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Thinking Geospatially: How Variable Relationships with Reaching Achievement Test Scores in the State of Missouri Vary* by Geospatial Location

Elizabeth Jane Wallington
Washington University in St. Louis

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Thinking Geospatially: How Variable Relationships with Reaching Achievement Test Scores in the State of Missouri Vary by Geospatial Location

by

Elizabeth Thorne Wallington

A dissertation presented to the Graduate School of Arts and Sciences of Washington University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

August 2014

St. Louis, Missouri
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List of Abbreviations

Socioeconomic Status (SES)
Missouri Assessment Program (MAP)
Geographic Weighted Regression (GWR)
National Assessment of Educational Progress (NAEP)
No Child Left Behind Act (NCLB)
Elementary and Secondary Education Act (ESEA)
Missouri Department of Elementary and Secondary Education (MODESE)
Multilevel Modeling (MLM)
Geographic Information Systems (GIS)
Free and Reduced-Price Lunch (FRL)
Median Household Income (MHI)
Federal Housing Authority (FHA)
Grade-Level Expectations (GLEs)
Ordinary Least Squares (OLS)
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ABSTRACT OF THE DISSERTATION

Thinking Geospatially: How Variable Relationships with Reaching Achievement Test Scores in the State of Missouri Vary by Geospatial Location

by

Elizabeth Thorne Wallington

Doctor of Philosophy in Education

Washington University in St. Louis, 2014

William F. Tate, Chair

The purpose of this was to examine whether district-level factors had an effect on literacy achievement, and whether the relationships between district composition factors and literacy achievement vary by geographic location, in this case the state of Missouri. The dissertation determined if the variable relationships were significant and if the statistically significant relationships were geographically nonstationary. Stationarity refers to the idea that relationships are stable across a geographic area. In contrast, nonstationarity indicates that relationships vary by geography. This means that relationships may be significant in one geographic area of the state but not significant in another. By including geographic location in the analysis, this dissertation is additive both to the literature on variable effects on literacy achievement as well as policy debates around literacy achievement. This study consisted of secondary data analysis using variables provided by the Missouri Department of Elementary and Secondary Education (MODESE) and representing all public schools in Missouri. The study analyzed these variables using Geographic Weighted Regression. This modeling technique was used to
examine relationships and moderating effects of district demographic and socioeconomic composition. The dependent variable was literacy achievement as measured by scale scores on the Communication Arts MAP test for grades 4 and 8 and the English II end-of-course exam for high school students. By using geographic location as a variable and GWR as an analytic technique, it was possible to examine variable relationships between district demographics, socioeconomic composition and literacy achievement measures statewide. This showed whether and how the relationships between variables, including demographics and socioeconomic factors, vary across the state. That is, the study determined whether the relationships are significant and how that significance varies across the state. Overall, geospatial location was found to be an important factor in interpreting variable effects on literacy achievement. Significant relationships were found across grade levels and variables, and nonstationarity was observed.
Chapter One: Introduction to the Problem

Introduction

It is widely recognized that mastering literacy is essential for living in a modern society, just as a literate population is essential for a country to compete in a globalized world. Literacy is a human right—Literacy is necessary to facilitate any further learning (Agnet, 2008, p. 42).

The importance of literacy is well recognized, but the goal of a functionally literate society has yet to be fully realized. Race, ethnicity, gender, and socioeconomic status are well-documented factors associated with underdevelopment in literacy and continue to impact access to literacy learning opportunities (Lee, 2004). Research has shown that factors such as race, socioeconomic status, teacher quality, financial contexts, and student behavior all impact learning opportunities that support literacy development and achievement (Borman & Dowling, 2010; Konstatopoulous & Borman, 2011). Recent research has also shown that these relationships vary by location (Hogrebe & Tate, 2013). Understanding which district level variables have a significant impact on literacy achievement, and where the significant relationships occur geographically, can potentially offer an innovative way to think about education policy and access to literacy development.

The purpose of the research conducted here is to examine the relationship between district-level school composition variables, literacy achievement, and the geographic variation of these relationships across the state of Missouri. While the context of Missouri will be discussed in greater detail in Chapter Two, it is helpful to understand from the outset that Missouri was selected for several reasons. First,
Missouri, like many states, has made improving literacy achievement a top priority of state education policy (Missouri Department of Education, 2012). While research has demonstrated that proficiency in tested curriculum areas varies by district, what is less clear are the district-level factors leading to these outcomes (McCombs, Kirby, Barney, Darilek, & Magee, 2006; Scherrer, 2013; Rumberger & Palardy, 2005; Konstantopoulos & Chung, 2011). The purpose of the research offered here is to use geospatial analysis to attempt to determine which district-level variables are most important, or have the strongest correlations, by district across the state. This evidence has the potential to inform the design of appropriate interventions at the district level.

