extent were the PERCE/SERCE academic achievement scores affected by group level experiences in the early years of life? These two questions are relevant as the present study intends to use EDI scores to predict individual levels of academic achievement in elementary school, for children attending preschools and schools in the same school neighbourhood.

**Early Development Instrument (EDI)**

As noted before, the understanding of nested systems (Bronfenbrenner, 1979), social determinants of health (CSDH, 2008), ecologically oriented theories (Mashburn & Pianta, 2006; Pianta & Walsh, 1996; Rimm-Kaufman & Pianta, 2000; Sameroff, 1995), and social constructivist approaches (Meisels, 1998; Meisels, 1999; Vygotsky & Luria, 1930/1993) have changed the notion of school readiness, from perspectives centred on the child or the school, to one that takes community and society readiness into consideration (Pelletier & Corter, 2002).
Studies on the EDI conducted across Canada, Australia (Irwin et al., 2007; Kershaw et al., 2005; Lloyd & Hertzman, 2009) and other countries around the world (Janus & Reid-Westoby, 2016) have contributed to this ecological perspective by means of addressing population level determinants of children’s performance in the school system.

The EDI is a rating scale population tool that kindergarten teachers complete for each child in their class to assess early development as reflected in children’s school readiness (Janus & Offord, 2007). This instrument reflects developmental outcomes children should be able to reach under optimal circumstances (Janus & Duku, 2007). The primary purposes of the EDI are to monitor populations of children over time and to predict success in elementary school (Hertzman, 2006). In addition, the EDI can be used to guide community efforts to enhance child development (Janus & Offord, 2007; Kershaw et al., 2005). This tool is usually used toward the end of kindergarten year and it takes approximately 20 minutes per child to complete the ratings. The inventory is intended to be used as a group level measure and its results should be interpreted as such.

The EDI assesses five general domains: (1) physical health and well-being; (2) social competence; (3) emotional maturity; (4) language and cognitive development; and (5) communication skills and general knowledge. EDI domains are further divided into fifteen sub-domains (see Table 1). The instrument has a total of 103 questions (Janus & Offord, 2007). Children’s scores are considered to reflect a vulnerability if a domain falls below the domain-specific place (e.g., provincial) cut-off. In the case of Canada, this cut-off is 10% of each provincial baseline distribution (Janus et al., 2007). The EDI outcomes can be reported by the number and type of domain in which children are vulnerable. This information is useful to identify populations of children at greater risk. The EDI uses different point scales for the
domains. The present study used a 3-point scale in the domains Social Competence and Emotional Maturity; while the other domains used 2 and 3-point scales.
TABLE 1

*Domains, Sub-Domains, and Sample Questions - Early Development Instrument (EDI)*

<table>
<thead>
<tr>
<th>EDI domains</th>
<th>Sub-domains</th>
<th>Example items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical health and well-being (3-4)</td>
<td>Physical readiness for school day</td>
<td>Too tired/sick to do school work</td>
</tr>
<tr>
<td></td>
<td>Physical independence</td>
<td>Independent in washroom habits most of the time</td>
</tr>
<tr>
<td></td>
<td>Gross and fine motor skills</td>
<td>Is able to climb stairs</td>
</tr>
<tr>
<td>Social competence (4)</td>
<td>Overall social competence</td>
<td>Has a good overall social/emotional development</td>
</tr>
<tr>
<td></td>
<td>Responsibility and respect</td>
<td>Demonstrates respect for adults</td>
</tr>
<tr>
<td></td>
<td>Approaches to learning</td>
<td>Works independently</td>
</tr>
<tr>
<td></td>
<td>Readiness to explore new things</td>
<td>Eager to explore new items</td>
</tr>
<tr>
<td>Emotional maturity (4)</td>
<td>Prosocial and helping behaviour</td>
<td>Tries to help someone who has been hurt</td>
</tr>
<tr>
<td></td>
<td>Anxious and fearful behaviour</td>
<td>Appears unhappy or sad</td>
</tr>
<tr>
<td></td>
<td>Appears unhappy or sad</td>
<td>Gets into physical fights</td>
</tr>
<tr>
<td></td>
<td>Hyperactivity and inattention</td>
<td>Can't sit still, is restless</td>
</tr>
<tr>
<td>Language and cognitive development (3-4)</td>
<td>Basic literacy</td>
<td>Able to read complete words</td>
</tr>
<tr>
<td></td>
<td>Interest in literacy/numeracy, and uses memory</td>
<td>Interested in games involving numbers</td>
</tr>
<tr>
<td></td>
<td>Advanced literacy</td>
<td>Able to read sentences</td>
</tr>
<tr>
<td></td>
<td>Basic numeracy</td>
<td>Is able to recognize numbers 1-10</td>
</tr>
<tr>
<td>Communication skills and general knowledge (3-4)</td>
<td>No sub-domains</td>
<td>Able to clearly communicate one’s own needs and understand others’ needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shows interest in general knowledge about the world</td>
</tr>
</tbody>
</table>

*Source: Janus et al., 2007.*
The EDI has been used to map the ‘geography of opportunity’ for early child
development (Hertzman et al., 2002). For example, the British Columbia Atlas of Child
Development (Kershaw et al., 2005) employs a methodology that combines information on four
intersecting data sets that can affect or reflect trajectories in early development and learning: (1)
provincial and school district maps on census information (e.g., median family income); (2)
provincial and school district maps on the results of the EDI; (3) provincial maps to show
program capacities (e.g., number of child care spaces); and (4) the British Columbia Ministry of
Education Foundation Skills Assessment (FSA) scores in numeracy, reading, comprehension,
and writing skills in grades 4 to 7. Having information on the 'geography of opportunity' can add
to the understanding of the area level supports needed for healthy development.

Studies conducted across Canada have found that the EDI has good psychometric
properties in relation to the domains' internal consistency (range Cronbach alpha .84 to .96), and
test-retest reliability correlations (range .82 to .94) (Janus et al., 2007). The EDI has moderate to
high inter-rater reliability between public school teachers and day care teachers (Janus et al.,
2007), and the concurrent test-criterion validity of the instrument demonstrates low to moderate,
yet consistent correlation with the Peabody Picture Vocabulary Test (PPVT) and parent
interviews about children's behaviour (Janus & Offord, 2007). The correlations between the
PPVT and the two domains, Language and Cognitive Development and Communication Skills
and General Knowledge range from 0.31 to 0.47, and are all statistically significant (Janus &
Offord, 2007).

The instrument has similar psychometric properties across Canada, Australia, United
States and Jamaica. For example: (1) with the exception of the domains Physical health and
well-being, all EDI domains have internal consistencies of 0.86 or higher in all four countries;
(2) domain items tend to load on the same factor; (3) goodness of fit analyses show similar magnitudes and patterns in Canada, United States and Australia (lowest in Emotional maturity, highest in Language and cognitive development); and (4) with the exception of the subdomains Physical readiness for school day, Gross and fine motor skills, and Approaches to learning, the 16 subdomains of the EDI have high and similar internal consistencies (Cronbach’s alpha) in all countries. These results provide further evidence for the tool to be considered a valid international checklist (Janus, Brinkman, & Duku, 2011). Examinations of the EDI’s psychometric properties have been also carried out for international versions of the instrument adapted for use in Hong Kong, Scotland, Sweden, Ireland, Brazil, Peru, and Indonesia and the Philippines (Janus & Reid-Westoby, 2016).

**Findings from the EDI.** Research conducted in Canada, Australia, and Mexico provides evidence of the utility of the EDI as a school readiness tool. A summary of studies on the EDI is presented in Appendix B. In Canada, evidence from the Community Component of the National Longitudinal Survey of Children and Youth (NLSCY) indicated that differences in family SES, family status, parent involvement in literacy support, child health, and parent health contribute to community gaps in school readiness. The NLSCY results also indicated that child’s suboptimal health, coming from a low income family background, and male gender contribute most strongly to EDI vulnerabilities at school entry (Janus & Duku, 2007). The NLSCY data analyzed came from 5 communities across the country (located in British Columbia, Saskatchewan, Manitoba, Newfoundland and Labrador, Prince Edward Island, and Ontario). The sample was not intended to be nationally representative, but represents communities nationwide (Janus & Duku, 2007). Another research initiative, across Canada, found that particular aspects of the demography of the school (e.g., higher proportion of non-native English speaker students)
are associated with lower scores on the PPVT-R and the EDI (Social Knowledge and Competence, Language and Cognitive Development, and Emotional Maturity domains). Additionally, the study found an association between the demography of the neighbourhood (e.g., proportion of high school graduation and recent immigrants to Canada) and PPVT-R scores (Kohen et al., 2009). This is an important finding because it provided evidence that the demography of the school and the neighbourhood can affect levels of school readiness. The data analyzed by Kohen et al. (2009) were collected in six provinces, and consisted of a total of 2,743 children, attending 181 kindergarten classes, and living in 272 different neighbourhoods.

Several research initiatives conducted in British Columbia provided further evidence on the utility of the EDI as a population measurement tool. For example, D'Angiulli et al. (2009) found that groups of children vulnerable on any one scale of the EDI are approximately 2 to 4 times more likely to score below expectations in grade 4 academic achievement than those not considered vulnerable. This study used data from the British Columbia Ministry of Education Foundation Skills Assessment (FSA) that measures numeracy, reading, comprehension, and writing skills in elementary school. In a separate study, the EDI was used to investigate population level variations in learning trajectories, from school readiness (EDI scores) to academic achievement (grade 4 FSA scores). For this purpose, Lloyd & Hertzman (2009) computed a Community Index of Child Development (CICD), which was created at the aggregate level by linking EDI and FSA data. The study found a statistically significant negative correlation between CICD scores and the percentage of adults in the neighbourhood who had not graduated from high school. This finding suggests that the index takes into account neighbourhood SES variations, and therefore can be used to monitor trajectories in learning at the area level. This study also reported an association between the demography of the
neighbourhood (e.g., concentrated immigration, residential instability) and grade 4 FSA scores. In another research initiative also in British Columbia, Lloyd, Li, & Hertzman (2010) used the EDI to examine the effect of conditions of neighbourhood disadvantage experienced by children in kindergarten on their later academic achievement. This study used gender, EDI scores, and sociodemographic factors (Aboriginal/Indigenous, English as a Second Language status) as covariates. Results indicated that higher concentrations of neighbourhood disadvantage in kindergarten children predicted lower reading comprehension outcomes in grade 7, even after controlling for child level covariates. The findings from Lloyd, Li, & Hertzman (2010) are relevant as the present study also uses EDI scores to reflect community readiness, and uses this measure to predict academic achievement. The samples in the three studies in British Columbia described above are considered representative of the population of children in that province.

In Ontario, the EDI was used as part of Toronto First Duty (TFD) to investigate the effect early childhood integrated services have on children's school readiness levels. The aim of the TFD demonstration project was to bring together existing ECD services into an integrated school based service array to support child development. These services included: public school kindergarten, childcare, family literacy, parenting support and other early childhood services. The investigative purpose of TFD was to study the effectiveness of the integrated services in relation to dose effects (family participation levels) and the children' social ecology (parents' involvement in school). Results indicated that participation dose in TFD predicted three EDI domains, even after controlling for demographic, parent engagement, and site factors. These domains were: physical health and well being, language and cognitive development, and communication and general knowledge (Patel et al., 2016). The notion of integrated services portrays an improved TEE in which ECD services work together synergistically to better support
child development.

Evidence from a study in Australia using the AEDI (Australian version of the Canadian EDI) found school readiness vulnerability scores to be strongly associated with numeracy and literacy assessment in grades 3, 5, and 7 (Brinkman et al., 2013). Results indicated that this association is equally as strong across all these grade levels. This study used data from the AEDI and NAPLAN longitudinal study (National Assessment Program in Literacy and Numeracy), linked at the level of the individual child. The final sample had an under representation of Aboriginal and Torres Strait Islander children, and children from the wealthiest and poorest suburbs (Brinkman et al., 2013). However, it still provides important evidence regarding the AEDI and the possibility of tracking learning trajectories from kindergarten to grade 7.

The EDI was also used in Mexico in 2008 to examine social risk factors that may affect levels of school readiness. The social risk factors studied were SES, family status, and child gender. The data analyzed came from 1,672 children (5-years-old) who participated in a high-quality government funded kindergarten program called Centro de Desarrollo Infantil (CENDI), located in the city of Monterrey, Nuevo Leon. The sample can be considered representative from a government funded program in the province, and was composed mainly of families from low SES status. Results indicated that SES (mother's maternal education), family status (lack of mother's married status), and child's gender (favouring girls over boys) have meaningful associations with children's kindergarten EDI outcomes. A child with a mother with low education was 1.7 times more likely to score low on the EDI (Janus, 2011).

The question, “Can the EDI be used to reflect the geography of opportunity and predict trajectories in school readiness and academic achievement at the area level?”, was asked at the beginning of this section. The evidence presented confirms that the answer to this question is
yes. The EDI can be used at the aggregate level to predict the effect of school and neighbourhood disadvantage level variability on school readiness (Hertzman et al., 2002; Kohen et al., 2009). Additionally, the EDI can be used at the aggregate local level (e.g., neighbourhood, school district) to investigate population level variations in learning trajectories from kindergarten to grade 4 (D'Angiulli et al., 2009) and grade 7 (Brinkman et al., 2013). Thus, the existing evidence suggests that the use of EDI scores as a measure of school neighbourhood influences affecting early development and academic achievement is scientifically grounded.

**The PERCE/SERCE (UNESCO/LLECE) Studies**

UNESCO/LLECE has implemented three large regional assessments of academic achievement of children in Latin America and Caribbean (LA/C) primary schools: PERCE (First International Comparative Study on Language Mathematics and Associated Factors), SERCE (Second Regional Comparative and Explanatory Study on Reading and Mathematics), and TERCE (Third Regional Comparative and Explanatory Study on Reading, Mathematics, and Natural Sciences). PERCE, SERCE, and TERCE assessments were conducted in 1997, 2006, and 2014, respectively. The objectives were to assess academic achievement, enrich the discussion of education quality in the region, and support decision making in educational public policies. In addition to assessing learning outcomes, PERCE, SERCE, and TERCE also included the administration of questionnaires to students, families, teachers, and schools, which helped in the identification of associated factors, affecting pupils’ learning (e.g., pedagogical, economic, social, and cultural factors). These research initiatives were based on nationally representative samples selected by means of a random stratified sample. The criteria for stratification were: type of management/geographic area (urban public, urban private, rural), size of the school (small, medium, or large), and class registration (e.g., third grade, sixth grade). In the analysis, a
hierarchical linear model (HLM) approach was used in order to take into account the nested structure of the educational data (children nested within schools, and schools nested within countries). What is presented next is a summary of the PERCE results, followed by a more extensive overview of SERCE findings. Results of TERCE are not discussed in this research study because its final report has not been completed by UNESCO/LLECE.

The PERCE study\textsuperscript{14} evaluated school achievement in language and mathematics achievement of a total of 54,000 children in 13 countries\textsuperscript{15}. The sample included approximately 100 schools per country. Within each school, 20 grade 3 and 20 grade 4 students were included. The students were selected following a stratified random sample approach, not proportional to the population of each country, not self-weighted, and with equal chances of being selected. The test scores were scaled to a regional mean of 250 and a standard deviation of 50 (UNESCO/LLECE, 1998). Table 2 presents the results for LA/C and Mexico of three regression models conducted to analyze the data. First, a Null Model, which partitioned the variation into within-school and between-school components for a composite measure of the sociocultural status (SCS) of the family as predictors of language and math scores. Second, a Model 1, that regressed the academic outcomes on the SCS. Third and last, a Model 2, that regressed the academic outcomes on the SCS, plus a group of individual, school, and community level associated factors. The purpose of the regression analysis was to determine the effect of the associated factors on language and mathematic scores. Only the results from LA/C and Mexico are presented in Table 2. The associated factors examined were the following:

\textsuperscript{14} The information on the PERCE study presented in this section, unless specified otherwise, comes from Willms \\& Somers (2001).

\textsuperscript{15} Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Dominican Republic, Honduras, Mexico, Paraguay, Peru and Venezuela.
• Sociocultural Status Index (SCS, measured at the individual student level), which comprises: parents’ educational level; amount of time the parent is present in the home during working days; whether there are more than 10 books in the home; and whether the two parents live in the student's home.

• Early childhood experience (measured at the individual student level): child attended daycare; parent read to child when little; and parents regularly helped their children with homework.

• Classroom practices (measured at the aggregate school level): multigrade classrooms; pupils are grouped by ability; parental involvement (e.g., parent participates in school-related activities, knows the child's teacher, and attends parent-teacher meetings); classroom climate (e.g., whether there are students in the classroom who disturb others, whether fights happened, and whether students in the class were good friends).

• School resources (measured at the aggregate school level): pupil-teacher ratio; school infrastructure (e.g., library, lab, gym, classroom); instructional materials (e.g., blackboard, library calculators, maps); size of the library; teaching experience; and teacher training).

• School socioeconomic level (measured at the individual and aggregate school level): general socioeconomic context of the school community. This information was based on the school administrator's perception regarding the SCS of the children attending school.
## TABLE 2

*School Effects in Latin America and the Caribbean (LA/C), and Mexico - PERCE Study*\(^1\ 2\)

<table>
<thead>
<tr>
<th>Within School Variance</th>
<th>Between School Variance</th>
<th>Scale point differences in academic scores(^3) - LA/C countries (only statistically significant results are shown)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LA/C countries</td>
<td>Mexico</td>
</tr>
<tr>
<td>Null Model: Variations within and between schools in SCS and schooling outcomes</td>
<td>Sociocultural status of the family (SCS)</td>
<td>54.5%</td>
</tr>
<tr>
<td>Language</td>
<td>56.5%</td>
<td>72.6%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>45.7%</td>
<td>75.5%</td>
</tr>
<tr>
<td>Model 1: Relation between schooling outcomes and SCS</td>
<td>Language</td>
<td>5.6%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>5.5%</td>
<td>11.0%</td>
</tr>
<tr>
<td>Model 2(^3): Relation between academic achievement outcomes and SCS, early childhood experience, school resources, classroom practices, and SES context of the school community</td>
<td>Language</td>
<td>13.6%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>15.6%</td>
<td>11.3%</td>
</tr>
<tr>
<td>Percentage of school variance explained by the associated factors(^4)</td>
<td>Language</td>
<td>8.0%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>10.1%</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

\(^1\) Adapted from the work of Willms & Somers (2001).

\(^2\) The PERCE study had a mean score of 250 and a standard deviation of 50.

\(^3\) This model comprises individual and school aggregate level factors.

\(^4\) These values were calculated by subtracting the Model 2 variance from the Model 1 variance.
The results suggest that school segregation is at work in this population. As noted earlier, school segregation refers to greater variance between schools than within schools in SCS and SES background; it represents a learning disadvantage as children's readiness related competencies (Rimm-Kaufman & Pianta, 2000) and performance at school (Jenkins, Micklewright, & Schnepf, 2008) are affected by their peers. In Mexico, 46% of the variance in SCS in the Null Model corresponds to differences between schools; the result for LA/C is quite similar. This level of segregation is significantly higher than that of primary schools in Cuba (28.0%) (Willms & Somers, 2001), and secondary schools in Canada and the U.S. (33.0%) (Jenkins et al., 2008). For Mexico, but not for LA/C, the variance between schools in academic achievement is significantly lower than the SCS variance. Also for Mexico but not for LA/C, most of the variation in school achievement is explained by within school differences.

Model 1, while controlling for gender and grade, estimated the relation between schooling outcomes and SCS. This model provides an estimate of the effects of SCS on learning. For Mexico, 11% of the within school variation and 34.8% of the between school variation in language scores is explained by the family background of the students. The outcome is similar for mathematics. However, the interpretation of these results must be made in relation to the null model. Taken together, results from Model 1 and the null model indicate that there is a larger within school variation in Mexico than in LA/C, whereas the between school variations are about the same.

In addition to the variables controlled for in Model 1, Model 2 used a group of individual (child's early experiences) and group (classroom practices, school resources, SES context of the school community) level factors to study their effect on learning. For Mexico, Model 2 explains 11.7% of the within, and 54.6% of the between school variation in language; while for
mathematics, the model explains 11.3% of the within and 46.5% of the between school variance. The between school variances for Mexico fell approximately 14 points below the percentages of the region. These results indicate that the effect among schools of SCS and the associated factors is stronger in LA/C than in Mexico.

Model 2 also allowed estimating the effect exerted by the associated factors net of the effect of SCS. This net effect is calculated by subtracting Model 2 from Model 1 variances. As shown at the bottom of Table 2, the magnitude of the between and within school differences is significantly larger for LA/C than for Mexico. These results corroborate that the associated factors play a more prominent role affecting academic achievement in LA/C than Mexico (in other words, in Mexico the effect of SCS is more prominent, while the effect of the associated factors is less prominent). As illustrated, in LA/C the effect of the associated factors explains more than 45.8% of the between school variations in academic achievement, whereas in Mexico these effects explain only between 6.8% to 19.8% of this variation. In Mexico, SCS differences are responsible for about 11.0% of the within school variations in language and mathematics, while the rest of the associated factors (e.g., childhood experience, school resources) explain only between 0.3% and 0.7% of this variation. The associated factors included in the SCS index can be conceived as encapsulated in the TEE.

Table 2 above also presents the scale point differences in academic scores that originated from the effect of the associated factors (right column). For example, the condition ‘10 or more books in the home’ is associated with an increase of 4.5 points in language, and 5.2 points in math scores. Only results from LA/C, that were statistically significant at the .05 level, are shown. The factors of ‘classroom climate’ and ‘size of library’ had the largest scale point effects on academic achievement.
The SERCE study is reviewed next. One difference between the two UNESCO/LLECE studies is that SERCE's HLM methodology compared the effect of a Home Education Index at the student and school levels, whereas in PERCE the emphasis was placed in examining the overall effect of the associated factors (level-1 and level-2 influences) on school achievement. In other words, the analysis done by SERCE was unique in that it allowed comparing student level effects (e.g., characteristics of the home environment at the level of the individual child) against school related influences (e.g., characteristics of the home environment shared by the school community). The objective of the present research study is to provide empirical support on the influence of group level variables, such as school neighbourhood effects, on school achievement. Therefore, the group level effects investigated by SERCE can provide important information. In the current study SERCE's associated factors are used as level-1 predictors; however, it is argued that they are also comprised in the TEE (level-2). In other words, SERCE individual level demographic factors are seen as being reflected in the aggregated school neighbourhood EDI vulnerability scores.

The SERCE study conducted in 2006 evaluated reading and mathematics achievement of 196,000 children in the third and sixth grades of primary school. A total of 18 countries\textsuperscript{16}, plus the Mexican State of Nuevo Leon, participated in the study. Test scores were scaled to a regional mean of 500 and a standard deviation of 100. In the analysis, two indexes were created in order to group the associated factors at the individual and aggregated school levels:

- Socioeconomic and Cultural Status index (SCS), which comprised: the combined educational level of the parents; student's first language; material of the floor in the

\textsuperscript{16} Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and the State of Nuevo Leon (Mexico)
household; home utilities (e.g., electricity, water, telephone); home assets (e.g., refrigerator, microwave, T.V., car), number of books in the home.

- Home Education Index (HEI), which comprised: child attended preschool, parent read to child when little, parent knows child's school teacher, and parent's opinion about the quality of the education in the school.