Second, Missouri provides a geographically diverse setting for analysis because of the urban-rural dichotomy present in the state. Missouri has two major metropolitan areas as well as substantial rural areas, so the significance of the district-level variables in both rural and urban areas can be studied, and differences, as well as commonalities, between the two can also be examined. A comparative understanding of these relationships will provide legislators and policy-makers with geographically specific insights into factors influencing literacy achievement.

Third, variations in school composition factors including race, ethnicity and socioeconomic status (SES) are seen across the state. African Americans and whites, for example, are the predominant racial groups in Kansas City and St. Louis, the two major metropolitan areas, while rural areas are predominantly white (US Census, 2010). The state also has a great deal of variation in terms of socioeconomic status, with the full continuum from poverty to affluence represented across the state (US Census, 2010).
Missouri’s school composition is unique in that the racial demographics are largely a binary, while the socioeconomic continuum varies widely.

Missouri is also considered a border south state with Southern influences, and so deserves special research consideration when thinking about race and academic achievement (Morris & Monroe, 2009). Morris and Monroe (2009) wrote that the United State’s South is “critical to understanding the dynamics of the achievement gap facing Black students,” (p. 21). Population trends demonstrate that the majority of Black Americans still live in the US South, so a study of literacy in the state of Missouri provides an opportunity to contribute to the literature on both education in the South and black achievement.

The state also offers a diverse economic context. Kansas City and St. Louis are both typical de-industrialized cities, while the rural areas of the state are experiencing the challenges of declining traditional agriculture economies (Paul, Nehring, Banker & Somwaru, 2004). This presents at least two divergent economic contexts for the current study, and again offers an opportunity to see differences in variable relationships within diverse political economies. That is, the state affords a variety of economic contexts in which to view variable effects on literacy.

This dissertation focuses on literacy. To be literate is defined as the ability to read and write, and is critical to a democratic society, future achievement in all subject areas, and the capacity to function in modern society (Lind, 2008). The Missouri Department of Elementary and Secondary Education uses “Communication Arts” to refer to courses related to reading, writing, and English. The state uses the Missouri Assessment Program (MAP) yearly exam to measure academic achievement. The MAP Communication Arts
exam is used to measure literacy proficiency. School and demographic factors (e.g. socioeconomic status, race/ethnicity, and school environment) that influence literacy attainment have been studied using data from across the United States and at different levels of analysis (e.g. school, district, neighborhood), but these studies do not examine how these relationships vary by location (e.g. Sirin, 2005). Neglecting whether and how effects vary by location is consequential in the problem formulation of policy development.

This study offers analysis of relationships between district-level school composition, context (i.e. geographic location), and literacy achievement. This study investigates the effects of district composition factors on literacy achievement. This research examines which, if any, factors have significant relationships with literacy achievement. Data analysis was conducted using GWR to examine how these relationships vary across districts as a function of geospatial location. The statistical significance of those relationships were examined at the local level, and the relationships were then be mapped across the state. These relationships will then be examined when controlling for SES and race, again examining nonstationarity of the effects.

The purpose of the dissertation is to examine whether district-level factors have an effect on literacy achievement, and whether the relationships between district composition factors and literacy achievement vary by geographic location, in this case the state of Missouri. The dissertation seeks to determine if the variable relationships are significant and are geographically nonstationary. Stationarity refers to the idea that

---

1 The term literacy achievement is used in this dissertation to mean scores received on achievement tests. Achievement test scores are widely used to study proficiency in a variety of subjects (Sirin, 2005) and will be operationalized as the dependent variable in this study.
relationships are stable across a geographic area. In contrast, nonstationarity indicates that relationships vary by geography (Fotheringham, Brunsdon, Charlton, 2002). This means that relationships may be significant in one geographic area of the state but not significant in another. By including geographic location in the analysis, the dissertation will augment both the literature on variable effects on literacy achievement as well as policy debates around literacy achievement.

**Literacy Achievement**

Graff (1987) wrote that literacy, at its foundation, is “the ability to read and write,” and is, therefore, the “…most distinguishing feature of a civilized man and a civilized society” (p. 78). Historically, a more literate population was found in Northern and urban areas of the United States during late 18th and early 19th centuries, but the common school movement, circulation of print materials, and improved transportation reduced these biases by creating opportunities for a broader population to be exposed to print materials and to become literate (Kintgen, Kroll & Rose, 2001). Thus, literacy expanded throughout the country, albeit unevenly.