Table 3 below presents the results for LA/C and Nuevo Leon of three statistical parameters that were used to examine the magnitude of the association between the academic achievement scores and SCS:

- Mean school academic achievement, adjusted for SCS.
- Slope of the association between mean school academic achievement and SCS. This parameter measures the level of inequity in mean school achievement scores that is attributable to SCS. The larger the slope the larger the academic achievement inequity that is attributable to SCS.
- Strength of the linear relationship or gradient ($R^2$) between the mean school achievement and SCS. The parameter $R^2$, also known as coefficient of determination, represents a measure of the proportion of the mean school achievement variance explained by SCS. $R^2$ measures the proportion of the data that is the closest to the regression line (or line of best fit).
<table>
<thead>
<tr>
<th></th>
<th>Reading 3rd grade</th>
<th>Math 3rd grade</th>
<th>Reading 6th grade</th>
<th>Math 6th grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Slope</td>
<td>$R^2$</td>
<td>Mean</td>
</tr>
<tr>
<td>LA/C</td>
<td>480.4</td>
<td>15.0</td>
<td>0.3</td>
<td>480.4</td>
</tr>
<tr>
<td>Nuevo Leon</td>
<td>524.9</td>
<td>23.0</td>
<td>0.4</td>
<td>509.5</td>
</tr>
</tbody>
</table>

Note: Adapted from UNESCO/LLECE (2010). These results correspond to the percentiles 5 to 95 of the average SCS in schools in Nuevo Leon and LA/C (Latin American and Caribbean countries).

1 $\text{Slope} = \frac{1}{n} \sum_{i=1}^{n} (Y_i - \bar{Y}) (X_i - \bar{X}) - \frac{1}{n} \sum_{i=1}^{n} (X_i - \bar{X})^2$.

2 $R^2$ values have to be multiplied by 100 to represent the proportion of variance explained. The formula used to compute this parameter is: $R^2 = \frac{\text{Explained Variation}}{\text{Total Variation}}$.

As seen, the slopes (with the exception of 6th grade reading) and the strength of the linear relationship ($R^2$) values are higher in the Mexican State than the region, indicating that in Nuevo Leon academic achievement scores are highly affected by SCS. These outcomes indicate that in Nuevo Leon the effect of SCS on academic achievement varies significantly across schools; and that schools are characterized by high levels of segregation. These findings align with PERCE, in which the effect of SCS on academic achievement is stronger on Mexico than in LA/C (see Table 2, Model-1).

Below, Table 4 presents the results of an HLM analysis of the SERCE outcomes. Results found the Home Education Index-HEI to be a better predictor of academic achievement than the SCS index. For this reason, the HEI was chosen over the SCS, and incorporated into the regression model to estimate the adjusted and net school effects. The HLM analysis consisted of:

1. A Null Model for each academic outcome;
2. A Model 1- adjusted school effect, that
regressed the academic outcomes controlling for the HEI at the student level; and (3) a Model 2 - *net school effect*, that regressed the academic outcomes controlling for the HEI at the student and school levels (UNESCO/LLECE, 2010).

**TABLE 4**

*Home Education Index*: Between School Effects in Latin America and the Caribbean, and Nuevo Leon - Level 1 and Level 2 of Academic Achievement - SERCE Study

<table>
<thead>
<tr>
<th></th>
<th>Third Grade</th>
<th></th>
<th>Sixth Grade</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Reading</td>
<td>Math</td>
<td></td>
</tr>
<tr>
<td>Null Model - gross effect: proportion of learning variance that corresponds to schools, but without considering differences among students (no factors are controlled for).</td>
<td>LA/C</td>
<td>46%</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuevo Leon</td>
<td>16%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Model 1 - adjusted effect: proportion of learning variance that corresponds to schools, after subtracting the effect of the Home Education Index at the student level.</td>
<td>LA/C</td>
<td>46%</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuevo Leon</td>
<td>16%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Model 2 - net effect: proportion of learning variance that corresponds to schools, after subtracting the effect of the Home Education Index at the student and school levels.</td>
<td>LA/C</td>
<td>34%</td>
<td>39%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuevo Leon</td>
<td>6%</td>
<td>9%</td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Compiled from UNESCO/LLECE (2010).

1 The Home Education Index (HEI) is comprised of the following factors: Parents' educational status, parental involvement in school activities, parents read to child when little, and child attended a preschool when little.

2 SERCE grouped the academic achievement scores into four levels of performance, with Levels 1 and 2 representing the poorer outcomes, and Levels 3 and 4 the higher outcomes. These levels are based on students' distributions at each national level. Results in Table 4 correspond to Levels 1 and 2. See Appendix C for a summary of the ranges that define Levels 1 to 4. See also: INEE (2008) for a description of the learning skills expected to be achieved in each level.
Results in Table 4 show that gross effects were significantly higher for LA/C (range 43%-48%) than for Nuevo Leon (range 16%-19%). In Nuevo Leon, variations in academic achievement corresponded mainly to within school differences (range 81%-84%). The results also reveal that percentages of between school variance explained in the Null Model and Model 1 are about the same. This indicates that the HEI at the student level had no impact in between school variation on academic achievement beyond the effect revealed by the Null Model. This outcome may derive from the high levels of school segregation found in the Mexican State. However, as explained below, the HEI at the school level can have a significant impact on school learning.

Net between school effects (Model 2) were estimated by controlling for the HEI at the child and school levels. For this purpose, average HEI scores were calculated per school and entered into the regression model. Results showed that the net school effect for both groups dropped between 7% to 13% in relation to the null and adjusted models. This speaks for the significant contribution HEI (averaged school) has on school achievement, and the interwoven influence of individual, family, peers, and school related factors on school learning. The net effect explained by Model 2 corresponds to what Willms (2006) refers to as compositional and contextual effect.

The SERCE study also analyzed the scale point differences of the associated factors. These results, which are presented in Appendix D, come from the final model (Model 2). As seen, the magnitude of the scale point differences associated with HEI (school level) more than double those of the HEI at the student level (with the exception of third grade math in Nuevo Leon). Results also indicated that the differences in the HEI (student level) are larger for Nuevo Leon than for LA/C. This is an expected outcome, as student level predictors are linked to sociocultural factors, which have a stronger effect on Nuevo Leon than in LA/C. This same
pattern of larger differences favouring Nuevo Leon was found in the Home Education Index-averaged school (with the exception of 3th grade math).

SERCE also reported scale point differences associated to a school climate\textsuperscript{17} index that was created. These outcomes were reported only for LA/C. Results indicated that the school climate index-averaged school was the most influential factor affecting academic achievement; the scale point differences of this index averaged school were five times larger than those of the index at the student level (UNESCO/LLECE, 2010).

The question, “To what extent were the PERCE/SERCE academic achievement scores affected by group level experiences coming from the early years of life?”, was asked at the beginning of this section. The PERCE and SERCE initiatives were not longitudinal studies and for this reason their results cannot be used with certainty to answer the above question. However, in PERCE and SERCE the effect of predictors related to the early years of life (e.g., child attended preschool, mother read to child when little) and SES\textsuperscript{18} was significant. In particular, results from SERCE’s HEI provide evidence that group level experiences coming from the first years of life can significantly affect academic achievement.

An important finding from SERCE is that the effect of the associated factors was more influential at the aggregated school level than at the individual/family level. This was found in relation to the parents’ level of participation in school related activities, SES context of the school community (PERCE); and also in relation to the SCS, HEI and school climate indexes (SERCE). This is relevant to the present study, in which EDI vulnerability scores are aggregated

\textsuperscript{17} School climate refers to the perception a child has towards the character and quality of school life (e.g., quality of inter-personal relationships, student and family involvement, and level of collaboration among school personnel) (Treviño, Place, & Gempp, 2013).

\textsuperscript{18} The evidence shows that the effect of SES on learning is present throughout childhood.
at the school neighbourhood level to test their influence on academic achievement.
CHAPTER THREE: METHOD

This study investigated whether neighbourhood school level influences, as measured by the proportion of children who are vulnerable on two or more domains of the EDI, can predict outcomes in learning at the individual child level within a school (school readiness for academic achievement). The focus of the study was on between school neighbourhood effects and the influence of the TEE on individual learning differences among schools.

This chapter provides a general overview of the study approach, the process for cleaning and organizing data, the preselection of predictors, the method for merging the EDI and SERCE data, and the HLM methodology and models that were used.

General Overview

The EDI and school data analyzed came from preschools and schools in Nuevo Leon. The EDI data were collected by the Nuevo Leon Secretariat of Education, whereas the school data were collected by SERCE. These data were nested at the neighbourhood level by linking preschools and schools at the postal code level. This study used a two-level HLM analysis, with predictors at level-1 (SERCE individual child- and family-level measures) and level-2 (EDI vulnerability scores, averaged at the school neighbourhood or postal code level). The SERCE level-1 predictors comprised student/family (e.g., family SES) and school related factors (e.g., student's perception of the school climate). The dependent variables corresponded to SERCE third and sixth grade reading and math scores, which were predicted at the individual child level within a school. The unconditional model (which served as a baseline comparison) and the three models tested, examined the relation between: SERCE predictors and outcomes; EDI predictors and SERCE outcomes; and all predictors (SERCE/EDI) and SERCE outcomes.

The multilevel approach in the study was developed with the following considerations:
(1) school children are nested within schools; (2) the proportion of school neighbourhood EDI vulnerability scores reflects the Total Environment Effect (TEE) of the school neighbourhood area (postal code) in which preschools/schools are located; (3) the TEE also comprises aggregated individual/family influences (as compositional effects) as well as other unmeasured influences present at the area level; and (4) the average EDI vulnerability scores within a school neighbourhood represent the average for the group of schools within that school neighbourhood. About 80% of the school neighbourhoods had only one school, while the rest of the school neighbourhoods had two or more.

**Hypotheses**

Research evidence described in the literature review indicated that: (1) the demography of the school (Kohen et al., 2009) and the neighbourhood (Lapointe et al., 2007; Kohen et al., 2009) can affect school readiness; (2) the demography of the school (UNESCO/LLECE, 1998; Caldas & Bankston, 1999; UNESCO/LLECE, 2010; Davies et al., 2016) and the neighbourhood (Lloyd & Hertzman, 2009) can affect academic achievement; (3) trajectories in learning can be summarised at the neighbourhood level by linking at the individual child level EDI scores with academic achievement data (Lloyd & Hertzman, 2009); concentrated neighbourhood disadvantage at kindergarten entry can have lasting effects on academic achievement (Lloyd, Li, & Hertzman, 2010); (4) family factors have the strongest effect on school readiness and academic achievement, followed by school characteristics, and then neighbourhood factors (Leventhal & Brooks-Gunn, 2000); (5) the influence of neighbourhood effects on child development and academic achievement can be considered reasonably powerful (Brooks-Gunn et al., 1993); (6) in Nuevo Leon the effect of SCS on academic achievement varied significantly across schools (UNESCO/LLECE, 2010); (7) SERCE reading and mathematics scores were
strongly affected by a Home Education Index, which comprised factors related to school preparedness and the parents’ involvement in school activities\(^{19}\) (UNESCO/LLECE, 2010); and (8) the effect of the HEI on academic achievement was found to be stronger\(^{20}\) when shared by the school community (UNESCO/LLECE, 2010). The above evidence suggests that SERCE outcome data are sensitive to level-2 influences (e.g., neighbourhood effects); and that the use of the proportion of EDI vulnerability scores as a marker of school neighbourhood influences affecting academic achievement is scientifically grounded. The hypothesis of the study is that the combined effect of SERCE (level-1) plus EDI vulnerability (level-2) predictors has a stronger effect on SERCE academic achievement scores (level-1) than SERCE predictors alone.

**Data**

**Early Development Instrument (EDI)**

The Nuevo Leon EDI data were collected in 2008 by the Secretariat of Education for the State of Nuevo Leon, Mexico. Their depository is the Offord Centre for Child Studies, McMaster University, Hamilton, Canada. These data were made available to the current author following a Memorandum of Understanding among the University of Toronto’s Dr. Eric Jackman Institute of Child Study, IIIEPE (Instituto de Investigación, Innovación, y Estudios de Postgrado para la Educación del Estado de Nuevo León), and the McMaster University’s Offord Centre for Child Studies (see Appendix E).

Before the collection of data took place, the EDI questionnaire was translated into Spanish. This work was done in collaboration with the Offord Centre for Child Studies. The text was revised by teachers from the Nuevo Leon Secretariat of Education. A few changes were

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\(^{19}\) For example: child attended preschool, parent read to child when little, parent's opinion about the quality of the education in the school.

\(^{20}\) Suggesting an ‘additive effect’ was in place
made to the translation. For example, in relation to the background questions to the EDI survey, the terms French Immersion, English as a Second Language, and Junior/Senior Kindergarten were omitted or adapted in order to reflect the local context. In addition, two items were added to the questionnaire: the child is able to communicate properly in his/her mother tongue (Language and Cognitive Domain), and the child sucks his/her clothing/hair\(^2\) (Social and Emotional Domain).

In addition to the administration of the EDI, a complementary survey was used to collect information on the children's health, nutritional status, family SES, and parent involvement in early education activities. This information was excluded from the analysis due to inconsistencies in data collection (e.g., the way children's morbidity, height, weight, and low-birth weight were recorded), and also because of a lack of agreement with IIIEPE regarding its use.

**SERCE**

The SERCE data on academic achievement and associated factors came from a UNESCO/LLECE 2006 study conducted in 21 Latin American and Caribbean countries. The State of Nuevo Leon, Mexico also participated in this evaluation. The UNESCO/LLECE office in Santiago, Chile is the depository of the SERCE data. The data were made available to the current study following an e-mail agreement between the current author and the UNESCO/LLECE office in Santiago.

The SERCE data consisted of academic achievement scores (third and sixth grade reading and math), and information on associated factors collected through the administration of Student, Parent, Teacher, School Principal, and School Administration questionnaires. The

\(^2\) Teachers considered that this behaviour reflects some form of delay. No further explanation was provided.
present study only analyzed responses from the Student and Parent Questionnaires, as more than 60% of the data were missing in the other questionnaires. The Student Questionnaire had one version for third grade students (20 questions), and another for sixth grade students (40 questions), while the Parent Questionnaire consisted of a single survey intended for both grade levels (20 questions) (see Appendices F-H).

Preparing Data for Analysis

The preparation of data for analysis consisted of a five step process: data cleaning/completion, conversion of SERCE predictors into dichotomous variables, preselection of level-1 SERCE predictors after they were dichotomized, conversion of the level-2 EDI predictor into a dichotomous variable, and merging of EDI and SERCE data.

Data Cleaning and Completion

The original EDI data had a total of 171,209 student records from 41 municipalities. Review of these data showed that the preschool and municipality names were often spelled in different ways (e.g., typos, abbreviations, and misspellings). The review also showed that parents’ postal codes and addresses were missing. For this reason, it was decided that preschools’ postal codes (collected from sources explained below) would be used instead of parents’ postal codes as the main criterion to link the EDI (preschools) and SERCE (schools) data.

The main source used to verify the correct spelling of the preschools was the 2010 “Sistema Nacional de Información de Escuelas” (SNIE). The SNIE is a thorough and complete database of Mexican schools gathered by the Secretariat of Public Education, Mexico, including public and private schools at every level. The names of the preschools were revised in accordance with SNIE source, and other secondary sources (see Appendix I). The SNIE was also used as the main source to provide the preschools' postal codes and addresses.
EDI data with corrected and completed information were kept in the analysis if they met all the following criteria: (1) the preschool name was unique in the same and surrounding municipalities (to avoid postal code mismatches); (2) the preschool postal code matched one of the postal codes of the SERCE schools; (3) no more than one EDI domain was missing; (4) the child had no special needs; and (5) the child had between 3.67 and 7.5 years of age. The last three criteria are used by the Offord Centre for Child Studies in the identification of valid EDI records, and allow for national (Canadian Normative Sample) and international comparability of results. Records were excluded from the analysis if they did not satisfy all of the above requirements (N=11,128) or were not found in the SNIE database (N=109,670). A total of 50,395 records satisfied the above criteria. These EDI records came from 649 preschools, located in 116 postal codes, in 29 municipalities.

Only minor work was required to clean the SERCE data. The SNIE database was used to verify that the school names were spelled correctly and to get the schools' postal codes. The original SERCE data had a total of 10,736 students with academic achievement records, attending 165 schools, living in 29 municipalities. Schools were excluded if it was not possible to match their postal codes with the preschools' postal codes. The final sample was composed of 10,158 students attending 151 schools located in 116 postal codes.

**Conversion of SERCE Predictors into Dichotomous Variables**

The Student and Family questionnaires consisted of multiple choice questions whose responses were transformed into dichotomous variables (i.e., presence or absence of risk), representing either a Good Environment condition that may enhance school learning, or a Poor Environment condition that may be detrimental to school learning. Examples of Good/Poor Environment conditions are: presence/absence of books in the home; caregiver read/did not read
to the child when little; student attended/did not attend preschool when younger). The criteria of what constitutes a Good/Poor Environment condition were based partly on evidence from the risk literature that was reviewed earlier. These criteria were tested empirically for their predictive value as described below in the section on Preselection. Appendices F-H show the complete list of predictors from the Student and Parent Questionnaires. Included in these appendices are the questions, answer options, and criteria that supported their preselection as level-1 predictors. Appendix J presents a more detailed description of the methodology that was used to transform predictors into dichotomous ones.

**Preselection of Level-1 (SERCE) predictors**

All level-1 predictors were tested against some basic statistical criteria as a means to preselect them for the analysis. This reduced the number of candidate items from 80 to 18. The statistical criteria used in the preselection were the following:

a) Percentage of missing data: not larger than 20%;

b) Effect size within the interval: $d \geq 0.4$ to $d \leq -0.4$. According to Hattie (2009) this interval corresponds to a medium effect size. The effect size was used to measure the association between the predictors' Good/Poor Environment condition and the academic achievement scores. The Effect Sizes were calculated with the formula:

$$d = \frac{\text{Mean Achievement school in Good Environ. Condition} - \text{Mean Achievement school in Poor Environ. Condition}}{\text{Standard Deviation pooled}}$$

c) Differences in academic achievement scores between the Good/Poor Environment condition: larger than 25 points in reading and math scores, which in the SERCE study represented 0.25 of a standard deviation.

d) Factor analysis (when applicable): Cronbach's alpha values larger than $\alpha=0.7$. Some SERCE questions had more than two answer options (e.g., do you have a calculator, notebook,
textbook, pencil you can use in class?). In cases like this, a Cronbach’s alpha factor analysis was used to test the efficiency of grouping the items into a single variable. The Alpha coefficient assesses how closely related a set of items are as a group. In other words, it measures the internal consistency of a set of scale or test items.

e) The school’s postal code matched one of the postal codes of the EDI preschools.

A summary of the preselected predictors, academic achievement scores, and effect sizes for the Good/Poor Environment condition are displayed next in Tables 5 and 6. In the tables, items from the Student and Parent Questionnaires are presented together according to grade and subject.
TABLE 5

SERCE Third Grade Student and Parent Questionnaires - Preselected Level-1 Predictors
Average Academic Achievement Scores and Effect Sizes for Good/Poor Environment Condition-Nuevo Leon\(^1\)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Reading</th>
<th></th>
<th>Math</th>
<th></th>
<th></th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Poor</td>
<td>ES</td>
<td>Good</td>
<td>Poor</td>
<td>ES</td>
</tr>
<tr>
<td>Student Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. If you were told you have to change schools, how would you feel? Q10)</td>
<td>568.5</td>
<td>529.0</td>
<td>0.42</td>
<td>571.3</td>
<td>536.5</td>
<td>0.38</td>
</tr>
<tr>
<td>2. Do you have a notebook, a reading textbook, and a math textbook to use in the school? (Q12-Q14)</td>
<td>577.5</td>
<td>533.7</td>
<td>0.46</td>
<td>581.1</td>
<td>538.0</td>
<td>0.47</td>
</tr>
<tr>
<td>Parent Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Mother’s education (Q1)</td>
<td>579.2</td>
<td>535.8</td>
<td>0.46</td>
<td>581.3</td>
<td>543.6</td>
<td>0.41</td>
</tr>
<tr>
<td>4. Home flooring [Material of the household floor] (Q8)</td>
<td>580.9</td>
<td>540.6</td>
<td>0.43</td>
<td>584.6</td>
<td>545.1</td>
<td>0.43</td>
</tr>
<tr>
<td>5. Home services [What services do you have in your home?] (Q9)</td>
<td>572.1</td>
<td>532.0</td>
<td>0.42</td>
<td>575.2</td>
<td>539.2</td>
<td>0.39</td>
</tr>
<tr>
<td>6. Home assets [What assets do you have in your home?] (Q10)</td>
<td>577.0</td>
<td>537.6</td>
<td>0.42</td>
<td>580.0</td>
<td>553.7</td>
<td>0.39</td>
</tr>
<tr>
<td>7. Number of books at home [How many books do you have in your house. Include all books: poetry, novels, dictionaries, etc.] (Q11)</td>
<td>578.5</td>
<td>537.7</td>
<td>0.42</td>
<td>581.3</td>
<td>543.9</td>
<td>0.41</td>
</tr>
<tr>
<td>8. Attended preschool for at least two years [When your child was between 4 and 6 years of age, did he/she attend a preschool?] (Q14)</td>
<td>575.4</td>
<td>540.5</td>
<td>0.37</td>
<td>579.6</td>
<td>545.0</td>
<td>0.40</td>
</tr>
</tbody>
</table>

\(^1\)See Appendices F-H for a complete list of SERCE predictors. The alpha-numeric codes (e.g., Q10) correspond to their question number in the Questionnaire. Range reading scores: 529.0 to 580.9; range math scores: 536.5 to 584.6.
### TABLE 6

**SERCE Sixth Grade Student and Parent Questionnaires - Preselected Level-1 Predictors**  
Average Academic Achievement Scores and Effect Sizes for Good/Poor Environment Condition-Nuevo Leon

<table>
<thead>
<tr>
<th>Student Questionnaire</th>
<th>Subject and Environment Condition</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Do you fight a lot in class? [How is your class?] (Q22)</td>
<td>Good: 551.6  Poor: 504.8  ES: 0.50</td>
<td>4,095</td>
</tr>
<tr>
<td>2. Do you have a pencil you use in class? (Q31)</td>
<td>Good: 545.8  Poor: 500.5  ES: 0.45</td>
<td>4,270</td>
</tr>
<tr>
<td>3. In your math/reading class, do you understand things easily? (Q33)</td>
<td>Good: 559.6  Poor: 522.3  ES: 0.40</td>
<td>4,501</td>
</tr>
<tr>
<td>4. In your math and reading class, do you feel nervous? (Q33)</td>
<td>Good: 571.9  Poor: 516.3  ES: 0.59</td>
<td>3,912</td>
</tr>
<tr>
<td><strong>Math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Mother’s education (Q1)</td>
<td>Good: 563.5  Poor: 516.6  ES: 0.50</td>
<td>4,091</td>
</tr>
<tr>
<td>2. Home flooring [Material of the household floor] (Q8)</td>
<td>Good: 565.6  Poor: 520.4  ES: 0.48</td>
<td>4,262</td>
</tr>
<tr>
<td>3. Home services [What services do you have in your home?] (Q9)</td>
<td>Good: 554.1  Poor: 508.1  ES: 0.49</td>
<td>4,332</td>
</tr>
<tr>
<td>4. Home assets [What assets do you have in your home?] (Q10)</td>
<td>Good: 558.3  Poor: 513.8  ES: 0.48</td>
<td>4,340</td>
</tr>
<tr>
<td>5. Number of books at home [How many books do you have in your house. Include all books: poetry, novels, dictionaries, etc.] (Q11)</td>
<td>Good: 559.6  Poor: 515.4  ES: 0.47</td>
<td>4,270</td>
</tr>
<tr>
<td>6. Attended preschool for at least two years [When your child was between 4-6 years of age, did he/she attend a preschool?] (Q14)</td>
<td>Good: 560.7  Poor: 523.7  ES: 0.40</td>
<td>4,274</td>
</tr>
</tbody>
</table>

See Appendices F-H for a complete list of SERCE predictors. The alpha-numeric codes (e.g., Q10) correspond to their question number in the Questionnaire.

Range reading scores: 500.5 to 571.9; range math scores: 514.8 to 581.7.
Conversion of level-2 (EDI) predictor into a dichotomous variable

EDI norms are based on average EDI population scores, which make them population specific. EDI results are grouped according to these norms into four percentile categories: 75% to 100%, 25% to 75%, 10% to 25%, and 0% to 10%. Children in a site's distribution who score in the range 25% to 100% are considered on track, while those who score in the category 10% to 25% are considered at risk, and those in the bottom 0% to 10% vulnerable (Janus et al., 2007). Vulnerable children are those who score in the lowest 10th percentile in their site in one or more EDI domains (Janus et al., 2007). The Nuevo Leon EDI results were grouped according to the same criteria, as a means to identify those children with vulnerability scores.

The EDI outcomes can be reported in different ways, for example: (1) as the average score of all domains or each individual developmental domain; (2) as the percentage of children scoring low on one domain; and (3) as the percentage of children scoring low on two or more domains. This study adopted scoring low (vulnerable) on at least two domains (e.g., domain scores in the 0% to 10% of the distribution) as the normative criterion to define vulnerability. This decision was taken following an examination of the Nuevo Leon EDI data, which showed that of the 171,209 children evaluated, 29.1% scored low on one domain, and 14.3% scored low on two or more domains. The lower percentage of cases corresponding to low on at least two domains suggested that this reporting format was a finer grained predictor for analysis. In other words, it offered a more extreme measure of school readiness vulnerability.

The EDI scores (Vulnerable in two or more domains=1, Vulnerable in one domain or less=0) were averaged at the level of each school neighbourhood (postal code) encompassing the schools; in this way, EDI scores were transformed into continuous average values ranging from 0 to 1, where 0 represented the level of minimum vulnerability, and 1 the level of maximum
vulnerability. These average scores represented the proportion of children with EDI vulnerability in a school neighbourhood area. For example, a value of 1 indicated that 100% of the children in the area presented vulnerabilities in the EDI, whereas a value of 0 indicated that 0% of the children had a vulnerability on two or more domains in the instrument. Given their theoretical importance, EDI age (age of EDI administration, in years, averaged school neighbourhood) and EDI gender (female=0, male=1) were also included in the analysis as level-2 control variables. Although in the present study they are not conceived as predictors, their use allowed cross-examining tendencies in EDI vulnerability scores at the school neighbourhood level in relation to age and gender.

**SERCE Outcome Variables**

The SERCE outcomes corresponded to third and sixth grade reading and math achievement scores. For Mexico the mean was 500, with a standard deviation of 100, and a range from 200 to 800 points. For Nuevo Leon, the mean reading and mathematics scores among schools ranged from 539 to 557 points.

**Merging EDI and SERCE Data for Analysis**

EDI and SERCE data were merged by postal code. In the process, the predictor EDI vulnerability was averaged at the school neighbourhood level. In this way, all schools within a school neighbourhood area (postal code) had a single level-2 predictor (e.g., proportion of children with EDI vulnerabilities), and as many sets of academic achievement scores as students in the school neighbourhood area.

In HLM, it is necessary to make a decision on how some predictors are centered. The predictor SERCE age (third and sixth grade) was centred around the school group mean, while the level-2 predictor EDI vulnerability was centred around the grand mean. This type of centring
was done in response to the way the data were nested. Considering that children were nested within schools, the predictor SERCE age was centred around the school means. The EDI predictor (and the control variables EDI age, and EDI gender) was centred around the grand means because level-2 is the higher level of analysis.

**HLM Models**

This study adopted an HLM methodology that took into account the nested nature of the data. Two hierarchical levels were analyzed: school children (level-1) who were nested within schools and their neighbourhoods (level-2). Preschools and schools were linked by postal code area, which was used to define school neighbourhood. This linkage permitted matching individual SERCE scores with school neighbourhood EDI scores. The EDI vulnerability scores were analyzed at the aggregated school neighbourhood level.

Data were analyzed using HLM 7 Hierarchical Linear and Nonlinear Modeling (Scientific Software International, 2010). Initially, the unconditional model was tested to partition the variance of the dependent variable at the school level. The unconditional model also served as a baseline comparison. Then, a series of regression models was examined to find the best model fit that explained the most variance. Three models were tested separately for each grade level and subject: random intercept, means as outcomes, and random intercepts and slopes. These models are explained next.

- **Unconditional (null) Model.** This model had no predictors. It served as a baseline comparison to other models. It allowed examination of how much variability in academic achievement was attributable to the school grouping effect (Huang, 2009). As a first step, a variance component analysis was conducted to measure the relatedness or dependence of the dependent variable (academic achievement data). Statistically significant chi-
square values (meaning that there is significant variance among schools in the outcome variable) provide a justification for running HLM analysis (Woltman, Feldstain, MacKay, Rocchi, 2012). Chi-square results were statistically significant for all grade levels and subjects. In addition to the chi-square analysis, the unconditional model used the intraclass correlation coefficient (ICC) to estimate the percentage of between and within school variances attributed to schools. The ICC was calculated through equation \( E(1) \), in which \( \sigma \) (sigma) represents the within school variance, and \( \tau \) (tau) the between school variance.

\[
ICC = \frac{\tau_{00}}{\tau_{00} + \sigma^2}
\]

Results from the variance components analysis are presented in Table 7. As seen, most of the variation in language and mathematics achievement comes from within school differences rather than from between school differences (range within school variance: 79.4% to 82.5%; range between school variance: 17.5% to 21.7%).

**TABLE 7**

<table>
<thead>
<tr>
<th>Grade level</th>
<th>( \chi^2 ) Value</th>
<th>( Df )</th>
<th>( p )-value</th>
<th>Within school variance (%)</th>
<th>Between school variance (%)</th>
<th>ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>1252.9</td>
<td>144</td>
<td>&lt;.001</td>
<td>82.3%</td>
<td>17.7%</td>
<td>0.177</td>
</tr>
<tr>
<td>Third Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>1131.3</td>
<td>144</td>
<td>&lt;.001</td>
<td>82.5%</td>
<td>17.5%</td>
<td>0.175</td>
</tr>
<tr>
<td>Sixth grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>1425.5</td>
<td>144</td>
<td>&lt;.001</td>
<td>78.3%</td>
<td>21.7%</td>
<td>0.217</td>
</tr>
<tr>
<td>Third Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>1403.9</td>
<td>142</td>
<td>&lt;.001</td>
<td>79.4%</td>
<td>20.6%</td>
<td>0.206</td>
</tr>
</tbody>
</table>
Results in Table 7 indicate that all chi-square values were significant, and that most of the variance in academic achievement scores comes from within school differences.

- Model 1 - Random Intercept Model. This model examined the relation between the level-1 predictors (e.g., SERCE preselected predictors) and the outcome variable (e.g., reading and math scores). It allowed the intercept parameter at level-1 to vary at level-2 (schools), while keeping the slopes constant (Dickinson & Basu, 2005; Field, 2009). This model was used along with the unconditional model to determine how much of the level-1 variance is explained by the addition of level-1 predictors (effect-size). This calculation was done through equation \( E(2a) \), in which \( r^2 \) between (Model 1) represents the proportion of variance explained by Model 1, \( \tau \) (null) the between school variance from the unconditional model, and \( \tau \) (random intercept) the between school variance of the random intercept model.

\[
E(2a) \quad r^2 \text{ between (Model 1)} = \frac{\tau \text{ (null)} - \tau \text{ (random intercept)}}{\tau \text{ (null)}}
\]

The within school effect associated with this model was calculated with equation \( E(2b) \), in which \( r^2 \) represents the proportion of within school variance explained by the addition of level-1 predictors, \( \sigma^2 \) (null) the variance from the unconditional (null) model, and \( \sigma^2 \) (random intercept) the variance of the random intercepts model.

\[
E(2b) \quad r^2 \text{ within (Model 1)} = \frac{\sigma^2 \text{ (null)} - \sigma^2 \text{ (random intercept)}}{\sigma^2 \text{ (null)}}
\]

- Model 2 - Means as Outcomes Model. This model allowed examination of the relation between the higher level predictor (e.g., EDI vulnerability) and the outcome variable at the individual child level (e.g., reading and math scores) within a school. Its purpose was to determine how much of the individual variation in achievement around the grand mean
is explained by the addition of the level-2 predictors (effect size). The percentage of variance explained by this model was calculated through equation $E(3a)$ below, in which $r^2$ between (Model 2) represents the proportion of variance explained by Model 2, $\tau$ (null) the between school variance from the unconditional model, and $\tau$ (means as outcomes) the between school variance of the means as outcome model. Because the level-2 predictor was averaged at the school level, this model did not explain any within school variation (for this reason, within school variations were excluded from this and the following model).

$$E(3a) \quad r^2 \text{between (Model 2)} = \frac{\tau_{\text{null}} - \tau_{\text{means as outcome}}}{\tau_{\text{null}}}$$

- Model 3- Random Intercepts and Slopes Model. The final step in the HLM analysis was to examine a model with both level-1 (SERCE) and level-2 (EDI) predictors. The purpose of this model was to examine if the addition of level-1 and level-2 factors have an effect in reducing the intercept variance at level-2, and in this way, explain between school differences in academic achievement at level-1. The proportion of between school variance explained by this model was computed through equations $E(4a)$:

$$E(4a) \quad r^2 \text{between (Model 3)} = \frac{\tau_{\text{null}} - \tau_{\text{random intercepts and slopes}}}{\tau_{\text{null}}}$$

In the above formulae, $r^2$ between (Model 3) represents the proportion of between school variance explained by Model 3, $\tau$ (null) the between school variance from the random intercepts model (level-1), and $\tau$ (random intercepts and slopes) the between school variance of the random intercepts and slopes model.

The $r^2$ values that derived from equations $E2(a)$, $E3(a)$, and $E4(a)$ indicate the proportion reduction in variance in the intercepts, related to between school differences, that results from the
addition of the predictors. Of particular interest, is an examination of the proportion reduction in variance statistics from Model 1 to Model 3. This difference corresponds to the effect the EDI predictor has on the dependent variable as a proportion reduction in variance, beyond the effect of SERCE predictors alone.

**Fixed and Random Effects**

In the present study results from the HLM models are presented as fixed and random effects. The fixed effect outcomes include values of the mean school achievement intercepts by model. In the unconditional model (no predictors), these scores correspond to the average academic achievement scores of all schools, without controlling for any predictor. The fixed effect outcomes also include scale point differences (spd) in academic achievement scores associated to each predictor. At level-1 (SERCE) the spd represent scale point differences in academic achievement between Good/Poor Environment condition; at level-2 (EDI vulnerability) they represent scale point differences between the condition of no vulnerability (0%; no children vulnerable in two or more domains) to vulnerability (100%; all children are vulnerable in two or more domains in a given school neighbourhood).

The random effect outcomes include the estimation of variance components and ICC (between and within) that were computed through equation $E(1)$. They also include the proportion of between and within variance reduction in school achievement associated to Models 1-3 [calculated through equations $E(2a)-E(4a)]$.

**Calculating the Effect of Level-2 Predictors**

As previously explained, Model 1 and Model 2 used the unconditional model as the null model, while Model 3 used Model 1 (random intercept model) as the null model. While this approach was appropriate to test the main hypothesis by examining variance reduction beyond
the effect of level-1 predictors, it did not allow calculating the amount of variance explained by the EDI and SERCE predictors. For this reason, additional $r^2$ values were computed for Model 3, this time using the unconditional model (no predictors) as baseline (see equation E5 below). This additional approach homogenized the analysis, so that all $r^2$ values referred to the same unconditional model. The $r^2$ values that derived from equation E(5) were used in equation E(6) to estimate the percentage of variance explained by the EDI predictors. The equations are the following:

$$E(5) \quad r^2 \text{ between (Model 3')} = \frac{\tau (null) - \tau \text{ (random intercepts and slopes)}}{\tau (null)}$$

$$E(6) \quad \% \text{ Variance Explained. EDI predict. (between)} = r^2 \text{ between (Model 3')} - r^2 \text{ between (Model 1)}$$

$$E(7) \quad \% \text{ Variance Explained. SERCE predict. (between)} = r^2 \text{ between (Model 3')} - r^2 \text{ between (Model 2)}$$

where $r^2 \text{ between (Model 3')}$ represents the proportion of variance explained by Model 3 in relation to the unconditional model, $\tau (null)$ the between school variance of the unconditional model, and $\tau \text{ (random intercepts and slopes)}$ the Model 3 between school variance of the random intercepts and slopes model. The between school variance explained by the EDI and SERCE predictors were calculated using equations E(6) and E(7).

**Final Selection of Predictors**

Initially, all SERCE preselected predictors included in Tables 5 and 6 were tested. Non-significant predictors were removed from the HLM analysis through the following steps: (1) the predictor with the highest non-significant $p$-value at Model 1 (random intercepts model) was excluded first; (2) the model was re-run and again the highest non-significant $p$-value was removed; these steps were repeated until only significant predictors were left. This procedure,
which is a recommended modelling strategy (Harrel, 2001), reduced the list of level-1 predictors to the following: *mother’s education; home flooring; home assets* (except third grade); *number of books at home; child attended preschool for at least two years; and if you were told you have to change schools, how would you feel?* (applied for third grade). The student *age* and *gender* were kept in the HLM as control variables, regardless of their significance.

While running the *means and outcomes* and *random intercepts and slopes* models, it was noticed that the use of more than two level-2 factors (EDI vulnerability as predictor, plus EDI gender and EDI age as control variables) made the models unstable. For this reason, it was decided that EDI gender would be excluded from the HLM analysis. The decision to retain EDI age instead of EDI gender was based on the association that was found between EDI age and EDI vulnerability (Figure 4). It was concluded that EDI age was more valuable as a control variable in order to examine its association with the dependent variable.
CHAPTER FOUR: RESULTS

This section is divided into two parts. The first presents a description of the data, specifically in relation to EDI vulnerability level, EDI vulnerability by age of administration, EDI vulnerability across school neighbourhoods, and SERCE reading and mathematics scores. The second part presents the outcomes from the HLM analyses organized by grade level and subject.

Descriptive EDI Results

The original sample had a total of 171,209 EDI records. From these records, 11,128 (6.6%) were excluded for not meeting the Offord Centre for Child Studies criteria for the identification of valid EDI scores (see Table 8). Another set of records were excluded because the child had special needs (4%), attended preschool for less than one month before the EDI administration (1.9%), was outside the age range of 3.67 to 7.5 years (0.4%), or more than two EDI domains were missing (0.3%). From the remaining number of eligible cases, another set of 109,678 (68.5% of valid EDI scores) was excluded because it was not possible to match their postal codes with the postal codes from the SERCE schools (because the postal codes were different). As shown in Table 8, the final sample consisted of 50,395 EDI records (31.5% of the valid EDI scores).
TABLE 8

*Exclusions from the Final EDI Sample - Nuevo Leon*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child had special needs</td>
<td>6,787</td>
<td>4.0%</td>
</tr>
<tr>
<td>Child attended preschool for less than one month before EDI was administered</td>
<td>3,294</td>
<td>1.9%</td>
</tr>
<tr>
<td>Child’s age was outside the range 3.67 to 7.5 years</td>
<td>609</td>
<td>0.4%</td>
</tr>
<tr>
<td>More than one EDI domain was missing (^{22})</td>
<td>438</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>11,128</strong></td>
<td><strong>6.6%</strong></td>
</tr>
</tbody>
</table>

No postal code matched between preschools (EDI) and schools (SERCE) | 109,670 | 68.5% \(^{2}\) |
Final sample for analysis | 50,395 | 31.5% |

A statistical analysis was conducted to examine possible differences between the final EDI sample and the valid EDI records that were excluded because they had no postal code match. Results indicated that the average EDI vulnerability was significantly greater in the final sample (Mean \(_{final} = .5648\), SD=1.08) than the excluded one [(Mean \(_{excluded no PC match} = .5525\), SD=1.03), \(t(160,667) = -6.896, p > 0.00001\)]; however, the effect size of this difference was very small (\(d=0.037\)). The final sample also had a slightly higher age average [(Mean \(_{final} = 5.57\), SD=.668; Mean \(_{excluded no PC match} = 5.55\), SD=.663), \(t(160,667) = 5.437, p > 0.039, d=0.029\)], and a slightly larger representation of males than the excluded sample [\(\chi^2 = 5.003, p > .025, OR(odd-ratio)=1.017\)]. The results from the effect size and odds-ratio analysis suggested that the two groups were quite similar in relation to the average EDI vulnerability scores, the age of EDI administration, and EDI gender. The statistically significant differences found in the *t*-tests should be viewed in light of the very large sample sizes involved.

\(^{22}\) This and the above reasons for exclusion were based on criteria used by the Offord Centre for Child Studies.
Table 9 organizes EDI data according to 
vulnerability level (e.g., the number of domains 
in which children scored low), vulnerability by domain (e.g., Physical, Social, Emotional), and 
gender\textsuperscript{23}. The table shows that a larger percentage of boys, as compared to girls, scored low in 
one EDI domain, two EDI domains, and vulnerabilities by domains. These outcomes speak of 
gender effects, or differences between boys and girls with regards to EDI vulnerability. This 
result of girls having higher scores than boys is found across the EDI literature (Janus & Offord, 
2007).

**TABLE 9**

*Percentage of Children with EDI Vulnerability, by Level and Domain: Nuevo Leon*

(*n=50,395*)

<table>
<thead>
<tr>
<th>Vulnerability level</th>
<th>Male %</th>
<th>Number of cases</th>
<th>Female %</th>
<th>Number of cases</th>
<th>Total %</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>No domain vulnerability</td>
<td>65.7%</td>
<td>17,003</td>
<td>75.8%</td>
<td>18,596</td>
<td>70.6%</td>
<td>35,599</td>
</tr>
<tr>
<td>Low on one Domain</td>
<td>16.2%</td>
<td>4,184</td>
<td>13.5%</td>
<td>3,305</td>
<td>14.9%</td>
<td>7,489</td>
</tr>
<tr>
<td>Low on two or more domains\textsuperscript{1}</td>
<td>18.1%</td>
<td>4,686</td>
<td>10.7%</td>
<td>2,621</td>
<td>14.5%</td>
<td>7,307</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>25,873</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>24,522</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>50,395</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vulnerability by Domain</th>
<th>Male %</th>
<th>Number of cases</th>
<th>Female %</th>
<th>Number of cases</th>
<th>Total %</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>11.2%</td>
<td>2,882</td>
<td>8.6%</td>
<td>2,099</td>
<td>9.9%</td>
<td>4,981</td>
</tr>
<tr>
<td>Social</td>
<td>14.1%</td>
<td>3,652</td>
<td>7.7%</td>
<td>1,889</td>
<td>11.0%</td>
<td>5,541</td>
</tr>
<tr>
<td>Emotional</td>
<td>14.7%</td>
<td>3,793</td>
<td>7.3%</td>
<td>1,781</td>
<td>11.1%</td>
<td>5,574</td>
</tr>
<tr>
<td>Language &amp; Cognition</td>
<td>14.5%</td>
<td>3,714</td>
<td>9.9%</td>
<td>2,431</td>
<td>12.2%</td>
<td>6,172</td>
</tr>
<tr>
<td>Communication-General</td>
<td>14.8%</td>
<td>3,839</td>
<td>9.6%</td>
<td>2,351</td>
<td>12.3%</td>
<td>6,190</td>
</tr>
</tbody>
</table>

Note: The present study adopted low on two or more EDI domains as the specific criterion to define EDI vulnerability.

\textsuperscript{23} As mentioned earlier, EDI gender was excluded from the HLM model. Table 9 compares gender differences in EDI vulnerability prior to the HLM analyses.
Table 9 also shows that about 14.5% of children were vulnerable in two or more EDI domains, and that for the entire sample the percentage of children vulnerable across the different domains ranged from 9.9% to 12.3%. A comparison of vulnerability by domain, presented in Table 9, against EDI Canadian normative data for 5-year-olds (Janus & Duku, 2004) attending senior kindergarten showed some differences between the two groups. Among boys, the percentage of domain vulnerability was about 4% to 10% higher in Nuevo Leon than in Canada. However, the results were more comparable among girls across countries.

Below, Figure 3 shows the proportion of children vulnerable on the EDI predictor by age of EDI administration. As expected, the percentage of children with EDI vulnerabilities went down with age. This gradient is regularly found in EDI studies. It reflects the development of new competencies related to maturational processes and learning\textsuperscript{24}.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{Proportion of Children with EDI Vulnerability\textsuperscript{1} by Age at EDI Administration (N=50,395)}
\end{figure}

\textsuperscript{1}In two or more EDI domains

\textsuperscript{24} For example, Brownell, et al., 2016 reported a small positive correlation ($r=0.1$) between the language and cognitive domains of the EDI and age at EDI assessment ($r = 0.10$).
Given that individual EDI vulnerability is modestly associated with age at EDI administration in Figure 3, it is expected that school neighbourhood EDI vulnerability will show the same pattern. The proportion of EDI vulnerability scores across school neighbourhoods (116 in total) was examined against the average-age of EDI administration. This exploratory analysis was important in order to learn about the association between these two variables. Figure 4 shows that this relation was negative, as it was for individuals, with an $R^2$ (coefficient of determination) value of 0.0198. This measure provides a ‘goodness of fit’ estimate of the strength of the relation. The magnitude of the $R^2$ indicated that this relation was low in approximately 98.02% (100% - 1.98%) of the observations. Figure 4 also shows that the average age of administration in most school neighbourhoods fell within the range of 5.4 to 5.7 years.

![Figure 4. Proportion of EDI Vulnerability across School Neighbourhoods and Age at EDI Administration - Nuevo Leon Data](image)

1 Number of EDI records=50,395; Number of school neighbourhoods=116

25 The $R^2$ score was about the same when the two outliers on the right side of the figure were excluded ($R^2$ Average age EDI administration $<6 = 0.002$).
Descriptive SERCE Results

The final (preselected) SERCE sample was composed of 10,158 students (third grade=5,415, sixth grade=4,743) from 151 schools (third grade=145, sixth grade=146), located in 116 school neighbourhoods (third grade=112, sixth grade=113). There was an average of 1.3 schools per school neighbourhood (sd = 0.66; range: 1-4). The average number of students per school was 67.3 (third grade=37.3, sixth grade=32.5). Information on the schools and the number of students that were tested is not included in the present document in order to maintain the school anonymity.

Below, Table 10 shows descriptive statistics of SERCE reading and mathematics scores. The information for boys and girls is presented separately and as a total. Result from a t-test indicated that girls had a small advantage over boys in third ($p<=.001$) and sixth grade reading ($p<=.003$), whereas boys outperformed girls in third grade mathematics ($p<=.05$). However, an effect size analysis showed that the academic achievement differences between boys and girls were rather small (range effect sizes: $d=0.001$ to $d=0.09$).
### TABLE 10

**SERCE Third and Sixth Grade Descriptive Statistics**

*Number of Students, Age and Academic Achievement Scores, by Gender - Nuevo Leon*

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Effect size boys/girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student age</td>
<td>2,677</td>
<td>10.7</td>
<td>12.6</td>
<td>2,493</td>
</tr>
<tr>
<td>Reading Scores</td>
<td>2,675</td>
<td>555.8</td>
<td>98.4</td>
<td>2,493</td>
</tr>
<tr>
<td>Math scores</td>
<td>2,641</td>
<td>565.7</td>
<td>94.6</td>
<td>2,457</td>
</tr>
<tr>
<td>Sixth Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Age</td>
<td>2,413</td>
<td>12.7</td>
<td>7.8</td>
<td>2,354</td>
</tr>
<tr>
<td>Reading Scores</td>
<td>2,378</td>
<td>535.7</td>
<td>92.5</td>
<td>2,362</td>
</tr>
<tr>
<td>Math scores</td>
<td>2,230</td>
<td>551.9</td>
<td>98.7</td>
<td>2,237</td>
</tr>
</tbody>
</table>

*p<.05; **p<.001; ***p<.0001*
HLM Results

A summary of the HLM results is presented in Tables 11-14 at the end of this chapter. The extended HLM outputs can be found in Appendices K-N, and the multilevel equations in Appendix O. Tables 11-14 organize the outcomes according to effect type (fixed and random) and model (unconditional model and Models 1-3). What is presented next are general descriptive results for all grade levels and subjects.

Results by Grade Level and Subject

Third grade reading (Table 11). All predictors with the exception of age (level-1), age-EDI administration (level-2), and gender (level-1) were statistically significant (see Models 1-3). The predictors with the largest regression coefficients or scale point differences (spd) were: EDI vulnerability (range -138.7 to -184.5); if you were told you have to change schools (range -31.6 to -31.8); number of books in the home (range +17.3 to +17.7); mother’s education (range +16.7 to +17.3); and attended preschool for at least two years (range +15.7 to +15.9). These spd values represent the effect of the predictors in academic achievement units associated with the predictors’ Good/Poor Environment conditions. The predictor EDI vulnerability was statistically significant in Model 3 (spd = -138.7). According to this result, a 10% increase in EDI vulnerability within a school neighbourhood would drop children's reading scores by about 13.8 points. The predictor age-EDI administration that was used as a control variable was not significant. Results from the unconditional model indicate that 17.7% of the variation in school

---

26 As mentioned before, the SERCE age and gender predictors were included in the model regardless of their statistical significance association with the dependent variable. Note that EDI-gender was excluded from the final HLM model.

27 Average school neighbourhood EDI vulnerability scores ranged from 0 to 1. An increment of one unit in the coefficient represents a change from the condition of 0% vulnerability to 100% vulnerability (all children vulnerable in two or more EDI domains) in a school neighbourhood.
achievement corresponds to between school variance, while 82.3% corresponds to within school variations.

Table 11 also includes outcomes from the random intercept effects across different models. Model 1 examined the relation between level-1 SERCE predictors and third grade reading scores. Results indicate that the level-1 predictors account for 4.4% of the within and 49.5% of the between school variability in reading achievement in relation to the unconditional model.

Model 2 investigated the association between level-2 predictors (EDI) and SERCE third grade reading scores. Results reveal that the addition of Level-2 predictors explains 17.5% of the between school variance.

Model 3 examined if the addition of level-1 and level-2 predictors reduce the intercept variance at level-2. Results indicate that the addition of the predictors reduce the between school intercept variance by 13.8%. In Models 2 and 3 there is no within school variability associated with the EDI vulnerability scores because the values of the predictor were averaged at the school neighbourhood level. For this reason the within school variability is not reported for these models.

**Third grade mathematics (Table 12).** In third grade mathematics, all predictors were statistically significant with the exceptions of age (level-1), and age-EDI administration, and Vulnerability (level-2). Because the level-2 factor did not have an effect, the level-1 spd were about the same in Models 1 and 3: if you were told you have to change schools (+27.7); mother’s education (range +15.9 to +16.3); number of books (range +15.3 to +15.5); attended preschool for at least two years (range +13.3 to +13.5); home flooring (range +10.7 to +11.0); and gender (-7 points favouring boys; a negative value indicates that males outperformed females). Results
also indicated that the EDI \textit{vulnerability} regression coefficients diminished from Model 2 (-103.5) to Model 3 (-64.6) by about 38 points. This same pattern (e.g., \textit{spd} scores decreasing from Model 2 to 3) was found in third grade reading. The unconditional model indicated that 17.5\% of the variance was between schools and 82.5\% was within schools. These outcomes are similar to those found in third grade reading in the unconditional model.

Results indicated that the proportional reduction of between school variance explained by the different models was: 49.9\% in Model 1 (with level-1 predictors), 49.9\% in Model 2 (with level-2 predictors), and 5.5\% in Model 3 (with level-1 and level-2 predictors). The amount of within school variance explained by Model 1 was 4\% (at level-1).

\textbf{Sixth grade reading (Table 13).} All predictors in Models 1-3, with the exception of Model 2 \textit{age-EDI administration}, were statistically significant. The predictors with the largest \textit{spd} were: \textit{EDI vulnerability} (range -126.6 to -204.0), \textit{number of books in the home} (range +18.9 to +19.3), \textit{mother’s education} (range +17.7 to + 18.0), \textit{home assets} (range 12.3 to 12.6), and \textit{gender} (+9.0 points favouring girls; a positive value indicates that females outperformed males). Results for EDI vulnerability indicate that a 10\% decrease EDI vulnerability (at level-2) would increase sixth grade reading scores in individual children within a school by 12.6 points (about 0.125 standard deviation units). Results also indicate that \textit{age-EDI administration} was significant, an outcome which will be further analyzed in the next section. The level-1 \textit{spd} found in Models 1 and 3 were similar, while the level-2 \textit{spd EDI vulnerability} dropped by 77.0 points from Model 2 to Model 3. Results from the unconditional model indicate that 21.7\% of the variation in school achievement corresponds to between school variance, while 78.3\% corresponds to within school variance.
Table 13 also shows that the percentage of between school variance explained by the different models was: Model 1 (52.6% at level-1), Model 2 (17.5% at level-2), and Model 3 (17.2% at level-1 and level-2); while the amount of within school variance explained in Model-1 was 1.9%.

**Sixth grade mathematics (Table 14).** All predictors in Models 1-3, with the exception of gender and EDI vulnerability, were statistically significant. Table 14 also shows that the level-1 regression coefficients were approximately the same in Models 1 and 3, while the level-2 EDI vulnerability coefficient dropped by more than half from Model 2 to Model 3. The unconditional model partitioning of the variance revealed that about 20.6% was between schools and 79.4% was within school variance.

Table 14 also shows that the percentage of between school variance explained by the different models was: 42.5% at level-1 in Model 1, 12% at level-2 in Model 2, and 6.2% at level-1 and level-2 in Model 3; while the amount of within school variance explained in Model 1 was 2.0%.
TABLE 11

Third Grade Reading: HLM Models of Level 1 (individual) and Level 2 (Community EDI) influence

<table>
<thead>
<tr>
<th>Level-1 (SERCE)</th>
<th>Unconditional Model(^1) (No predictors)</th>
<th>Model 1: Random Intercept Model (Level-1 predictors only)</th>
<th>Model 2: Means as Outcomes Model (Level-2 predictors only)</th>
<th>Model 3: Random Intercepts and Slopes Model (Level-1 &amp; Level-2 predictors)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept: School mean achievement</td>
<td>546.7</td>
<td>496.8</td>
<td>546.1</td>
<td>496.4</td>
</tr>
<tr>
<td>Age Student(^2)</td>
<td>-2.8</td>
<td>-2.85</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Gender Student (female/male)</td>
<td>3.8</td>
<td>3.8</td>
<td>17.3***</td>
<td>16.7***</td>
</tr>
<tr>
<td>Mother’s Education</td>
<td>17.3***</td>
<td>8.9**</td>
<td>8.3**</td>
<td>8.3**</td>
</tr>
<tr>
<td>Home Flooring</td>
<td>8.9**</td>
<td>17.7***</td>
<td>17.3***</td>
<td>17.3***</td>
</tr>
<tr>
<td>Number of Books at Home</td>
<td>15.9***</td>
<td>31.6***</td>
<td>31.8***</td>
<td>31.8***</td>
</tr>
<tr>
<td>Attended Preschool (at least two years)</td>
<td>If you were told you have to change schools...</td>
<td>54.5</td>
<td>33.1</td>
<td>54.5</td>
</tr>
<tr>
<td>EDI Vulnerability (two or more domains)(^3)</td>
<td>-184.5***</td>
<td>-184.5***</td>
<td>-138.7***</td>
<td>-138.7***</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance between schools (level-1)</td>
<td>1642.4</td>
<td>828.9</td>
<td>1354.9</td>
<td>714.5</td>
</tr>
<tr>
<td>Variance within schools (level-1)</td>
<td>7634.9</td>
<td>7301.0</td>
<td>7636.5</td>
<td>7297.8</td>
</tr>
<tr>
<td>ICC: % of variance - between schools</td>
<td>17.7%</td>
<td>10.2%</td>
<td>15.1%</td>
<td>8.9%</td>
</tr>
<tr>
<td>ICC: % of variance - within schools</td>
<td>82.3%</td>
<td>89.8%</td>
<td>84.9%</td>
<td>91.1%</td>
</tr>
<tr>
<td>Between school variance reduction (proportion) (Eq. E2a-E4a)</td>
<td>-----</td>
<td>4.4%</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Within school variance reduction (proportion)(Eq. E2b)</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

Note: The Fixed Effect regression coefficients show academic achievement differences between the Good/Poor (0/1) Environment conditions; these values are expressed in academic achievement units. For the EDI, they represent scale point differences between the condition of no vulnerability (0%; no children vulnerable) to vulnerability (100%; all children are vulnerable in two or more domains) in a given school neighbourhood.

\(^1\)Chi-square unconditional model: \(\chi^2(144) = 1252.94, p = .001\); \(^2\)Centred around the group mean; \(^3\)Centred around the grand mean.

\(* p < .05, ** p < .01, *** p < .001\)
### TABLE 12
*Sixth Grade Reading: HLM Models of Level 1 (individual) and Level 2 (Community EDI) influence*

<table>
<thead>
<tr>
<th></th>
<th>Unconditional Model¹ (No predictors)</th>
<th>Model 1: Random Intercept Model (Level-1 predictors only)</th>
<th>Model 2: Means as Outcomes Model (Level-2 predictors only)</th>
<th>Model 3: Random Intercepts and Slopes Model (Level-1 &amp; Level-2 predictors)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept: School mean achievement</td>
<td>555.8***</td>
<td>514.9***</td>
<td>555.4***</td>
<td>514.8***</td>
</tr>
<tr>
<td>Age²</td>
<td>-1.1</td>
<td>-1.1</td>
<td>-1.1</td>
<td>-1.2</td>
</tr>
<tr>
<td>Gender (female/male)</td>
<td>-7.0*</td>
<td>-7.0*</td>
<td>-7.0*</td>
<td></td>
</tr>
<tr>
<td>Mother’s Education</td>
<td>16.3***</td>
<td>15.9***</td>
<td>15.3***</td>
<td></td>
</tr>
<tr>
<td>Home Flooring</td>
<td>11.1***</td>
<td>10.7***</td>
<td>10.7***</td>
<td></td>
</tr>
<tr>
<td>Number of Books at Home</td>
<td>15.5***</td>
<td>15.3***</td>
<td>15.3***</td>
<td></td>
</tr>
<tr>
<td>Attended Preschool (at least 2 years)</td>
<td>13.5***</td>
<td>13.3***</td>
<td>13.3***</td>
<td></td>
</tr>
<tr>
<td>If you were told you have to change schools...</td>
<td>27.7***</td>
<td>27.7***</td>
<td>27.7***</td>
<td></td>
</tr>
<tr>
<td><strong>Level 2 (EDI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-EDI administration³</td>
<td></td>
<td>40.6</td>
<td>26.0</td>
<td></td>
</tr>
<tr>
<td>EDI Vulnerability (two or more domains on the EDI)³</td>
<td>-103.5</td>
<td>-64.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance between schools (level-1)</td>
<td>1526.1</td>
<td>764.3</td>
<td>1404.6</td>
<td>722.6</td>
</tr>
<tr>
<td>Variance within schools (level-1)</td>
<td>7211.0</td>
<td>6918.9</td>
<td>7215.3</td>
<td>6922.4</td>
</tr>
<tr>
<td>ICC: % of variance - between schools</td>
<td>17.5%</td>
<td>9.9%</td>
<td>16.3%</td>
<td>9.5%</td>
</tr>
<tr>
<td>ICC: % of variance - within schools</td>
<td>82.5%</td>
<td>90.1%</td>
<td>83.7%</td>
<td>90.5%</td>
</tr>
<tr>
<td>Between school variance reduction (proportion) (Eq. E1, E2a-E4a)</td>
<td>-----</td>
<td>49.9%</td>
<td>8.0%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Within school variance reduction (proportion)(Eq. E2b)</td>
<td>-----</td>
<td>4.0%</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

Note: The Fixed Effect regression coefficients show academic achievement differences between the Good/Poor Environment conditions; these values are expressed in academic achievement units. For the EDI, they represent scale point differences between the condition of no vulnerability (0%; no children vulnerable) to vulnerability (100%; all children are vulnerable in two or more domains) in a given school neighbourhood.

¹Chi-square unconditional model: χ²(144) = 1131.31, p=.001; ²Centred around the group mean; ³Centred around the grand mean
*p < .05, **p < .01, ***p < .001*
Note: The Fixed Effect regression coefficients show academic achievement differences between the Good/Poor Environment conditions; these values are expressed in academic achievement units. For the EDI, they represent scale point differences between the condition of no vulnerability (0%; no children vulnerable) to vulnerability (100%; all children are vulnerable in two or more domains) in a given school neighbourhood.

<table>
<thead>
<tr>
<th></th>
<th>Unconditional Model(^1)</th>
<th>Model 1: Random Intercept Model (Level-1 predictors only)</th>
<th>Model 2: Means as Outcomes Model (Level-2 predictors only)</th>
<th>Model 3: Random Intercepts and Slopes Model (Level-1 &amp; Level-2 predictors)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept: Mean school achievement</td>
<td>528.0***</td>
<td>417.0***</td>
<td>527.5***</td>
<td>419.0***</td>
</tr>
<tr>
<td>Age student(^2)</td>
<td>-0.6**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender student (female/male)</td>
<td>9.1***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s Education</td>
<td>18.0***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Flooring</td>
<td>9.8**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Assets</td>
<td>12.6***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Books at Home</td>
<td>19.3***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attended Preschool (at least 2 years)</td>
<td>8.6**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Level-1 (SERCE)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-EDI administration(^3)</td>
<td></td>
<td></td>
<td>58.9</td>
<td>64.6***</td>
</tr>
<tr>
<td>EDI Vulnerability (two or more domains on the EDI)(^3)</td>
<td></td>
<td>-204.0***</td>
<td>-126.6**</td>
<td></td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance between schools (level-1)</td>
<td>1930.3</td>
<td>915.2</td>
<td>1592.5</td>
<td>758.0</td>
</tr>
<tr>
<td>Variance within schools (level-1)</td>
<td>6976.7</td>
<td>6844.1</td>
<td>6978.7</td>
<td>6842.3</td>
</tr>
<tr>
<td>ICC: % of variance - between schools</td>
<td>21.7%</td>
<td>11.8%</td>
<td>18.6%</td>
<td>10.0%</td>
</tr>
<tr>
<td>ICC: % of variance - within schools</td>
<td>78.3%</td>
<td>88.2%</td>
<td>81.4%</td>
<td>90.0%</td>
</tr>
<tr>
<td>Between school variance reduction (proportion) (Eq. E1, E2a-E4a)</td>
<td>-----</td>
<td>52.6%</td>
<td>17.5%</td>
<td>17.2%</td>
</tr>
<tr>
<td>Within school variance reduction (proportion)(Eq. E2b)</td>
<td>-----</td>
<td>1.9%</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

Note: The Fixed Effect regression coefficients show academic achievement differences between the Good/Poor Environment conditions; these values are expressed in academic achievement units. For the EDI, they represent scale point differences between the condition of no vulnerability (0%; no children vulnerable) to vulnerability (100%; all children are vulnerable in two or more domains) in a given school neighbourhood.

\(^1\)Chi-square unconditional model: \(\chi^2(144) = 1425.51, p=.001\)

\(^2\)Centred around the group mean

\(^3\)Centred around the grand mean

\(* p < .05, ** p < .01, *** p < .001\)
### TABLE 14

*Sixth Grade Mathematics: HLM Models of Level 1 (individual) and Level 2 (Community EDI) influence*

<table>
<thead>
<tr>
<th></th>
<th>Unconditional Model (^1) (No predictors)</th>
<th>Model 1: Random Intercept Model (Level-1 predictors only)</th>
<th>Model 2: Means as Outcomes Model (Level-2 predictors only)</th>
<th>Model 3: Random Intercepts and Slopes Model (Level-1 &amp; Level-2 predictors)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept: Mean school achievement</td>
<td>539.7***</td>
<td>441.8***</td>
<td>539.3***</td>
<td>459.6***</td>
</tr>
<tr>
<td>Age student(^2)</td>
<td></td>
<td>-1.0***</td>
<td>-1.0***</td>
<td>0.45</td>
</tr>
<tr>
<td>Gender student (female/male)</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s Education</td>
<td>19.2***</td>
<td></td>
<td></td>
<td>19.4***</td>
</tr>
<tr>
<td>Home Assets</td>
<td>13.2***</td>
<td></td>
<td></td>
<td>13.5***</td>
</tr>
<tr>
<td>Number of Books at Home</td>
<td>23.4***</td>
<td></td>
<td></td>
<td>23.3***</td>
</tr>
<tr>
<td>Age-EDI administration(^3)</td>
<td></td>
<td></td>
<td>55.4*</td>
<td>59.6**</td>
</tr>
<tr>
<td>EDI Vulnerability</td>
<td></td>
<td></td>
<td>-172.3**</td>
<td>-80.5</td>
</tr>
<tr>
<td>(two or more domains on the EDI)(^3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance between schools (level-1)</td>
<td>1942.2</td>
<td>1116.7</td>
<td>1709.05</td>
<td>1047.7</td>
</tr>
<tr>
<td>Variance within schools (level-1)</td>
<td>7469.05</td>
<td>7322.7</td>
<td>7469.2</td>
<td>7306.8</td>
</tr>
<tr>
<td>ICC: % of variance - between schools</td>
<td>20.6%</td>
<td>13.2%</td>
<td>18.6%</td>
<td>12.5%</td>
</tr>
<tr>
<td>ICC: % of variance - within schools</td>
<td>79.4%</td>
<td>86.8%</td>
<td>81.4%</td>
<td>87.5%</td>
</tr>
<tr>
<td>Between school variance reduction (proportion) (Eq. E1, E2a-E4a)</td>
<td>-----</td>
<td>42.5%</td>
<td>12.0%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Within school variance reduction (proportion)(Eq. E2b)</td>
<td>-----</td>
<td>2.0%</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

Note: The Fixed Effect regression coefficients show academic achievement differences between the Good/Poor Environment conditions; these values are expressed in academic achievement units. For the EDI, they represent scale point differences between the condition of no vulnerability (0%; no children vulnerable) to vulnerability (100%; all children are vulnerable in two or more domains) in a given school neighbourhood.

\(^1\)Chi-square unconditional model: \(\chi^2(144) = 1403.94, p = .001\)

\(^2\)Centred around the group mean

\(^3\)Centred around the grand mean

\(* p < .05, ** p < .01, *** p < .001\)
Proportion of Variance Explained by Level-1 and Level-2 Predictors

Below, Table 15 compiles the proportion of between-school variance explained by SERCE and EDI predictors. These calculations derive from equations $E(6)$ and $E(7)$, in which all $r^2$ values refer to the same unconditional model (no predictors). As seen, the proportion of between school variance explained by SERCE predictors ranged from 34.1 to 44.6, while the proportion of between school variance explained by EDI predictors ranged from 2.7% to 8.1%.

<table>
<thead>
<tr>
<th></th>
<th>SERCE</th>
<th>EDI vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third grade reading</td>
<td>39.0%</td>
<td>7.0%</td>
</tr>
<tr>
<td>Third grade mathematics</td>
<td>44.6%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Sixth grade reading</td>
<td>43.2%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Sixth grade mathematics</td>
<td>34.1%</td>
<td>3.6%</td>
</tr>
</tbody>
</table>

Equations $E(5)$ - $E(7)$ were used to calculate these variances. These variances correspond to the effects individually accounted by SERCE and EDI vulnerability.
CHAPTER 5: DISCUSSION

Background

This study tests the hypothesis that the proportion of EDI vulnerability scores across school neighbourhoods adds to the prediction of the individual child’s SERCE academic achievement scores beyond that of the SERCE predictors alone. Outcomes from the HLM models support the hypothesis that EDI scores (as a proxy for the Total Environment Effect, or TEE) reduce a small but significant proportion of variation in between school academic achievement for third grade reading. The result for sixth grade reading, was also significant, but is ‘less clear’ because the control variable age-EDI administration was also statistically significant in Model 3, perhaps because of the association between EDI vulnerability and age-EDI administration. This outcome suggests that age-EDI administration may have mediated the effect of the independent variable on the dependent variable. The results for third and sixth grade reading are partially consistent with evidence that has found an association between academic achievement and the demography of both the school (Caldas & Bankston, 1999; Kohen et al., 2009; UNESCO-LLECE, 2010) and the neighbourhood (Kohen et al., 2009; Lloyd, Li, & Hertzman, 2009). More specifically, the results are consistent with studies that have found that EDI vulnerability scores on groups of children upon entry to kindergarten predict language trends in elementary school (D’Angiulli et al., 2009). Besides these findings, two contributions of this study come from the conceptualization of the TEE as a SDH; and from the use of a cross sectional instead of a longitudinal approach. This latter contribution seems to make the TEE more closely related to neighbourhood effects than to individual level influences, and therefore likely makes for a stronger test of neighbourhood influences. The cross-sectional analysis means that different individuals contributed scores to the measured outcomes and to the measured
neighbourhood aggregate scores. This independence between aggregate scores and individual outcomes may make for a stronger test of neighbourhood influences. A question that will be answered later in this chapter is why the predictor EDI vulnerability was not significant in third and sixth grade mathematics.

The next section is divided into three parts. The first discusses the outcomes of the individual/family and neighbourhood effects. The second part deepens the discussion on the impact school effects have on children’s learning in Nuevo Leon. In this discussion results are compared against previous findings from relevant studies. Finally, the third part expands on the study's contributions, policy implications, strengths and limitations, and future directions.

**Individual/family and neighbourhood effects**

**Individual/family effects at level-1**

*Age.* Age was found to be negatively associated with sixth grade reading and sixth grade math\(^{28}\). This outcome is contrary to findings from PISA 2000, in which older age was positively associated with higher literacy skills (Siddiqi et al. 2012). In the present study, this negative association may have resulted from the high retention rate of approximately 12.2% among sixth graders in the Nuevo Leon SERCE sample (SERCE/LLECE, 2010). The percentage of third grade repeaters was not examined due to the large proportion of missing data. In SERCE, repeaters in Nuevo Leon scored about 0.5 standard deviations below the state mean in academic achievement. It is possible that the large proportion of children who repeated sixth grade lowered the average academic achievement scores in this grade level.

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\(^{28}\) SERCE did not report effects associated to age.
**Gender.** Gender was significantly associated with higher third grade mathematics scores for boys and higher sixth grade reading scores for girls. These outcomes are partially consistent with those from PERCE (Willms & Somers, 2001), in which third and fourth grade girls outperformed boys of their grade level in language, while the boys outperformed girls in mathematics. They are also consistent with SERCE, in which girls performed better than boys in third grade reading, while boys outperformed girls in third grade mathematics; and PISA 2012, which found that 15-year-old female students outperformed their male counterparts in reading literacy, whereas the boys outperformed the girls in mathematics (OECD, 2014). Taken together, this evidence suggests that the gender differences found in other studies were also found in the Nuevo Leon sample.

**Mother’s education.** Children whose mothers completed secondary education or more (Good Environment condition) were more competent in reading and mathematics than children whose mothers completed primary school or less (Poor Environment condition). This findings are in agreement with those from the PERCE (Willms & Somers, 2001) and PISA (Chiu, 2010) initiatives. In SERCE parental education, home flooring, home assets, and number of books in the home were used as part of a Socioeconomic and Cultural Status index (SCS); results from this index showed a strong association between school achievement and SCS, a finding that is consistent with the present study’s outcomes related to mother’s education, home flooring, and home assets.

**Home flooring.** Home flooring was significant in third grade reading, third grade mathematics, and sixth grade reading. The Good Environment condition (home floor made up of polished wood, ceramic, or parquet) was associated with higher academic achievement scores than the Poor Environment condition (home floor made up of earth or unpolished wood). This
was an expected association given that home flooring is a marker of economic advantage/disadvantage closely related to increased illness and malnutrition (Bradley & Putnick, 2012).

**Home assets.** This predictor which is also a SES marker was significant in sixth grade reading and sixth grade mathematics. Results indicate that children living in a Good Environment condition (presence of nine assets or more in the household) outperformed their counterparts living in a Poor Environment condition (presence of eight assets or less in the household) (see Appendix H for the list of assets that define the predictor).

**Number of books in the home.** The number of books in the home was statistically significant in all grade levels and subjects. Students from homes having 10 or more books in the household (Good Environment condition) outperformed those in households having nine books or fewer (Poor Environment condition). In SERCE, *number of books in the home* was used as part of the SCS Index, which makes the present findings consistent with SERCE.

**Attended preschool for at least two years (between ages 4 to 6; yes/no).** In the present study, children who attended preschool at 4 to 6 years of age (Good Environment condition) obtained higher academic achievement scores than those who attended preschool for one year or less at these ages (Poor Environment condition). In the sample: 51% of the children attended preschool for two years or more, 35% attended preschool for one year or less, and 13% had no preschool experience. This academic advantage was statistically significant for third grade reading and math, and for sixth grade reading. These results partially replicate those from SERCE, in which the Home Education Index was significant in all grade levels and subjects. The outcomes from the present study also align with those from other population initiatives such as
TERCE (UNESCO/LLECE, 2015) and PISA 2012 (OECD, 2013), where an association between preschool attendance and academic achievement was also observed.

*If you were told you have to change schools...* This predictor was used as a proxy for school climate and was selected for analysis for third grade only. Results showed that among third graders, those in the Good Environment condition (I would feel sad/very sad if I have to change school) obtained significantly larger scores in reading and mathematics than those in the Poor Environment condition (I would feel happy/it wouldn't matter to me to change school). The regression coefficients for this predictor were the largest among SERCE factors, which is an indication of the predictor's significant influence on academic achievement among third graders. It is possible that the *reduced influence* of the predictor among sixth graders reflects social and emotional development that reduces the effects of school climate. For example, older children may be more prepared to confront bullying and to feel more secure in navigating impersonal institutional settings, and therefore may be less affected by the school climate (Beran & Tutty, 2002). This explanation is consistent with evidence from SERCE (2010) and Gietz and McIntosh (2014) that the strength of the relationship between school climate-academic achievement slightly diminishes across elementary school. However, findings differ from SERCE (2010) and Gietz and McIntosh (2014) in that the predictor was not significant across all grade levels and subjects. The differences in the outcomes likely arise because the present study used a single predictors.

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29 The predictor did not fulfil the preselection criteria and therefore was not included in the HLM and tested in its significance. For this reason the term ‘reduced influence’ is used instead of ‘no significance’.
item to measure school climate, whereas the other studies made use of more comprehensive measures.30

In summary, the outcomes from the individual/family predictors discussed above align with those from the research literature. They suggest that family level demographic factors have similar effects in Nuevo Leon as in other Latin American jurisdictions. The minor differences found in relation to SERCE likely derived from dissimilarities in the HLM models, nesting criteria, and indexes that were used to analyze the data as well as measurement differences. For example, in SERCE’s analysis, children were nested within classrooms, which were nested within schools, which were nested within countries. Based on the evidence, several features can be underlined to describe how these predictors operate. Firstly, it is likely that factors such as mother’s education and attended preschool for at least two years affected academic achievement directly, whereas home flooring and home assets were markers of other factors associated with economic disadvantage that might affect learning. Secondly, as some of these factors are related to family SES and the home learning environment, it can be speculated that their influence was embedded in the family environments (as a compositional effect and part of the TEE) before children entered school. Finally, the above factors shaped the school demographics and the large within school effects in SCS and academic achievement that characterize Nuevo Leon.

**School neighbourhood effects**

EDI vulnerability. The present study used EDI vulnerability scores as a proxy to the TEE. The neighbourhood-level predictor proportion of children with EDI vulnerability was statistically significant in third and sixth grade reading (Model 3), favouring children in a

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30 As mentioned, SERCE made use of an index which included questions on the relationship among peers and the relationship between peers and teachers; whereas Gietz and McInstosh (2014) measured the student’s satisfaction through a 32 item questionnaire validated by the British Columbia Ministry of Education.
neighbourhood with a Good Environment condition (one vulnerability or none) over children in 
a neighbourhood with a Poor Environment condition (two vulnerabilities or more). The 
magnitude of the regression coefficients or \( spd \) (scale point differences) is lower than those 
forming the SERCE predictors. This finding is consistent with evidence that academic 
achievement scores are more strongly related to individual/family factors than to school and 
neighbourhood factors (Kohen et al., 2009; Leventhal & Brooks-Gunn, 2000).

As noted above, the effect of the EDI predictor was associated with reading but not with 
 mathematics scores. This outcome may have derived from a combination of family and 
schooling factors, in which families tend to be the main source of language skills, whereas 
schools tend to be so for the development of mathematics learning (UNESCO/LLECE, 2008). 
This result is consistent with SERCE, which showed that reading achievement is more affected 
by the Home Education Index-averaged school than by net school effects; whereas mathematics 
achievement is more affected by net school effects than by the Home Education Index-averaged 
school. This result is also consistent with evidence that family neighbourhood demographic 
factors (e.g., percentage of low-income families) exert a stronger influence on reading than on 
 mathematics achievement (Carlson & Cowen, 2015). However, it is worth noting that the 
neighbourhood measure used here (TEE) is mainly a preschool measure that reflects the quality 
of early experiences. In other words, even though school factors work at the neighbourhood 
level, quality of the school would not have much of a direct effect on school neighbourhood EDI 
vulnerability scores.

Taken together, the results replicate previous evidence on the utility of the EDI as a level- 
2 measure to predict trajectories in learning at the individual child level. For example, Lloyd & 
Hertzman (2009) linked EDI scores with school achievement (FSA) records at the aggregate
level to create a neighbourhood index capable of predicting trajectories in learning, which they termed the “Community Index of Child Development”. Additionally, Lloyd, Li, & Hertzman (2010) used a measure of concentrated neighbourhood disadvantage at kindergarten entry to predict academic achievement. Thus, findings from the present study provide further evidence that school neighbourhood influences (as measured by the EDI) can predict reading achievement in elementary school.

Age-EDI administration. This control variable was statistically significant in sixth grade reading and sixth grade mathematics. As previously discussed, an exploratory data analysis found a rather small positive association between the predictors EDI-vulnerability and age-EDI administration ($R^2 = 0.0198$). This association has also been found in other studies using the EDI (Brownell, et al., 2016). In the present study this small association may reflect effects of unmeasured variations in preschool practices across school neighbourhoods. For instance, it is possible that in some districts, preschool services were more universal and started earlier. Thus, EDI administration at a younger age would be associated with better EDI outcomes.

**Between and within school effects**

**School segregation in Nuevo Leon**

School segregation is a SDH that affects learning. Results show that the unconditional models in all grade levels and subjects revealed more within school variance (range 78.3% to 82.5%) than between school variance (range 17.5% to 21.7%). These outcomes indicate that the testing of the hypothesis points to a small yet significant amount of between school variance (about 20%). The magnitude of these variances is similar to those reported by SERCE (range between school effect: 16% to 19%). The small differences found between the two studies may be attributed to dissimilarities in the final samples. For instance, in the present study 14 schools
were excluded when merging the EDI and SERCE databases, and some schools were grouped in school neighbourhoods.

To track the source of variation between schools it is necessary to refer to the magnitude of the slopes and \( R^2 \) values reported by SERCE (Table 3). These parameters provide between school variation measures on the effect of SCS on academic achievement. They show that across the Mexican state children with similar SCS and academic achievement scores are clustered within the same schools. This clustering explains why in the SERCE study the HEI at the individual child level brought no variance reduction in between school academic achievement scores beyond the variance revealed by the unconditional model (Table 4); and why in the present study SERCE predictors in Model 1 reduced a significant proportion of between school variance (range 42.5% to 52.6%). These findings suggest that part of the between school variance found in Nuevo Leon comes from the socioeconomic background of students aggregated at the school level. This form of segregation affects the capacity of the schools to promote learning; and explains why net school effects in Nuevo Leon are relatively small and similar to those from LA/C (range 7% to 13%). This has implications for the formulation of education policy.

Based on these results, it is reasonable to speculate that individual and family factors, which contribute to variations in SCS and between school achievement, also contribute to variations in school readiness across school neighbourhoods. This notion is consistent with evidence that population gaps in academic achievement originate early in life (Merry, 2013).

**Total Environment Effect (TEE)**

The present study investigates the influence of the TEE on academic achievement. This is tested through Model-3, which examines whether the addition of the level-1 and level-2 factors
explains between school differences in academic achievement at level-1. Results show that Model-3 explained an additional 5.5% to 17.2% between-school intercept variance beyond that in the unconditional model (means as outcome model). The models with more variability explained were third grade reading (13.8%) and sixth grade reading (17.2%). These results can be interpreted as the effect on learning in individual children associated with EDI vulnerability at the school neighbourhood level. Thus, results from Model 3 indicate that the EDI explains neighbourhood influences beyond the demographics of individual children and their families. Additionally, results from Model 3 support the notion that in Nuevo Leon trajectories in reading achievement are established before children enter the school system.

The question is whether these outcomes reflect average school neighbourhood effects or, rather, whether they reflect the aggregation of individual scores which primarily only reflect family and individual effects, such as the one exerted by level-1 predictors. These two types of school influences can be explained in terms of what Willms (2006) and other researchers refer to as compositional and contextual effects. In the present study, compositional effects are the result of the aggregation of children who share similar levels of EDI vulnerability and level-1 factors; whereas contextual effects are the result of the demographic characteristics of the school neighbourhood composition and its learning influences. Thus, what the EDI measures are global school neighbourhood effects related to the preschool period, which include level-1 and level-2 influences, as well as other unmeasured effects coming from the school neighbourhood.

Net Between School Effects

Results from Model-3 refer to the proportion reduction in variance attributed to the TEE. An additional step in the analysis consisted of calculating the net effects associated with the EDI vulnerability and SERCE predictors. The net EDI vulnerability and SERCE effects are presented
in Table 15. As shown, SERCE predictors (level-1) explain between 34% and 44.6% of the between school variance in academic achievement across grade levels and subjects, while EDI vulnerability (level-2) accounts for 7% of the variation in third grade reading, 8.1% of the variation in sixth grade reading, and less than 3.6% of the variation in third and sixth grade mathematics. All these effects on academic achievement correspond to individual variations within a school neighbourhood. The results from the EDI on reading are comparable to those from SERCE (UNESCO/LLECE, 2010), in which the Home Education Index (net effect-averaged school) reduced variations in school achievement by 7% to 13%. It is worth noting that the predictor EDI vulnerability and the HEI both measured aspects related to early learning experiences and both correspond to group level influences. The results from the present study (except for mathematics) are also consistent with evidence that neighbourhood influences account for approximately 5% to 10% of the variability in child and adolescent academic outcomes (Leventhal & Brooks-Gunn, 2000). The fact that the TEE had no effect on mathematics is consistent with its conceptualization as a preschool measure not affected by school effects.

**Contributions of the Present Study**

This study makes several contributions. First, the results add to the understanding of school neighbourhood influences affecting academic achievement. In particular, the results indicating small but significant neighbourhood effects, reinforce the need to monitor and enhance neighbourhood readiness as a means to support the skills and developmental capacity needed for children to succeed in school.

A second contribution of this study is that it constitutes the first attempt to integrate EDI and SERCE administrative databases. As shown in the literature review, EDI and SERCE have
contributed separately to the understanding of individual, family and group level factors associated with academic achievement. By linking the databases, the present study offers the opportunity to examine the influence of both early childhood and school neighbourhood effects (level-2) on academic achievement. This allows examination of school learning outcomes in relation to the developmental footprint left on children by the TEE. This is the first time SERCE data have been examined this way.

A third contribution comes from the innovative way EDI scores were conceptualized. The literature review shows that the EDI is used as a population measure of community readiness (e.g., ‘ready communities’) and to monitor populations of children at school entry to predict success in elementary school (‘ready children’). The present study used EDI scores as a marker of school neighbourhood influences affecting academic achievement, thus aligning with the ‘ready communities’ notion. This approach adds to the conceptualization of EDI vulnerability scores as a SDH affecting academic achievement in individual children at the area level.

**Policy Implications**

This section does not intend to formulate specific education policy recommendations. To do so would require a deep understanding of human development programs and SDH in Nuevo Leon. Rather, it intends to articulate some general questions that can guide the discussion around potential policy implications of the findings. Three of the findings that characterize Nuevo Leon frame this discussion: the high levels of school segregation; the evidence that trajectories in reading achievement are established before school entry; and the evidence that school neighbourhood influences affect academic achievement beyond the demography of individual children and their families.
School segregation

The large within school effects found in Nuevo Leon and in LA/C (as reported by SERCE) highlight the need of putting actions into place that improve the quality of life of populations, with special attention to families and young children. Based on the results these efforts should be directed both to individuals and school neighbourhoods. These may include reducing income inequalities, ensuring appropriate housing, and universal access to quality health and education services. Efforts should also be directed to reduce the high levels of school segregation and gaps in school readiness and academic achievement.

Improving quality and equity in education is not an easy task, as it requires a long-term view and a broad perspective on human development policy. Indeed, most factors of socio-economic disadvantage that were used as level-1 predictors do not fall under the umbrella of education policy. Nevertheless, schools can play a fundamental role in society in promoting learning and social equity and in creating a culture oriented towards diversity and social integration. For example, school boards can direct the allocation of extra resources to populations of children and families who need extra support. These resources may include school breakfast, extra curricular activities, parent workshops, and visiting by itinerant human development specialists including speech pathologists, community development workers, and other professionals. Some questions schools and school systems can ask regarding their vision, mission, and practices are: What can they do to moderate the impact of SCS gradients on school achievement? Can resources be assigned differentially to schools and programs as a means of providing students with appropriate educational opportunities? Are stakeholders aware of and knowledgeable about the influence of school and neighbourhood compositional and contextual
effects on learning? Are stakeholders aware of and are they knowledgeable about the effects of school segregation on school readiness and academic achievement?

**Trajectories in early childhood development**

Improving quality and equity in education also requires safeguarding the healthy development of young children and pregnant mothers. Evidence from the present study speaks to the need for programs to reduce gaps in school readiness, and additionally, of the need to track and monitor child development at the neighbourhood level. In endeavouring to meet this goal, the following questions should be addressed: What policies are needed to enable parents to provide better care for their children? Should services be for all children or for targeted populations? How effective are early childhood development programs in promoting school readiness? How equitable is the quality of preschool education across school neighbourhoods? How feasible is it to create a neighbourhood atlas of early child development in jurisdictions like Nuevo Leon?  

**School neighbourhood influences**

Finally, enhancing quality and equity in education also requires improving neighbourhood readiness. This endeavour may represent a complex task, particularly in socioeconomically disadvantaged communities. Besides advocating for changes in social policies and services, the question is what can families and communities do to support their children’s healthy development. Collecting EDI data can be a useful first step towards community mobilization, as it creates awareness on readiness and provides a community measure related to success in school. EDI outcomes have been used (along with other information) to develop comprehensive plans for young children (Janus et al., 2007; Janus,

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31 The British Columbia Atlas for Early Child Development (Kershaw, et al., 2005) can be used as a reference.
2013). Initiatives like this have been conducted in Ontario, British Columbia, and Manitoba. Programs to enhance readiness can target the transformation of the community’s social and organizational environment. This includes improving the neighbourhood’s social capital (e.g., networks, norms, cooperation values), and connecting families and child development services in a bi-directional way. Some questions that can guide the discussion are: How can we build society and neighbourhood readiness? How can we enhance parental participation and involvement in school related activities? How can we integrate child development services? How can we improve school climate? How can we improve social ties/interaction to favour child development?

**Strengths and Limitations**

This study has several strengths and limitations. The HLM methodology used to examine school neighbourhood influences constitutes a first strength. This statistical approach accounted for the possible interdependence of preschool and school children at the school level. The children whose records were collected through the EDI and SERCE studies cannot be considered independent from one another because they shared common experiences related to the location of the preschools/schools.

A second strength of this study comes from its large sample size and representativeness of the outcomes (school readiness and academic achievement) across Nuevo Leon, Mexico. This is important, as results provide information that can be used at different context levels in the Mexican state to investigate variations in school neighbourhood influences affecting academic achievement in individual children.
A third strength comes from the systematic cleaning and completion of information in the databases. Given the large size of the data and the magnitude of the cleaning process, the possibility of making errors was always present (e.g., assigning a preschool with a wrong postal code). This possibility was minimized by double-checking the changes that were made and by using different sources to verify the preschools' postal codes, names, and addresses (see Appendix I). This endeavour ensured the validity of the data.

The findings must also be considered with respect to several limitations. The first pertains to the fact that EDI scores are only examined as total vulnerability scores and not in relation to the developmental domains comprising the instrument. This limited the capacity of the study to examine how each particular domain contributes to academic achievement.

A second limitation lies within the HLM regression models. The models did not examine the between and within school effects explained separately by each level-1 predictor (e.g., percentage of variance explained by each predictor). This information may have been useful to know more about family and school effects in Nuevo Leon.

Finally, a third limitation comes from the fact that large numbers of data from SERCE's Teacher, School Principal, and School Administration Questionnaires were missing. The exclusion of these questionnaires reduced the data available for analysis, and limited the HLM methodology to a two-level model. Additionally, complementary data collected as part of the EDI administration (e.g., family SES questionnaires) were not part of the analysis due to inconsistencies in the way the information was recorded and a lack of agreement with IEEPE regarding their use. The impossibility of using complementary EDI data deprived the study of predictors that, according to evidence, account for population level differences in school readiness (Janus & Duku, 2007; Walker, Chang, Powell, & Grantham-McGregor, 2005).
Future Directions

One future direction of this research involves replicating the study methodology of linking two or more administrative databases in other locations. It would be particularly interesting to link SERCE and TERCE (Third Regional Comparative and Explanatory Study) with MICS (Multiple Indicator Clusters Survey-UNICEF), DHS (Demographic Health Surveys - ICF/USAID), PISA, and national ECD and academic achievement databases. Depending on the databases that are linked, this enterprise could provide information on trajectories in learning and the multilevel factors affecting them at the school and neighbourhood levels.

A second future direction is to add a stronger early child development component to future UNESCO/LLECE research initiatives. This could be done by administering the EDI to preschool children attending the same schools evaluated by UNESCO/LLECE. The purpose of this study would be to provide stakeholders and policy makers with information that links school readiness and academic achievement. This enterprise is important given the evidence that children in Latin America and the Caribbean enter the school system with deficits in language and cognitive skills (Berlinski & Schady, 2015).

Finally, a third future direction pertains to the need to expand the current research on society readiness and the effect of school and neighbourhood influences on trajectories in learning, with emphasis on population studies that track individual children’s development across time at the area level. Although there is some literature addressing this theme (Lloyd & Hertzman, 2009; Lloyd, Li, & Hertzman, 2010), there is a need to know more about how neighbourhood social capital (Jones & Shen, 2014) and its demography (Kohen et al., 2009; Lapointe, 2006) affect school readiness and about how individual and family factors operate at the aggregate school level.
Summary

The current research study investigated if academic achievement in individual children among third and sixth graders can be predicted by the proportion of children with vulnerabilities in readiness for school within school neighbourhoods, beyond the effect of demographic predictors for individual children. For this purpose, two databases were linked, one featuring school readiness data (EDI vulnerability scores) and the other academic achievement data (SERCE). These data bases were matched by postal code. To support this investigation, the literature on multilevel factors affecting trajectories in learning, school readiness, and academic achievement was reviewed. Also reviewed was evidence from the EDI and SERCE literature regarding contextual/compositional effects affecting learning. A two-level Hierarchical Linear Modeling (HLM) analysis was conducted to examine the data, with SERCE individual-level achievement and SERCE individual student related predictors at level-1, and proportion of EDI school neighbourhood vulnerability as predictor at level-2. This study demonstrates that school neighbourhood influences affect academic achievement beyond the demography of individual children and their families. Additionally, it adds to the conceptualization of the EDI as a SDH and marker of school neighbourhood influences affecting academic achievement. The study outcomes speak of three lines of action to improve quality and equity in education, which are: reducing population gaps in SCS, human development, and school/social segregation; safeguarding the healthy development of young children; and enhancing neighbourhood readiness.
References


Retrieved from http://www.ohiolink.edu/etd/


10.1016/j.healthplace.2009.11.009


UNESCO/LLECE. (2008). *Student achievement in Latin America and the Caribbean: Results from the Second Regional Comparative and Explanatory Study (SERCE).* Santiago, Chile: UNESCO/OREALC.


APPENDICES
## APPENDIX A

### Review of Neighbourhood Effect, School Readiness, and Academic Achievement Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Study purpose, measures, and data source</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowen &amp; Bowen (1999)</td>
<td><em>Study purpose:</em> Investigate students’ reports of neighbourhood and school exposure to crime and violence and their effect on academic achievement. Among the experiences of crime and violence investigated were: someone the student lives with was robbed or mugged, someone broke into the student's home or the home of a neighbour, and someone tried to sell the student illegal drugs. <em>Data sources and sample:</em> Data were collected in 2006-2007 that correspond to a nationally representative sample of 2,099 middle and high school students.</td>
<td>Neighbourhood and school exposure to different forms of crime and violence explained about 17% of the variance in school trouble avoidance/discipline, 14% of the variance in attendance, and 5% of the variance in academic achievement.</td>
</tr>
<tr>
<td>Ainsworth (2002)</td>
<td><em>Study purpose:</em> Investigate the mediation of neighbourhood disadvantage effects (e.g., collective socialization, social control, social capital, limited occupational opportunity, and institutional factors) on math and reading educational outcomes in tenth graders. In addition, investigate the magnitude of this mediation on academic achievement. <em>Data sources:</em> The National Education Longitudinal Study (NELS) of 1988 matched to 1990 United States census data at the zip code level. The NELS is nationally representative of the United States. <em>Sample:</em> Approximately 25 eighth-graders each from 1,000 randomly selected middle schools. The final sample had 13,196 tenth graders.</td>
<td>The findings were the following: 1) Collective socialization variables (e.g., time spent on homework, educational expectation) are the strongest mediators of neighbourhood effect on academic achievement; and 2) the mediation of neighbourhood disadvantage effects explains about 40% of the neighbourhood effect on academic achievement.</td>
</tr>
<tr>
<td>Sampson et al. (2002)</td>
<td><em>Study purpose:</em> Investigate the salience of social-interactional and institutional mechanisms within neighbourhoods that may account for</td>
<td>Four types of neighbourhood social-interactional and institutional mechanisms were identified:</td>
</tr>
</tbody>
</table>

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32 Appendix A is ordered by the year of publication.
| Evans (2004); Evans (2006) | Study purpose: Review of the literature to explain possible effects of physical neighbourhood characteristics, and other family and school level factors on school readiness and academic achievement. The physical neighbourhood characteristics examined were: residential instability, noise, crowding, toxic exposure, quality of municipal services, retail services, recreational opportunities, natural settings, street traffic, accessibility of transportation, and the physical quality of educational and health care facilities. | Findings from the literature review indicate that: a) Children from nine to eleven years of age living in poor physical quality neighbourhoods show higher levels of psychological distress than a group of control children, independent of family SES (Homel & Burns, 1989); b) proximity to street traffic is associated with lower motor skills, diminished social networks, and limited outdoor play among 5-year-old children (Huttenmoser, 1995). |
| Woolley et al. (2012) | Study purpose: Investigate the effect of *neighbourhood bonding social capital* and physical infrastructure on school achievement. *Neighbourhood bonding social capital* was defined in terms of the level of interaction among neighbourhood residents (e.g., neighbours do favours for each other, ask each other for advice, have parties together, visit each other in their homes or on the street, spend time with neighbourhood children, and spend time with neighbourhood teens). Neighbourhood physical infrastructure was defined in terms of abandoned cars, neglected buildings, poor lighting, or trash present in the vicinity. | Results indicated that low levels of *neighbourhood bonding social capital* and low levels of community physical infrastructure predict poor school achievement. In addition, the effect of *neighbourhood bonding social capital* and physical infrastructure is stronger as children progress from grade 1 to 8, than it is in grades 9 to 12. |
Data sources: 1) information from the 2000 U.S. census from a Midwest city; 2) a community phone survey that asked questions related to bonding social capital and physical infrastructure; and 3) a citywide reading and math achievement database (grades 1 to 8). The academic achievement scores were measured with the MAT Reading Grade Equivalence and the MAT Mathematics Grade Equivalence (MAT stands for Metropolitan Achievement Test).

Sample: 2,067 respondents that came from 221 block groups and 40 census track areas.

<table>
<thead>
<tr>
<th>Study purpose: Investigate the effect of neighbourhood social capital (e.g., networks, norms, values, and understandings that facilitate cooperation between and within groups) and self-efficacy (e.g., the level to which collective goals are achieved) on preschool children's vocabulary skills.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data sources: a) Neighbourhood information from Census Canada including: residents' perceptions on their neighbourhood social capital and self-efficacy; and b) the National Longitudinal Survey of Children and Youth (NLSCY) in Canada (Subset Cycle 3 - Early Child Development Cohort). Children in the NLSCY study were evaluated with the Peabody Picture Vocabulary Test (PPVT-R/EVIP).</td>
</tr>
<tr>
<td>Sample: 3,923 birth to one-year-old children, who were followed up to age 4-5.</td>
</tr>
</tbody>
</table>

1) Children from neighbourhoods with higher levels of social capital scored higher on receptive vocabulary skills, even after controlling for neighbourhood economic disadvantages.
2) Children from neighbourhoods with higher levels of collective efficacy obtained higher receptive vocabulary scores, even after controlling for child and family level variables.

Jones & Shen (2014)

Study purpose: Investigate whether perceived social networks in the neighbourhood are related to kindergarten children’s expressive vocabulary skills via the home literacy environment (e.g., number of children’s books in the household).

The parents’ perceived neighbourhood social networks is positively associated with home literacy, which in turn is positively related to children’s vocabulary skills. This result addresses the need to strengthen social support networks as a
**Sample:** Participants of a Head Start centre located in a Midwestern city in the United States. A total of 89 parents and their children participated in the study.

**Measures:** a) Children's vocabulary skills were evaluated with the Picture Vocabulary from the Third Edition of the Woodcock Johnson Tests of Achievement (WJ-III); b) families' home literacy environment was assessed with the Stony Brook Family Reading Survey (Bracken & Fischel, 2008); and c) the families' perceived social relationships were measured with the Local Social Networks (LSN) subscale from the Neighborhood Characteristics Questionnaire (Barnes, 1997).

means to improve children's vocabulary skills via the home literacy environment.
## APPENDIX B

### Review of EDI Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose / data source</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janus &amp; Duku (2007)</td>
<td>Understanding the Early Years Project: Investigating social risk factors</td>
<td>Results found a school readiness entry gap among the general population. All five social risk factors that were examined, in addition to age and gender, contributed to this gap.</td>
</tr>
<tr>
<td></td>
<td>Study purpose: Analyze the social risk factors that contribute to the population gap in children’s school readiness in Canada. The social risk factors studied were: SES, family status, child health, parent health, and parent involvement in literacy support.</td>
<td>Child’s suboptimal health, coming from a family with low income, and male gender contributed most strongly to EDI vulnerabilities at school entry.</td>
</tr>
<tr>
<td></td>
<td>Data source: Community Component of the National Longitudinal Survey of Children and Youth (NLSCY) (Statistics Canada, 1999). The sample consisted in 2,196 children from 5 communities across Canada located in British Columbia, Saskatchewan, Manitoba, Newfoundland and Labrador, Prince Edward Island, and Ontario. The sample was not intended to be nationally representative but represents communities across Canada.</td>
<td></td>
</tr>
<tr>
<td>Kohen et al. (2009)</td>
<td>Understanding the Early Years Project: Multilevel effects on school readiness</td>
<td>Neighbourhood disadvantage effects: a) A higher proportion of adults with incomplete secondary education, and a higher proportion of immigrants in the neighbourhood were both associated with lower PPVT-R scores; b) a higher proportion of youth unemployment, and a higher proportion of Aboriginal residents in the neighbourhood were both associated with lower scores on the</td>
</tr>
</tbody>
</table>
**Measures:** Among others a) the Peabody Picture Vocabulary Test-Revised (PPVT-R) and b) the Social Knowledge and Competence, Emotional Maturity, and Language and Cognitive Development domains of the EDI.

**Data sources:** a) Neighbourhood disadvantage characteristics obtained from the 2001 Census Canada; and b) results from the Understanding the Early Years Initiative (PPVT-R and EDI scores). These data were collected in six provinces across Canada, and consisted of a total of 2,743 children, attending 181 kindergarten classes, and living in 272 different neighbourhoods.

**Method:** A cross-classified HLM analysis that allowed to jointly estimate the between individuals-families /schools / neighbourhood variations in school readiness.

<table>
<thead>
<tr>
<th>D'Angiulli et al. (2009)</th>
<th>Population-level associations between preschool vulnerability and grade-four basic skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study purpose:</strong> Analyze if EDI vulnerability scores on groups of children upon entry to kindergarten predicts their later failure to meet expectations on the British Columbia Ministry of Education's Foundation Skills Assessment (FSA). The FASA measures numeracy, reading, comprehension, and writing skills in elementary school.</td>
<td></td>
</tr>
<tr>
<td><strong>Data sources:</strong> The EDI and the grade 4 FSA population-databases, linked at the level of the individual child. These data came from 4 school districts in British Columbia, and can be considered representative of the population of children in the province. Vulnerability in the FSA was defined as either the numeracy or reading comprehension subtest falling below provincial expectations.</td>
<td></td>
</tr>
</tbody>
</table>

| Language and Cognitive Development domain of the EDI. Neighbourhoods explained up to 5% of the variability in preschool children's outcomes. |
|--------------------------|---------------------------------------------------------------------------------------|
| **Demography of the school:** A higher proportion of non-native English speaker students within the school was associated with lower scores on the PPVT-R and the three domains of the EDI. Schools accounted from 3 to 17% of the preschool children's outcomes. |

<p>| 1) Language and cognitive vulnerability on the EDI yielded the strongest association with FSA scores; 2) children with vulnerabilities on the EDI are approximately 2 to 4 times more likely to score below expectations in the FSA; and 3) the cumulative percentage of children not meeting expectations on the FSA increases linearly with the number of EDI vulnerabilities. |</p>
<table>
<thead>
<tr>
<th>Study Title</th>
<th>Study purpose</th>
<th>Data sources</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing a Community Index of Child Development (CICD)</td>
<td><em>Study purpose:</em> Investigate population level variations in learning trajectories from kindergarten to grade 4.</td>
<td><em>Data sources:</em> The EDI and the grade 4 FSA population-databases, in addition to Census Canada data from the years 2001 and 2006, linked at the level of the individual child. The EDI data were collected in 1999/2000. These data came from 63 neighbourhoods nested within 4 school districts in British Columbia, and can be considered representative of the population of children in the province. A Community Index of Child Development (CICD) was created at the aggregate level by linking EDI and FSA data. The purpose of the CICD is to monitor trajectories in learning. This index depicts the ratio of positive to negative EDI-to-FSA pathways/deflections in a given aggregate unit (neighbourhood).</td>
<td>1) A wide variation in CICD scores across the children's districts of residence in kindergarten, and 2) contrasting patterns of CICD neighbourhood convergence (e.g., children from high vulnerability neighbourhoods catch up with children from low vulnerability neighbourhoods, from kindergarten to grade 4). An ecological correlation between a neighbourhood SES indicator (% of adults without high school graduation) and the neighbourhoods' CICD score was calculated in order to confirm the orientation and magnitude of the association. This correlation was found to be strong and negative, which suggests that the index takes into account neighbourhood SES variations.</td>
</tr>
<tr>
<td>Examining Early Childhood Neighbourhood Disadvantage Effects on Academic Achievement</td>
<td><em>Study purpose:</em> Investigate the long-term effects that neighbourhood conditions of disadvantage at kindergarten entry have on the later language and mathematics achievement in grade 7. This study used gender, EDI scores, and sociodemographic factors (Aboriginal/Indigenous, English as a Second Language status) as covariates.</td>
<td><em>Data sources:</em> The EDI and the grade 7 FSA population-databases, in addition to Census Canada data from the years 2001 and 2006, linked at the level of the individual child. The EDI data were collected in 1999/2000, and the FSA data 7 years</td>
<td>Higher concentrations of neighbourhood disadvantage in kindergarten children predicted in grade 7: a) lower reading comprehension outcomes, even after controlling for the child level covariates (e.g., EDI scores) and children's residential mobility</td>
</tr>
</tbody>
</table>
later, when children were in grade 7. The EDI and FSA data came from 2 school districts in British Columbia. The total sample consisted in 2,648 urban children, and it cannot be considered representative of the population of children in the province.

**Methodology:** Two neighbourhood disadvantage indexes were created, one for preschoolers, and another for grade 7 students. These indexes were computed utilizing the following census variables: Low income rate, male unemployment rate, % lone parent families, male unemployment rate, % not graduating from high school, % of families receiving social assistance, and % of parents with less than grade 9 education (this last variable was not included in the grade seven index).

In addition, the study found that Grade 7 concentrated neighbourhood disadvantage did not independently predict reading and comprehension scores.

### Janus (2011)
**Application of the EDI in Nuevo Leon, Mexico**

**Study purpose:** Analyzed the social risk factors that contribute to the school readiness gap in Monterrey, Mexico. The social risk factors studied were: SES, family status, and child's gender.

**Data source:** 1,672 Mexican children (5-years-old) who participated in a high-quality government funded kindergarten program called Centro de Desarrollo Infantil (CENDI), located in the city of Monterrey, Nuevo Leon. The sample can be considered representative of a government funded program.

SES (mother's maternal education), family status (lack of mother's married status), and child's male gender proved to have meaningful associations with children's kindergarten outcomes. A child with a mother with low education was 1.7 times more likely to score low on the EDI.

### Brinkman et al. (2013)
**NAPLAN longitudinal study (National Assessment Program in Literacy and Numeracy) (Australia)**

**Study purpose:** Analyze if AEDI (Australian adaptation of the Canadian EDI) vulnerability scores on groups of children at kindergarten entry predict a failure to meet expectations on the NAPLAN on reading and numeracy assessment in grades 3, 5, and 7.

1) The AEDI is strongly associated with NAPLAN numeracy and literacy assessment in grades 3, 5, and 7; 2) a child who is vulnerable on one domain of the AEDI is 2.3 times more likely to be in the bottom 20% of the NAPLAN assessment than a child who is not vulnerable on the AEDI; and 3) the association between the...
**Data sources:** The AEDI and the NAPLAN grades 3, 5, and 7 population-based databases, linked at the level of the individual child. Data were successfully linked for 1,823 children. The final sample had an under representation of Aboriginal and Torres Strait Islander children, and children from the wealthiest and poorest suburbs; therefore, the sample can be considered representative of middle class Australia. Vulnerability in the FSA was defined as performance below the 20% provincial expectations.

AEDI and NAPLAN scores is equally as strong across grades 3, 5, and 7.
Score ranges that define Levels 1 to 4 of academic achievement in Latin America and the Caribbean -SERCE (UNESCO/LLECE) study

<table>
<thead>
<tr>
<th></th>
<th>Reading</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3rd Grade</td>
<td>6th Grade</td>
</tr>
<tr>
<td>Below Level 1</td>
<td>&lt; 367.4</td>
<td>&lt; 299.6</td>
</tr>
<tr>
<td>Level 1</td>
<td>367.4-461.3</td>
<td>299.6-424.5</td>
</tr>
<tr>
<td>Level 2</td>
<td>461.3-552.1</td>
<td>424.5-513.7</td>
</tr>
<tr>
<td>Level 3</td>
<td>552.1-637.5</td>
<td>513.7-593.6</td>
</tr>
<tr>
<td>Level 4</td>
<td>&gt; 637.5</td>
<td>&gt; 593.6</td>
</tr>
</tbody>
</table>

## APPENDIX D

Scale Point Differences in Academic Achievement Scores in Nuevo Leon and LA/C

<table>
<thead>
<tr>
<th>SERCE¹</th>
<th>Third Grade Reading</th>
<th>Sixth Grade Reading</th>
<th>Third Grade Math</th>
<th>Sixth Grade Math</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LA/C</td>
<td>Nuevo Leon</td>
<td>LA/C</td>
<td>Nuevo Leon</td>
</tr>
<tr>
<td>School level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural school</td>
<td>3.83</td>
<td><strong>-12.77</strong></td>
<td>-0.42</td>
<td>-6.23</td>
</tr>
<tr>
<td>Public urban school</td>
<td>-1.46</td>
<td><strong>+15.43</strong></td>
<td>-0.84</td>
<td>+25.60</td>
</tr>
<tr>
<td>Computers available for 3rd /6th grade students</td>
<td><strong>+0.81</strong></td>
<td>+0.74</td>
<td>+0.45</td>
<td></td>
</tr>
<tr>
<td>School infrastructure</td>
<td><strong>+1.12</strong></td>
<td>+2.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School basic services</td>
<td>+8.78</td>
<td>+11.57</td>
<td>+9.42</td>
<td>+6.94</td>
</tr>
<tr>
<td>School climate</td>
<td>+36.6</td>
<td>+22.02</td>
<td>+13.41</td>
<td>+47.74</td>
</tr>
<tr>
<td>Teacher has another job outside the school</td>
<td>-11.12</td>
<td>+0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Education Index (average school)</td>
<td><strong>+23.46</strong></td>
<td>+34.81</td>
<td>+23.06</td>
<td>+31.41</td>
</tr>
</tbody>
</table>

| Student level |       |                 |       |                 |       |                 |       |                 |
| Girl | +4.92 | +6.79 | +3.60 | -7.09 | -8.92 | -9.54 |       |       |
| Aboriginal | -13.07 | -40.38 | -14.20 | -60.03 | -7.67 | -27.32 | -5.97 | -47.31 |
| Student's grade retention | -24.31 | -43.50 | -27.13 | -48.39 | -22.30 | -46.50 | -24.84 | -54.06 |
| Preschool attendance | +2.87 | +6.23 | +3.55 | +7.43 | +2.40 | +6.73 | +2.94 | +5.90 |
| School climate perceived by students | +9.83 | +10.10 | +5.18 | +9.82 | +9.98 | +9.38 | +5.07 | +6.18 |
| Home Education Index | **+11.89** | +14.17 | +10.78 | +14.11 | +10.04 | +15.10 | +9.13 | +14.51 |
| Intercept | **460.60** | 545.61 | 432.52 | 484.78 | 511.08 | 526.50 | 456.87 | 487.82 |

¹ Compiled from UNESCO/LLECE (2010). Appendix D shows SERCE's associated factors scale point differences in reading and math scores. These results come from the final regression model, adjusted for the Home Education Index (HEI) at the school level. Differences that are statistically significant at the \(p<.05\) level are shown in bold. SERCE had a mean of 500 and a standard deviation of 100.
APPENDIX E

Memorandum of Understanding to Analyze EDI Nuevo Leon Data

This is an understanding between:

The University of Toronto, the Dr. Eric Jackman Institute of Child Study (JICS)

and

McMaster University, Offord Centre for Child Studies (OCCS)

and

IIIEPE (Instituto de Investigación, Innovación, y Estudios de Postgrado para la Educación del Estado de Nuevo León)

This Memorandum of Understanding (MOU) concerns the sharing of Early Development Instrument (EDI) data collected by the Secretaria de Educación, Nuevo León in 2008.

BACKGROUND

The Early Development Instrument (EDI)

The EDI was developed by Drs. Magdalena Janus and Dan Offord at the Offord Centre for Child Studies (OCCS). The instrument is an outcome measure of children’s early development and measures children’s readiness to learn in the school environment in relation to developmental benchmarks in five domains: physical health and well-being; social competence; emotional maturity; language and cognitive development; and communication skills and general knowledge.

The OCCS and McMaster University own all right, title and interest in the copyright and all other intellectual property rights in the EDI. The OCCS is the national repository for EDI data both nationally and internationally. All data are stored at the OCCS so that national and international norms can be monitored. All data collection using the EDI is carried out under the direction of the staff at the Centre, within precise guidelines which have been established by the authors (Offord and Janus) at the Centre.
IIEPE is legally represented by Doctor Rafael Garza Mendoza, President of the Institute, appointed by the Executive Power of the Government of the State of Nuevo Leon, Official Minute Number 159-A/2012, signed on August 8, 2012.

For the purpose of this Memorandum of Understanding, IIEPE’s legal address is located in: 20 de Noviembre s/n, between Aramberri and Tapia, Colonia Centro, Monterrey, Nuevo Leon.

The Dr. Eric Jackman Institute of Child Study (JICS)

The Dr. Eric Jackman Institute of Child Study (JICS) is a transdisciplinary unit within the education division of the University of Toronto (the Ontario Institute for Studies in Education-OISE- and its Department of Applied Psychology and Human Development). Dr. Carl Corter is a Full Professor at the JICS and OISE/University of Toronto.

Alfredo Tinajero is a doctoral student at OISE. Dr. Carl Corter is Alfredo Tinajero’s thesis supervisor.

Alfredo Tinajero will access the EDI data collected in Monterrey, State of Nuevo Léon, Mexico in 2008 in a study as part of his doctoral thesis.

IT IS AGREED BY ALL THE PARTIES THAT:
- data may not be reproduced, disclosed, modified or used for the benefit of a third party except as provided through this memorandum or written permission by any organization;
- no individual data will be reported for the purposes of identification or diagnosis;
- authorship of all publications/presentations will be based on intellectual contributions in the entire project as appropriate
- all publications/presentations will acknowledge all parties
- linkage of individual student data with other data sources must be done in a secure and confidential manner that ensures that the identities of individual respondents and children are protected;
- in all analyses using individual level data only group level results will be reported.

**TERMS OF UNDERSTANDING**
The term of this MOU is for a period of November 1, 2012 to October 31, 2013 and may be extended upon written mutual agreement.

Either organization may terminate this MOU upon thirty (30) days written notice.

**AUTHORIZATION**
The signing of this MOU is not a formal undertaking. It implies that the signatories will strive to reach, to the best of their ability, the objectives stated in the MOU.

On behalf of the organization I represent, I wish to sign this MOU and contribute to its further development.

University of Toronto, The Dr. Eric Jackman Institute of Child Study (JICS):

Name: Dr. Carl Corter  
Title: Professor  
Date: 3 January 2013

Signature: ____________________________

McMaster University, Offord Centre for Child Studies:

Name: Dr. Magdalena Janus  
Title: Associate Professor  
Date:  
Signature:  

IIIEPE (Instituto de Investigación, Innovación, y Estudios de Postgrado para la Educación del Estado de Nuevo León)

Name: Dr. Rafael Garza Mendoza  
Title: President  
Date:  
Signature: ____________________________
## APPENDIX F

**SERCE Questionnaire – Third Grade Students - Criteria for Variable Preselection**

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Answer options</th>
<th>Question Preselected?</th>
<th>Reason inclusion/exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>Numeric value</td>
<td>Yes</td>
<td>Its importance in research studies</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>a) Boy; b) Girl.</td>
<td>Yes</td>
<td>Its importance in research studies</td>
</tr>
<tr>
<td>3</td>
<td>Language spoken at home</td>
<td>a) Spanish; b) Aboriginal Language.</td>
<td>No</td>
<td>Only 1% of children spoke an aboriginal language</td>
</tr>
<tr>
<td>4</td>
<td>How often an adult in your household reads to you?</td>
<td>a) Often or very often; b) Sometimes; c) Never.</td>
<td>No</td>
<td>Responses showed an unclear pattern in the association IV/DV</td>
</tr>
<tr>
<td>5</td>
<td>Grade retention (number of times)</td>
<td>a) Never; b) 1; c) 2; d) 3; e) More than 3; f) Don't Know; g) Don't remember.</td>
<td>No</td>
<td>Missing data: 74%</td>
</tr>
<tr>
<td>6</td>
<td>Do you work?</td>
<td>a) No; b) Yes, at home; c) Yes, outside home.</td>
<td>No</td>
<td>Missing data: 68%</td>
</tr>
<tr>
<td>7</td>
<td>What kind of work do you do?</td>
<td>Qualitative</td>
<td>No</td>
<td>Qualitative variable</td>
</tr>
<tr>
<td>8</td>
<td>Are you paid for working?</td>
<td>a) Yes; b) No, but I receive goods in exchange; c) No.</td>
<td>No</td>
<td>Missing data: 68%</td>
</tr>
<tr>
<td>9</td>
<td>How do you feel in school?</td>
<td>a) Happy; b) Bored; c) Entertained; d) Nervous; e) Calm. Options: Yes / No.</td>
<td>No</td>
<td>Missing data: 33%</td>
</tr>
</tbody>
</table>
If you were told you have to change schools how would you feel?

a) Happy; b) It wouldn't matter to me; c) A little bit sad; d) Very sad.

Yes

Responses a-b (Poor Environment condition) were grouped and compared against responses c-d (Good Environment condition). Above 35 points difference in Reading/Math scores between Good/Poor Environment condition. Effect Size: $d_{\text{reading}}=.43; d_{\text{math}}=.38$.

How is your class?

a) There is bullying; b) We fight a lot; c) We are good friends; d) We have a good time completing the homework assigned by the teacher. Options: Yes / No.

No

A Good Environment condition was defined by no bullying, no fights, we are good friends, and we have a good time completing homework. Differences in academic scores between Good/Poor Environment condition were small for answer options a, b and d (range: 1-16 points); answer option b had 29% of missing data.

Do you have language textbook you use in class?

a) Yes, just for me; b) Yes, by I have to share it; c) No.

Yes

Responses b and c (Poor Environment condition) were grouped and compared against response a (Good Environment condition). Questions 12-14 were combined into an index. Cronbach's $\alpha=.807$. Effect Size: $d_{\text{reading}}=.45; d_{\text{math}}=.46$.

Do you have math textbook you use in class?

Do you have a notebook you can use in class?

Do you have a pencil you can use in class?

a) Yes, just for me; b) Yes, by I have to share it; c) No.

No
| 16 | In your class, with what frequency you....? | a) Use your textbook; b) Your teacher assigns you homework; c) Read; d) Write in the blackboard. *Options:* Everyday/almost every day; once/twice per week; less than once a week. | No | Missing data individual items: above 25% |
| 17 | In you school, with what frequency you....? | a) Have a quiz; b) Use the school computer; c) Go to the school library. *Options:* Once or twice per week; once or twice per month; every 2 to 3 months. | No | Missing data individual items: between 16%-40% |
| 18 | To do your homework at home, do you use...? | a) Dictionary; b) Encyclopedia; c) Other books; d) Calculator; e) Internet. *Options:* Yes / No. | No | Missing data individual items: above 24% |
| 19 | When needed, who helps you at home with your homework? | a) My mom; b) My dad; c) A sibling; d) Other relative; e) A private teacher; f) Other person; g) Nobody. *Options:* Yes/ No. | No | The effect for father/mother involvement on academic achievement was small (less than 6 points). |
| 20 | In your home, does anyone talk to you about school, or help you with studying or doing your homework? | a) Yes, everyday; b) Yes, several times per week; c) Yes, from time to time; d) Almost never. | No | Differences in academic scores between Good/Poor Environment conditions were about 17 points. Missing data: 25%. |

1 The right column (when applicable) shows the criteria used for the variable preselection. The preselection process took into consideration the percentage of missing data, Effect Sizes, Cronbach's Alpha values in index formation (when calculated), and the difference in academic achievement scores between Good/Poor Environment condition.
**APPENDIX G**

**SERCE Questionnaire - Sixth Grade Students - Criteria for Variable Preselection**

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Answer options</th>
<th>Question Preselected?</th>
<th>Reason inclusion/exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>Numeric value.</td>
<td>Yes</td>
<td>Its importance in research studies</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>a) Boy; b) Girl.</td>
<td>Yes</td>
<td>Its importance in research studies</td>
</tr>
<tr>
<td>3</td>
<td>Language spoken by teacher during class, most of the time?</td>
<td>a) Spanish; b) Aboriginal Language.</td>
<td>No</td>
<td>Less than 0.01% of students responded: &quot;aboriginal language most of the time&quot;.</td>
</tr>
<tr>
<td>4</td>
<td>Language spoken at home</td>
<td>a) Spanish; b) Aboriginal Language.</td>
<td>No</td>
<td>Less than 0.01% of students responded: &quot;aboriginal language most of the time&quot;.</td>
</tr>
<tr>
<td>5</td>
<td>Number of people living in your household...</td>
<td>a) Younger than 18 years of age; b) Older than 18 years of age.</td>
<td>No</td>
<td>Missing data: above 36%</td>
</tr>
<tr>
<td>6</td>
<td>Number of rooms in the house.</td>
<td>Numeric value.</td>
<td>No</td>
<td>This question was excluded because question 5 was excluded</td>
</tr>
<tr>
<td>7</td>
<td>Home flooring</td>
<td>a) Parquet; b) Ceramic; c) Polished wood; d) earth; e) Unpolished wood.</td>
<td>No</td>
<td>Predictor was taken from Parent Questionnaire</td>
</tr>
<tr>
<td>8</td>
<td>Whom do you live with?</td>
<td>a) Your mom; b) Your dad. <strong>Options:</strong> yes/no.</td>
<td>No</td>
<td>Differences in academic scores between answer options a and b: between 3-7 points</td>
</tr>
<tr>
<td>9</td>
<td>Does your mom know how to read and write?</td>
<td>a) Yes; b) No.</td>
<td>No</td>
<td>The mother's educational level is used instead. Predictor was taken from Parent Questionnaire.</td>
</tr>
<tr>
<td>10</td>
<td>Does your dad know how to read and write?</td>
<td>a) Yes; b) No.</td>
<td>No</td>
<td>The mother's educational level is used instead.</td>
</tr>
<tr>
<td>11</td>
<td>About your mother:</td>
<td>a) Attended elementary school; b) Attended high school; c) Attended university.</td>
<td>No</td>
<td>The mother's educational level is used instead.</td>
</tr>
<tr>
<td>12</td>
<td>About your father:</td>
<td>a) Attended elementary school; b) Attended high school; c) Attended university.</td>
<td>No</td>
<td>The mother's educational level is used instead.</td>
</tr>
<tr>
<td>13</td>
<td>What assets/services do you have in your household?</td>
<td>a) Electricity; b) Running Water; c) Telephone; d) TV cable; e) Computer; f) Radio; g) Freezer; h) Dishwashing machine; i) Car; j) Motorcycle. <strong>Options:</strong> yes/no.</td>
<td>No</td>
<td>Predictor was taken from Parent Questionnaire</td>
</tr>
<tr>
<td></td>
<td>Grade retention (number of times)</td>
<td>a) Never; b) 1; c) 2; d) 3; e) More than 3; f) Don't Know; g) Don't remember.</td>
<td>No</td>
<td>Unclear association between IV/DV.</td>
</tr>
<tr>
<td>---</td>
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<td>-----------------------------------------------------------------</td>
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<td>------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td>Do you work?</td>
<td>a) No; b) Yes, at home; c) Yes, outside home.</td>
<td>No</td>
<td>Missing data: 68%</td>
</tr>
<tr>
<td>15</td>
<td>What kind of work you do?</td>
<td>Qualitative answer.</td>
<td>No</td>
<td>Qualitative answer</td>
</tr>
<tr>
<td>16</td>
<td>Are you paid for working?</td>
<td>a) Yes; b) No, but I receive goods in exchange; c) No.</td>
<td>No</td>
<td>Missing data: 68%</td>
</tr>
<tr>
<td>17</td>
<td>How many days per week do you work?</td>
<td>a) 1 day per week; b) 2 days per week; c) 3 days per week; etc.</td>
<td>No</td>
<td>Missing data: 68%</td>
</tr>
<tr>
<td>18</td>
<td>How many hours per day do you work?</td>
<td>a) 1 hour; b) 2 hours; c) 3 hours; d) 4 hours or more.</td>
<td>No</td>
<td>Missing data: 68%</td>
</tr>
<tr>
<td>19</td>
<td>How do you feel in school?</td>
<td>a) Happy; b) Bored; c) Entertained; d) Nervous; e) Calm. Options: almost always; sometimes; almost never.</td>
<td>No</td>
<td>A Good Environment condition was defined by the option almost always to responses happy, not-bored, entertained, not-nervous, and calm. After a Factor Analysis, only responses c, d and e were kept (Cronbach's $\alpha=.76$). The difference in reading and math scores between the Good/Poor Environment conditions were above 27 points. Effect Size: $d_{\text{reading}}=.29$; $d_{\text{math}}=.28$. This variable was mistakenly not preselected.</td>
</tr>
<tr>
<td>20</td>
<td>If you were told you have to change schools, how would you feel?</td>
<td>a) Happy; b) It wouldn't matter to me; c) A little bit sad; d) Very sad.</td>
<td>No</td>
<td>Answers a-b and c-d were grouped into Good/Poor Environment conditions. Differences between the two environment conditions were small. Effect Size: $d_{\text{reading}}=.26$; $d_{\text{math}}=.17$.</td>
</tr>
<tr>
<td>21</td>
<td>Original question: How is your class? Final question: Do you fight a lot in class?</td>
<td>a) There is bullying; b) we fight a lot; c) We are good friends; d) We have a good time completing the homework assigned by the teacher. Options: yes/no.</td>
<td>Yes</td>
<td>A Good Environment condition was defined by answer options no bullying, no fights, good friends, and we have a good time completing homework. A Factor analysis revealed low reliability values among the items (Cronbach's $\alpha=.318$). For this reason item b (we fight a lot) was kept as a single predictor. Difference between Good/Poor Environment condition: above 45 points.</td>
</tr>
<tr>
<td>Question</td>
<td>Possible Answers</td>
<td>Response</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-----------------</td>
<td>----------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Original question: In your school...?</td>
<td>a) Pupils and teachers get along well; b) Majority of teachers are interested in the students' well-being; c) Teachers listen to us; d) Teachers help us when we need extra support; e) Majority of teachers treat us with respect. Options: yes/no.</td>
<td>No</td>
<td>The Good Environment condition was defined by option yes. A Factor Analysis revealed low reliability values (Cronbach's $\alpha=.56$). An individual analysis of the responses indicated that the differences between the Good/Poor Environment condition did not fulfill the preselection criteria ($d_{reading}=.26; d_{math}=.24$).</td>
</tr>
<tr>
<td>24</td>
<td>Happened these things in class?</td>
<td>a) Teacher has to wait a long time for children to calm down; b) Students listen to what the teacher has to say; c) There is noise and disorder in the class. Options: always or almost always; sometimes; never or almost never.</td>
<td>No</td>
<td>Responses showed an unclear association with the DV. An index was created, but differences in academic scores between the Good/Poor Environment conditions were small (10-15 points). Effect Size: $d_{reading}=.16; d_{math}=.16$.</td>
</tr>
<tr>
<td>25</td>
<td>Original question: Did anything of these happen in your school during last month? Final question: During the last week in my school, I was either robbed or physically attacked by other student.</td>
<td>a) I was robbed; b) someone in my class was robbed; c) I was verbally threatened by other student; d) Somebody in my class was verbally threatened by other student; e) Other student physically attacked me; f) Somebody in my class was physically attacked by other student. Options: yes/no.</td>
<td>No</td>
<td>A Good Environment condition was defined by option no. Responses b, c, d, and g were excluded because differences in academic scores associated with Good/Poor Environment conditions were small. Options a and e were kept and combined into an index. Difference in academic achievement scores between Good/Poor Environment conditions: about 21 points. Effect Size: $d_{reading}=.26; d_{math}=.22$.</td>
</tr>
<tr>
<td>26</td>
<td>Do you have a calculator you can use in class?</td>
<td>a) Yes, just for me; b) Yes, but I have to share it; c) No.</td>
<td>No</td>
<td>For questions 26-31: responses b and c (Poor Environment condition) were grouped and compared against response a (Good Environment condition). A Factor Analysis revealed a strong association among questions 27-31(Cronbach's $\alpha=.80$). Given that the alpha values were similar for 2, 3, 4, and 5 factors, it was decided to keep only question 31. This significantly reduced the percentage of missing data that resulted from index formation. Differences in academic scores between Good/Poor Environment conditions=40 points. Effect Size=$d_{reading}&gt;=.45; d_{math}&lt;=.40$.</td>
</tr>
<tr>
<td>27</td>
<td>Do you have a language textbook you can use in class?</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Do you have a math textbook you can use in class?</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Do you have a science textbook you can use in class?</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Do you have a notebook you can use in class?</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Do you have a pencil you can use in class?</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>How often do you do the following in your class?</td>
<td>a) Use a textbook; b) Use other books; c) Your teacher assigns you homework; d) Read; e) Write down text from the blackboard or textbook; f) Write down something from your own (e.g., poem, story); etc. Options: everyday or almost every day; once or twice per week; less than once per week.</td>
<td>No</td>
<td>All responses had an unclear association with the DV. Data seems to be invalid.</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>33A</td>
<td>In your math class...</td>
<td>a) You feel happy; b) You like doing the homework; c) You understand things easily; d) Get bored; e) You like to solve problems; f) You feel nervous. Options: almost always; sometimes; almost never.</td>
<td>Yes</td>
<td>Response c to questions 33A, 33B, and 33C were grouped into index Do you Understand Things Easily? Response f to questions 33A, 33B, and 33C were grouped into index Do you Feel Nervous? Final questions: Index: In your language and math classes, do you understand things easily (Cronbach's $\alpha=.39$; Effect Size: $d_{reading}=.33$; Effect Size $d_{math}: d&lt;=.51$). Index: In your language and math classes, do you feel nervous (Cronbach's $\alpha=.81$; Effect Size: $d_{reading}=.59$; Effect Size $d_{math}: d&lt;=.52$).</td>
</tr>
<tr>
<td>33B</td>
<td>In your language class, when you read...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33C</td>
<td>In your language class, when you write...</td>
<td>You feel nervous. Options: almost always; sometimes; almost never.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>In you school, with what frequency you....?</td>
<td>a) Have a quiz; b) Use the school computer; c) Go to the school library. Options: i. once or twice per week; ii. once or twice per month; iii. every two or three months; iv. never.</td>
<td>No</td>
<td>A Good Environment condition was defined by options i and ii. The difference between the Good/Poor Environment condition was small and effects sizes did not fulfil section criteria.</td>
</tr>
<tr>
<td>35</td>
<td>To do your homework at home, do you use...?</td>
<td>a) Dictionary; b) Encyclopedia; c) Other books; d) Calculator; e) Computer; f) Internet. Option: yes/no.</td>
<td>No</td>
<td>A Good Environment condition was defined by option yes. Differences between Good/Poor Environment condition were small for responses a, b, c, and d (about 5-10 points). Responses e and f were grouped into an index. Students that used computer and internet at home (Good Environment condition) had a 40 points academic advantage against those who did not (Poor Environment condition). This question was mistakenly not preselected.</td>
</tr>
<tr>
<td>Question</td>
<td>Description</td>
<td>Options</td>
<td>Answer</td>
<td>Notes</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>---------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>36</td>
<td>What did you read during this past month?</td>
<td>a) A book; b) Comics; c) The newspaper or a magazine. Options: yes/no.</td>
<td>No</td>
<td>A Good Environment condition was defined by option yes. Responses b and c had a very small effect on the DV (below 5 points). Children who read newspaper or magazine had only a 15 points advantage in academic scores above those who did not read a newspaper/magazine (Effect Size: $d_{reading} &gt;= .17$; Effect Size $d_{math}: d &lt;= .16$).</td>
</tr>
<tr>
<td>37</td>
<td>In relation to question 36, did your teacher ask you to read this book, comic, newspaper or magazine?</td>
<td>a) Yes; b) No.</td>
<td>No</td>
<td>This question was excluded because question 36 was excluded.</td>
</tr>
<tr>
<td>38</td>
<td>Do the adults that live with you read the newspaper, magazine, or book?</td>
<td>a) Yes, every day; b) Yes, almost every day; c) A few times per week; d) Once or twice per week; e) Almost never; f) Never.</td>
<td>No</td>
<td>Responses a and b (Good Environment condition) were grouped and compared against responses c to f (Poor Environment condition). The difference in academic scores between the two environment conditions was small (about 9-13 points). Effect Size: $d_{reading} &gt;= .15$; Effect Size $d_{math}: d &lt;= .10$.</td>
</tr>
<tr>
<td>39</td>
<td>When needed, who help you at home to do your homework?</td>
<td>a) My mom; b) My dad; c) A sibling; d) Other relative; e) A private teacher; f) Other person; g) Nobody.</td>
<td>No</td>
<td>The responses mom, dad, sibling, other relative, or nobody help you at home to do your homework were associated with just small changes in academic scores (range 3-7 points).</td>
</tr>
<tr>
<td>40</td>
<td>In your home, does anyone talk to you about school, or help you studying or doing your homework.</td>
<td>a) Yes, everyday; b) Yes, several times per week; c) Yes, from time to time; d) Almost never.</td>
<td>No</td>
<td>Differences in average academic scores between answer options a, b, c, and d ranged from 6 and 12 points. Effect Size: $d_{reading} &gt;= .12$; Effect Size $d_{math}: d &lt;= .11$.</td>
</tr>
</tbody>
</table>

1 The right column (when applicable) shows the criteria used for the variable preselection. The preselection process took into consideration the percentage of missing data, Effect Sizes, Cronbach's Alpha values in index formation (when calculated), and the difference in academic achievement scores between Good/Poor Environment condition.
### APPENDIX H

SERCE Questionnaire - Parents - Criteria for Variable Preselection

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Answer options</th>
<th>Question Preselected?</th>
<th>Reason inclusion/exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Original question SERCE:</strong> What is the highest educational level you have attained? <strong>Final question present study:</strong> Mother’s education.</td>
<td>a) No studies; b) Primary incomplete; c) primary complete; d) secondary incomplete; e) secondary complete; f) higher education incomplete; g) higher education complete. <em>Options:</em> mother/father.</td>
<td>Yes</td>
<td>Only the mother's educational level (and not the father's) was included in the analysis. Responses a to d (Poor Environment condition) were grouped and compared against responses e to g (Good Environment condition). The difference in reading and math scores between the two environment conditions ranged from 38 to 47 points. Effect Size_{third grade reading}: $d=.47$; Effect Size_{sixth grade reading}: $d=.50$; Effect Size_{third grade math}: $d=.41$; Effect Size_{sixth grade math}: $d=.49$.</td>
</tr>
<tr>
<td>2</td>
<td>Who lives with your child in your household?</td>
<td>a) Father; b) Mother; c) Siblings; d) Other relatives; e) Other people outside the family. <em>Options:</em> yes/no.</td>
<td>No</td>
<td>Unclear association IV/DV</td>
</tr>
<tr>
<td>3</td>
<td>At what age your child started school?</td>
<td>a) 5 years or less; b) 6 years; c) 7 years; d) 8 or older.</td>
<td>No</td>
<td>Unclear association IV/DV</td>
</tr>
<tr>
<td>4</td>
<td>What's the language first learned by your child?</td>
<td>a) Spanish; b) Foreign language; c) Aboriginal Language.</td>
<td>No</td>
<td>Native speakers in sixth grade represent less than 1% of the sample.</td>
</tr>
<tr>
<td>5</td>
<td>Number of people living in your household...</td>
<td>a) Younger than 18 years of age; b) Older than 18 years of age.</td>
<td>No</td>
<td>Missing data: between 20% and 28%</td>
</tr>
<tr>
<td>6</td>
<td>Number of rooms in the house.</td>
<td>Numeric value.</td>
<td>No</td>
<td>This question was excluded because question 5 was excluded. This variable has no value by itself.</td>
</tr>
<tr>
<td>8</td>
<td>Home flooring</td>
<td>a) Parquet; b) Ceramic; c) Polished wood; d) earth; e) Unpolished wood.</td>
<td>Yes</td>
<td>Responses a to c (Good Environment condition) were grouped and compared against responses d to e (Poor Environment condition). The difference in reading and math scores between the Good/Poor Environment conditions ranged from 39 to 48 points. Effect Size third grade reading: $d=.43$; Effect Size sixth grade reading: $d=.49$; Effect Size third grade math: $d=.43$; Effect Size sixth grade math: $d=.43$.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>9</td>
<td>What services do you have in your household?</td>
<td>a) Electricity; b) Running Water; c) Sewage; d) Telephone; e) TV cable; f) internet. (Options: Yes / No)</td>
<td>Yes</td>
<td>Three services or less (Poor Environment condition) was compared against four services or more (Good Environment condition). The difference in reading and math scores between the Good/Poor Environment condition ranged from 35 to 40 points; Effect Size third grade reading: $d=.47$; Effect Size sixth grade reading: $d=.48$; Effect Size third grade math: $d=.38$; Effect Size sixth grade math: $d=.46$.</td>
</tr>
<tr>
<td>10</td>
<td>What assets do you have in your home?</td>
<td>a) Color TV; b) Radio; c) Stereo; d) Tape recorder; e) DVD / VHS; f) Computer; g) Cell phone; h) Freezer; i) Electric stove; j) Microwave; k) Washing machine; l) Drier; m) Dishwashing machine; n) car; o) motorcycle. (Options: Yes / No)</td>
<td>Yes</td>
<td>Eight assets or less (Poor Environment condition) was compared against nine assets or more (Good Environment condition). The difference in reading and math scores between the Good/Poor Environment condition ranged from 36 to 44 points. Effect Size third grade reading: $d=.42$; Effect Size sixth grade reading: $d=.48$; Effect Size third grade math: $d=.40$; Effect Size sixth grade math: $d=.45$.</td>
</tr>
<tr>
<td>11</td>
<td>How many books do you have in your house? Include all books: poetry, novels; dictionaries; textbooks.</td>
<td>a) Never; b) 1; c) 2; d) 3; e) More than 3; f) Don't Know; g) Don't remember.</td>
<td>Yes</td>
<td>Nine books or less (Poor Environment condition) was compared against ten books or more (Good Environment condition). The difference in reading and math scores between the Good/Poor Environment condition ranged from 36 to 46 points. Effect Size third grade reading: $d=.43$; Effect Size sixth grade reading: $d=.47$; Effect Size third grade math: $d=.40$; Effect Size sixth grade math: $d=.48$.</td>
</tr>
<tr>
<td>12</td>
<td>Did you read to your child when little?</td>
<td>a) Almost every day; b) Once or twice per week; c) Once or twice per month; d) Never or almost never.</td>
<td>No</td>
<td>Responses $a$ and $b$ (Good Environment condition) were grouped and compared against responses $c$ and $d$ (Poor Environment conditions). Effect Size third grade reading: $d=.22$; Effect Size sixth grade reading: $d=.24$; Effect Size third grade math: $d=.16$; Effect Size sixth grade math: $d=.21$.</td>
</tr>
<tr>
<td>13</td>
<td>Before your child was 3 years old, did he/she attend a nursery home?</td>
<td>a) No; b) Yes, for 1 year; c) Yes, for 2 years; d) Yes, for 3 years.</td>
<td>No</td>
<td>Responses $a$ and $b$ (Poor Environment condition) were grouped and compared against responses $c$ and $d$ (Good Environment condition). There was a 23 to 34 points difference in academic achievement scores between the two levels. The Question Attended Preschool Between 4 and 6 years of Age was preferred over this question.</td>
</tr>
<tr>
<td>14</td>
<td>When your child was between 4 and 6 years of age, did he/she attend a preschool?</td>
<td>a) No; b) Yes, for 1 year; c) Yes, for 2 years; d) Yes, for 3 years.</td>
<td>Yes</td>
<td>Responses $a$ and $b$ (Poor Environment condition) were grouped and compared against responses $c$ and $d$ (Good Environment condition). There was a 33 to 36 points difference in academic scores between the two conditions. Effect Size third grade reading: $d=.37$; Effect Size sixth grade reading: $d=.39$; Effect Size third grade math: $d=.38$; Effect Size sixth grade math: $d=.34$.</td>
</tr>
<tr>
<td>15</td>
<td>Have you participated this year in the following activities?</td>
<td>a) Activities that took place in school (e.g., cultural, recreational, sports); b) Meetings with other parents, organized by a school teacher; c) Meetings organized by the school principal; d) Meetings organized by the parents' association. Options: always or almost always; sometimes; never/almost never; I haven't been called)</td>
<td>No</td>
<td>Responses showed no effect on DV and there was no pattern in the association IV/DV.</td>
</tr>
<tr>
<td></td>
<td>Question</td>
<td>Options</td>
<td>No Response</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Do you know your child's school teachers?</td>
<td>a) No, I haven't met him yet; b) I know him/her by sight; c) I know him/her a little bit; d) I know him/her well.</td>
<td>IV had just a small effect on DV. The difference in academic achievement scores between option a and d ranged from 2 to 11 points.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Have you participated this year in the school elections?</td>
<td>a) Parent's association; b) School council. Options: yes; I was called but did not participate; there were no elections.</td>
<td>The IV had no effect on the DV. Missing data for the option there were no elections: above 30%.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>In your opinion, the school your child is attending to is...</td>
<td>a) Very good; b) Good; c) Regular; d) Bad; e) Very bad.</td>
<td>Responses a and b (Good Environment condition) were grouped and compared against responses c and d (Poor Environment condition). The difference in academic achievement between Good/Poor Environment conditions ranged from 12 to 21 points. Effect Size third grade reading: $d=.12$; Effect Size sixth grade reading: $d=.18$; Effect Size third grade math: $d=.14$; Effect Size sixth grade math: $d=.21$.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>What is your opinion about the school your child is attending to?</td>
<td>a) The functioning of the school is organized; b) Teachers &quot;teach&quot; well; c) Teachers are punctual and don't miss school; d) The school principal works well; e) Parents' opinions are considered by the school. Options: I agree; I disagree; I don't know.</td>
<td>Difference in academic achievement scores between Good/Poor Environment conditions: 2-17 points. It was decided not to create an index due to the large percentage of missing data.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Would you like your child to attend a different school?</td>
<td>a) No, he/she is fine there; b) Yes, but I could not afford it; c) Yes, but there are no other schools nearby; d) Yes, but I could not do it because of norms and other regulations.</td>
<td>Responses showed no effect on DV and there was no pattern in the association IV/DV.</td>
<td></td>
</tr>
</tbody>
</table>

1 The right column (when applicable) shows the criteria used for the variable preselection. The preselection process took into consideration the percentage of missing data, Effect Sizes, Cronbach's Alpha values in index formation (when calculated), and the difference in academic achievement scores between Good/Poor Environment condition.
APPENDIX I

Secondary Sources Used to Verify Preschool Names on the EDI Database

http://mexico.pueblosamerica.com/nuevo-leon/
http://mx.titching.com/schools/nuevo-leon/13599
http://alaescuela.com.mx/
http://www.alumnosonline.com/primarias/nuevo-leon/
http://www.guiapv.com/codigos_postales/
http://tucodigo.mx/index.php
APPENDIX J

Procedures to Convert SERCE Predictors into Dichotomous Variables

1. For multiple choice questions that required the selection of a single response (e.g., mother's educational level, which has six answer options):
   - Answer options were sorted from the poorest to the richest environment condition.
   - The least beneficial condition received a value of 1, the next a value of 2, etc.
   - Average reading and math scores were calculated for each answer option. This allowed examining gradients among answer options.
   - Cut-off points for Good/Poor Environment condition were decided based on scientifically sound criteria (for example, for mothers' education the cut-off point was secondary complete). All responses with values below the cut-off point received a score of 0 (Poor Environment condition), while all responses with values at or above the cut-off point received a score of 1 (Good Environment condition).

2. For questions such as Number of home assets in the household, which required the selection of multiple options:
   - Answer options responded with a yes and that reflected a Good Environment condition received a score of 1; answer options answered with a no and that reflected a Poor Environment condition received a score of 0.
   - Average sum scores were calculated for the sample of students.
   - Average reading and math scores were calculated for each answer option. This allowed examining academic achievement gradients among answer options.
   - Cut-off scores were decided based on the identification of large changes in average sum scores among answer options (25 points difference in academic achievement)
   - Average sum scores below cut-off point received a value of 0 (Poor Environment condition), while average sum scores above cut-off point received a value of 1 (Good Environment condition).

3. For multiple choice questions that required the selection of multiple options [e.g., How do you feel in your school? Responses: a) happy; b) bored; c) entertained; d) nervous; e) calm. Options: i) almost always; ii) sometimes; iii) almost never]:

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• Options within each response were sorted according to what was considered least beneficial to most beneficial environment condition. Options with the least beneficial condition received a value of 1, the next a value of 2, etc.

• Average sum scores were calculated for each response

• A factor analysis was conducted; depending on these results, it was decided whether to try to create an index, or to try use responses individually (as an individual predictor)

• Average reading and math scores were calculated for each index or individual response. This allowed examining gradients in academic achievement.

• Cut-off scores (for the index or individual responses) were decided based on the identification of large changes in academic achievement scores

• All responses with values below cut-off scores received a score of 0 (Poor Environment condition), while all responses with values at or above cut-off scores received a value 1 (Good Environment condition).
APPENDIX K

HLM Results: Third Grade Reading -SERCE and EDI Nuevo Leon Data

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Variable</th>
<th>Coefficient ($\beta$)</th>
<th>SE</th>
<th>$t$ (4087)</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Intercept Model (Level-1 Predictors)</td>
<td>Age Student</td>
<td>-2.80</td>
<td>2.56</td>
<td>-1.09</td>
<td>4,087</td>
<td>0.272</td>
</tr>
<tr>
<td></td>
<td>Gender Student</td>
<td>3.76</td>
<td>2.74</td>
<td>1.37</td>
<td>4,087</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>Mother’s education</td>
<td>17.31</td>
<td>3.35</td>
<td>5.18</td>
<td>4,087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Home Flooring</td>
<td>8.95</td>
<td>3.06</td>
<td>2.92</td>
<td>4,087</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td></td>
<td>Number of books at home</td>
<td>17.66</td>
<td>2.88</td>
<td>6.13</td>
<td>4,087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Attended Preschool at 4 to 6 years of age</td>
<td>15.91</td>
<td>3.03</td>
<td>5.25</td>
<td>4,087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>If you had to change school</td>
<td>31.61</td>
<td>3.27</td>
<td>9.66</td>
<td>4,087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Means as Outcome Model (Level-2 Predictors)</td>
<td>Age -EDI</td>
<td>54.51</td>
<td>32.44</td>
<td>1.68</td>
<td>142</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>Two or more delays on the EDI</td>
<td>-184.53</td>
<td>42.39</td>
<td>-4.35</td>
<td>142</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Random Intercepts and Slopes Model (Level-1 and Level-2 Predictors)</td>
<td>Age Student</td>
<td>-2.85</td>
<td>2.56</td>
<td>-1.11</td>
<td>4087</td>
<td>0.266</td>
</tr>
<tr>
<td></td>
<td>Gender Student</td>
<td>3.83</td>
<td>2.74</td>
<td>1.40</td>
<td>4087</td>
<td>0.161</td>
</tr>
<tr>
<td></td>
<td>Mother’s education</td>
<td>16.70</td>
<td>3.33</td>
<td>5.02</td>
<td>4087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Home Flooring</td>
<td>8.26</td>
<td>3.04</td>
<td>2.72</td>
<td>4087</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Number of books at home</td>
<td>17.33</td>
<td>2.87</td>
<td>6.04</td>
<td>4087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Attended Preschool at 4 to 6 years of age</td>
<td>15.73</td>
<td>3.02</td>
<td>5.20</td>
<td>4087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>If you were told you have to change schools, how would you feel?</td>
<td>31.81</td>
<td>3.28</td>
<td>9.69</td>
<td>4087</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Age- EDI</td>
<td>33.11</td>
<td>24.52</td>
<td>1.35</td>
<td>141</td>
<td>0.179</td>
</tr>
<tr>
<td></td>
<td>Two or more delays on the EDI</td>
<td>-138.71</td>
<td>39.66</td>
<td>-3.50</td>
<td>141</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

1The table above shows the Beta Coefficients ($\beta$), standard errors (SE), $t$-ratios, degrees of freedom (df), and p-values of the predictors included in the HLM models.
### APPENDIX L

**HLM Results: Third Grade Mathematics - SERCE and EDI Nuevo Leon Data**

<table>
<thead>
<tr>
<th></th>
<th>Variable</th>
<th>Coefficient ($\beta$)</th>
<th>$SE$</th>
<th>$t$ ($df$)</th>
<th>$df$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Random Intercept</strong></td>
<td><strong>Model (Level-1 Predictors)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age Student</td>
<td>-1.13</td>
<td>2.42</td>
<td>-0.467</td>
<td>4030</td>
<td>0.641</td>
</tr>
<tr>
<td></td>
<td>Gender Student</td>
<td>-7.00</td>
<td>3.08</td>
<td>-2.27</td>
<td>4030</td>
<td>&lt;0.023</td>
</tr>
<tr>
<td></td>
<td>Mother’s education</td>
<td>16.27</td>
<td>3.08</td>
<td>5.28</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Home Flooring</td>
<td>11.14</td>
<td>3.22</td>
<td>3.46</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Number of books at home</td>
<td>15.53</td>
<td>2.65</td>
<td>5.86</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Attended Preschool at 4 to 6 years</td>
<td>13.47</td>
<td>3.15</td>
<td>4.28</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>of age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>If you had to change school</td>
<td>27.66</td>
<td>3.22</td>
<td>8.60</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Means as</strong></td>
<td><strong>Outcome Model (Level-2 Predictors)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age -EDI</td>
<td>40.60</td>
<td>30.46</td>
<td>1.33</td>
<td>142</td>
<td>0.185</td>
</tr>
<tr>
<td></td>
<td>Two or more delays on the EDI</td>
<td>-103.49</td>
<td>56.99</td>
<td>-1.82</td>
<td>142</td>
<td>0.071</td>
</tr>
<tr>
<td><strong>Random Intercepts</strong></td>
<td><strong>and Slopes Model (Level-1 and</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Level-2 Predictors)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age Student</td>
<td>-1.16</td>
<td>2.42</td>
<td>-0.48</td>
<td>4030</td>
<td>0.631</td>
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<td>Gender Student</td>
<td>-6.97</td>
<td>3.07</td>
<td>-2.263</td>
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</tr>
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<td>Mother’s education</td>
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<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Home Flooring</td>
<td>10.70</td>
<td>3.19</td>
<td>3.35</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Number of books at home</td>
<td>15.29</td>
<td>2.64</td>
<td>5.78</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Attended Preschool at 4 to 6 years</td>
<td>13.32</td>
<td>3.13</td>
<td>4.26</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>of age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>If you were told you have to change</td>
<td>27.74</td>
<td>3.23</td>
<td>8.56</td>
<td>4030</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>schools, how would you feel?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age - EDI</td>
<td>25.98</td>
<td>22.64</td>
<td>1.148</td>
<td>141</td>
<td>0.253</td>
</tr>
<tr>
<td></td>
<td>Two or more delays on the EDI</td>
<td>-64.61</td>
<td>43.33</td>
<td>-1.49</td>
<td>141</td>
<td>0.140</td>
</tr>
</tbody>
</table>

1 The table above shows the Beta Coefficients ($\beta$), standard errors ($SE$), $t$-ratios, degrees of freedom ($df$), and $p$-values of the predictors included in the HLM models.
## APPENDIX M

### HLM Results: Sixth Grade Reading -SERCE (level-1) and EDI (level-2) Nuevo Leon Data

<table>
<thead>
<tr>
<th>Model (Level-1 Predictors)</th>
<th>Variable</th>
<th>Coefficient ($\beta$)</th>
<th>SE</th>
<th>$t$ (4087)</th>
<th>df</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Intercept Model</td>
<td>Age Student</td>
<td>-0.58</td>
<td>0.19</td>
<td>-2.99</td>
<td>3,933</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td></td>
<td>Gender Student</td>
<td>9.06</td>
<td>2.78</td>
<td>3.26</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Mother’s education</td>
<td>17.99</td>
<td>3.13</td>
<td>5.75</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Home Flooring</td>
<td>9.80</td>
<td>3.14</td>
<td>3.11</td>
<td>3,933</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td></td>
<td>Home Assets</td>
<td>12.60</td>
<td>3.08</td>
<td>4.09</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Number of books at home</td>
<td>19.26</td>
<td>2.60</td>
<td>7.34</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Attended Preschool at 4 to 6 years of age</td>
<td>8.64</td>
<td>3.09</td>
<td>2.80</td>
<td>3,933</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Means as Outcome Model</td>
<td>Age -EDI</td>
<td>58.89</td>
<td>31.06</td>
<td>1.89</td>
<td>142</td>
<td>&lt;0.060</td>
</tr>
<tr>
<td></td>
<td>Two or more delays on the EDI</td>
<td>-203.98</td>
<td>55.94</td>
<td>-3.64</td>
<td>142</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Random Intercepts and Slopes Model (Level-1 and Level-2 Predictors)</td>
<td>Age Student</td>
<td>-0.58</td>
<td>0.19</td>
<td>-3.00</td>
<td>3,933</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td></td>
<td>Gender Student</td>
<td>9.15</td>
<td>2.78</td>
<td>3.29</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Mother’s education</td>
<td>17.72</td>
<td>3.12</td>
<td>5.68</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Home Flooring</td>
<td>9.12</td>
<td>3.13</td>
<td>2.92</td>
<td>3,933</td>
<td>&lt;0.004</td>
</tr>
<tr>
<td></td>
<td>Home Assets</td>
<td>12.30</td>
<td>3.06</td>
<td>4.01</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Number of books at home</td>
<td>18.93</td>
<td>2.64</td>
<td>7.17</td>
<td>3,933</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Attended Preschool at 4 to 6 years of age</td>
<td>8.30</td>
<td>3.04</td>
<td>2.72</td>
<td>3,933</td>
<td>&lt;0.006</td>
</tr>
<tr>
<td></td>
<td>If you were told you have to change schools, how would you feel?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age- EDI</td>
<td>64.56</td>
<td>18.50</td>
<td>3.49</td>
<td>141</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Two or more delays on the EDI</td>
<td>-126.62</td>
<td>42.89</td>
<td>-2.95</td>
<td>141</td>
<td>0.004</td>
</tr>
</tbody>
</table>

1 The table above shows the Beta Coefficients ($\beta$), standard errors (SE), $t$-ratios, degrees of freedom (df), and $p$-values of the predictors included in the HLM models.
## APPENDIX N

HLM Results: Sixth Grade Mathematics - SERCE and EDI Nuevo Leon Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient ($\beta$)</th>
<th>SE</th>
<th>$t$ (4087)</th>
<th>df</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Random Intercept Model (Level-1 Predictors)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Student</td>
<td>-1.02</td>
<td>0.23</td>
<td>-4.32</td>
<td>3,754</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender Student</td>
<td>-0.21</td>
<td>3.12</td>
<td>-0.07</td>
<td>3,754</td>
<td>0.94</td>
</tr>
<tr>
<td>Mother’s education</td>
<td>19.19</td>
<td>3.17</td>
<td>6.05</td>
<td>3,754</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Home Flooring</td>
<td>6.47</td>
<td>3.43</td>
<td>1.89</td>
<td>3,754</td>
<td>0.059</td>
</tr>
<tr>
<td>Home Assets</td>
<td>13.24</td>
<td>3.46</td>
<td>3.82</td>
<td>3,754</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of books at home</td>
<td>23.39</td>
<td>2.82</td>
<td>8.282</td>
<td>3754</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Attended Preschool at 4 to 6 years of age</td>
<td>5.03</td>
<td>3.15</td>
<td>1.59</td>
<td>3,754</td>
<td>0.11</td>
</tr>
</tbody>
</table>

| Means as Outcome Model (Level-2 Predictors) | | | | | |
| Age -EDI | 55.38 | 27.62 | 2.00 | 140 | <0.047 |
| Two or more delays on the EDI | -172.28 | 57.73 | -2.98 | 140 | <0.003 |

| **Random Intercepts and Slopes Model (Level-1 and Level-2 Predictors)** | | | | | |
| Age Student | -1.00 | 0.23 | -4.29 | 3,803 | <0.001 |
| Gender Student | 0.45 | 3.07 | 0.146 | 3,803 | 0.884 |
| Mother’s education | 19.37 | 3.16 | 6.13 | 3,803 | <0.001 |
| Home Flooring | 6.69 | 3.58 | 1.870 | 3,803 | 0.062 |
| Home Assets | 13.49 | 3.42 | 3.94 | 3,803 | <0.001 |
| Number of books at home | 23.30 | 2.82 | 8.26 | 3,803 | <0.001 |
| Attended Preschool at 4 to 6 years of age | | | | | |
| If you were told you have to change schools, how would you feel? | | | | | |
| Age- EDI | 59.59 | 18.59 | 3.205 | 139 | <0.002 |
| Two or more delays on the EDI | -80.46 | 53.43 | -1.50 | 139 | <0.134 |

1The table above shows the Beta Coefficients ($\beta$), standard errors (SE), $t$-ratios, degrees of freedom (df), and $p$-values of the predictors included in the HLM models.
APPENDIX O
Multilevel Model Equations, by Grade

Third Grade

1) Model 1 - Unconditional Model

(Level-1 Model)

\[ Y_{ij} = \beta_{0j} + r_{ij} \]

(Level-2 Model)

\[ \beta_{0j} = \gamma_{00} + u_{0j} \]

(Mixed Model)

\[ Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \]

2) Model 2 - Random Intercept Model

(Level-1 Model)

\[ Y_{ij} = \beta_{0j} + \beta_{1j}(\text{AGE}_{ij}) + \beta_{2j}(\text{GNDR}_{NRij}) + \beta_{3j}(\text{EDMOTH}_{Rij}) + \beta_{4j}(\text{HMFLR}_{Rij}) + \beta_{5j}(\text{NMBRBK}_{Rij}) + \beta_{6j}(\text{ATTPRE}_{Rij}) + \beta_{7j}(\text{CHNGE}_{Rij}) + r_{ij} \]

(Level-2 Model)

\[ \beta_{0j} = \gamma_{00} + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} \]
\[ \beta_{2j} = \gamma_{20} \]
\[ \beta_{3j} = \gamma_{30} \]
\[ \beta_{4j} = \gamma_{40} \]
\[ \beta_{5j} = \gamma_{50} \]
\[ \beta_{6j} = \gamma_{60} \]
\[ \beta_{7j} = \gamma_{70} \]

(Combined Model)

\[ Y_{ij} = \gamma_{00} + \gamma_{10}\text{AGE}_{ij} + \gamma_{20}\text{GNDR}_{NRij} + \gamma_{30}\text{EDMOTH}_{Rij} + \gamma_{40}\text{HMFLR}_{Rij} + \gamma_{50}\text{NMBRBK}_{Rij} + \gamma_{60}\text{ATTPRE}_{Rij} + \gamma_{70}\text{CHNGE}_{Rij} + u_{0j} + r_{ij} \]
3) Model 3 - Means as Outcomes Model

(Level-1 Model)
\[ Y_{ij} = \beta 0j + rij \]

(Level-2 Model)
\[ \beta 0j = \gamma 00 + \gamma 01*(\text{AGE}_{EDIj}) + \gamma 02*(\text{LTWODOM}_j) + u0j \]

(Combined Model)
\[ Y_{ij} = \gamma 00 + \gamma 01*\text{AGE}_{EDIj} + \gamma 02*\text{LTWODOM}_j + u0j + rij \]

4) Model 4 - Random Intercepts and Slopes Model

(Level-1 Model)
\[ Y_{ij} = \beta 0j + \beta 1j*(\text{AGE}_{ij}) + \beta 2j*(\text{GNDR}_{NRij}) + \beta 3j*(\text{EDMOTH}_{Rij}) + \beta 4j*(\text{HMFLR}_{Rij}) + \beta 5j*(\text{NMBRBK}_{Rij}) + \beta 6j*(\text{ATTPRE}_{Rij}) + \beta 7j*(\text{CHNGE}_{Rij}) + rij \]

(Level-2 Model)
\[ \beta 0j = \gamma 00 + \gamma 01*(\text{AGE}_{EDIj}) + \gamma 02*(\text{LTWODOM}_j) + u0j \]
\[ \beta 1j = \gamma 10 \]
\[ \beta 2j = \gamma 20 \]
\[ \beta 3j = \gamma 30 \]
\[ \beta 4j = \gamma 40 \]
\[ \beta 5j = \gamma 50 \]
\[ \beta 6j = \gamma 60 \]
\[ \beta 7j = \gamma 70 \]

\[ Y_{ij} = \gamma 00 + \gamma 01*\text{AGE}_{EDIj} + \gamma 02*\text{LTWODOM}_j + \gamma 10*\text{AGE}_{ij} + \gamma 20*\text{GNDR}_{NRij} + \gamma 30*\text{EDMOTH}_{Rij} + \gamma 40*\text{HMFLR}_{Rij} + \gamma 50*\text{NMBRBK}_{Rij} + \gamma 60*\text{ATTPRE}_{Rij} + \gamma 70*\text{CHNGE}_{Rij} + u0j + rij \]
Sixth Grade

1) Model 1- Unconditional Model

(Level-1 Model)

\[ Y_{ij} = \beta_{0j} + r_{ij} \]

(Level-2 Model)

\[ \beta_{0j} = \gamma_{00} + u_{0j} \]

(Combined Model)

\[ Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \]

2) Model 2 - Random Intercept Model

(Level-1 Model)

\[ Y_{ij} = \beta_{0j} + \beta_{1j} \times (\text{AGE}_{ij}) + \beta_{2j} \times (\text{GENDER}_{Nij}) + \beta_{3j} \times (\text{EDMOTHER}_{ij}) + \beta_{4j} \times (\text{HOMEFLR}_{ij}) + \beta_{5j} \times (\text{HOMEASST}_{ij}) + \beta_{6j} \times (\text{NUMBRBKS}_{ij}) + \beta_{7j} \times (\text{ATTPRES}_{Cij}) + r_{ij} \]

(Level-2 Model)

\[ \beta_{0j} = \gamma_{00} + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} \]
\[ \beta_{2j} = \gamma_{20} \]
\[ \beta_{3j} = \gamma_{30} \]
\[ \beta_{4j} = \gamma_{40} \]
\[ \beta_{5j} = \gamma_{50} \]
\[ \beta_{6j} = \gamma_{60} \]
\[ \beta_{7j} = \gamma_{70} \]

(Mixed Model)

\[ Y_{ij} = \beta_{00} + \beta_{10} \times \text{AGE}_{ij} + \beta_{20} \times \text{GENDER}_{Nij} + \beta_{30} \times \text{EDMOTHER}_{rij} + \beta_{40} \times \text{HOMEFLR}_{ij} + \beta_{50} \times \text{HOMEASST}_{ij} + \beta_{60} \times \text{NUMBRBKS}_{ij} + \beta_{70} \times \text{ATTPRES}_{Cij} + u_{0j} + r_{ij} \]
3) Model 3 - Means as Outcomes Model

(Level-1 Model)
\[ Y_{ij} = \beta_{0j} + r_{ij} \]

(Level-2 Model)
\[ \beta_{0j} = \gamma_{00} + \gamma_{01}(AGE_{EDIj}) + \gamma_{02}(LTWODOMj) + u_{0j} \]

(Combined Model)
\[ Y_{ij} = \gamma_{00} + \gamma_{01}AGE_{EDIj} + \gamma_{02}LTWODOMj + u_{0j} + r_{ij} \]

4) Model 4 - Random Intercepts and Slopes Model

(Level-1 Model)
\[ Y_{ij} = \beta_{0j} + \beta_{1j}(AGE_{ij}) + \beta_{2j}(GENDER_{Nij}) + \beta_{3j}(EDMOTHER_{ij}) + \beta_{4j}(HOMEFLR_{ij}) + \beta_{5j}(HOMEASST_{ij}) + \beta_{6j}(NUMBRBKS_{ij}) + \beta_{7j}(ATTPRESC_{ij}) + r_{ij} \]

(Level-2 Model)
\[ \beta_{0j} = \gamma_{00} + \gamma_{01}(AGE_{EDIj}) + \gamma_{02}(LTWODOMj) + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} \]
\[ \beta_{2j} = \gamma_{20} \]
\[ \beta_{3j} = \gamma_{30} \]
\[ \beta_{4j} = \gamma_{40} \]
\[ \beta_{5j} = \gamma_{50} \]
\[ \beta_{6j} = \gamma_{60} \]
\[ \beta_{7j} = \gamma_{70} \]

(Combined Model)
\[ Y_{ij} = \gamma_{00} + \gamma_{01}AGE_{EDIj} + \gamma_{02}LTWODOMj + \gamma_{10}AGE_{ij} + \gamma_{20}GENDER_{Nij} + \gamma_{30}EDMOTHER_{ij} + \gamma_{40}HOMEFLR_{ij} + \gamma_{50}HOMEASST_{ij} + \gamma_{60}NUMBRBKS_{ij} + \gamma_{70}ATTPRESC_{ij} + u_{0j} + r_{ij} \]