The twentieth century saw a significant decline in illiteracy rates and an increased access to literacy skills across the United States. A long-range perspective on measured literacy skills in the United States shows a great expansion in the twentieth century, with legitimate challenges still remaining. Key among those concerns is the influence of race and SES on access to literacy development (Ranpey, Dion & Donahue, 2009). Three decades of National Assessment of Educational Progress (NAEP) data demonstrated that NAEP reading scores had a slightly positive trend, with all racial and ethnic groups making gains (Lee, 2002). Blacks made more positive gains, across age groups, from
1971 to 2008 than other groups (Rampey, Dion & Donahue, 2009). While there has been
growth in the last 40 years, challenges regarding literacy achievement remain.

Literacy achievement continues to be a major focus of public policy at both the
federal and state levels. At the federal level, the emphasis is largely on assessment and
achievement, with both the No Child Left Behind (NCLB) act and the Race to the Top
program establishing reading achievement as a fundamental aspect of education policy
(US Department of Education, 2012). Both policies fall under the Elementary and
Secondary Education Act, 2010 (ESEA) and focus on academic achievement as measured
by statewide accountability tests. No Child Left Behind legislation requires states to
establish accountability measures designed to measure student achievement. States are
required to measure improvement on the accountability tests, with growth goals
established for each year. Race to the Top was included in the 2010 reauthorization of
ESEA in 2010. This allowed states relief from certain provisions of NCLB if the state
was able to show serious state-led efforts to promote achievement and increase
accountability. While the efficacy of these policies has been contentiously debated, the
significance here is that federal policy underscores the government’s recognition of the
importance of literacy (“Presidential Debate”, 2012).

Similarly, state education agencies continue to emphasize improved literacy
achievement. In Missouri, the Department of Elementary and Secondary Education
published “Missouri’s Top 10 by 20,” a list of ten goals to be reached by the year 2020
(Missouri Department of Education, 2012). Among the ten objectives are 1) for all
students to graduate high school prepared for either college or a career, and 2) for 75% of
all students to score at or above proficiency on both the mathematics and the reading
sections of the MAP test. These targets highlight the centrality of literacy achievement in the state’s strategic education plan.

One important understanding for policy-makers is that literacy development takes place in context. That is, a child’s literacy development is inextricably linked to the environment in which it occurs. An extensive review of literature establishing the importance of context to literacy development will be provided in the next chapter. Significant here is that the dissertation seeks to contribute new understandings of the role of context in influencing literacy achievement by examining how the effects of these variables vary by geographic location. By identifying which district-level variables have a significant relationship with literacy achievement and how those relationships vary across the state, it will also be possible to identify some of the most significant district-level contextual factors impacting literacy development in those districts. This is an extension both of the literature on literacy achievement and to the policy discourse in that it provides another layer of analysis and understanding of effects on literacy achievement outcome measures.

**Research Design**

The dissertation will examine geographic variation of school district composition factors and literacy achievement. The research proposed here will examine what, if any, district level factors have a statistically significant relationship with literacy achievement measures.

**Research Questions**

Literacy achievement is of great importance in the United States and Missouri. Past research has indicated that school district composition variables are important factors
affecting literacy achievement. The proposed research study will be guided by the following research questions:

1. Using a GWR model, which, if any, of the district-level composition variables are significantly related to MAP Communication Arts scale scores for grades four, eight, and the English II end-of-course exam?
2. How do these relationships change when controlling for race and SES?
3. Do the relationships vary across districts as a function of geographic location?

**Research Methods**

This study consisted of secondary data analysis using variables provided by the Missouri Department of Elementary and Secondary Education (MODESE) and representing all public schools in Missouri. The study analyzed these variables using GWR. Like multi-level modeling (MLM), GWR allows relationships to vary across groups, but also takes into account the underlying spatial continuum that MLM ignores (Fotheringham, Charleton & Brunton, 2002). This modeling technique was used to examine relationships and effects of district demographic and socioeconomic composition. The dependent variable was literacy achievement as measured by scale scores on the Communication Arts MAP test for grades four and eight and the English II end-of-course exam for high school students.

GWR includes geographic location as a contextual variable. By using geographic location as a variable and GWR as an analytic technique, it is possible to examine variable relationships between district demographics, socioeconomic composition and literacy achievement measures statewide. This shows whether and how the relationships between variables, including demographics and socioeconomic factors, vary across the
state. That is, the research will determine whether the relationships are significant and how that significance varies across the state. The findings extend the literature on literacy achievement as well as the policy discourse because geographic location is included in the actual model. Thus, the findings have the potential to influence state and district level policy decision-making.

**Limitations**

The dissertation has several limitations. First, the study is limited to a single state. One purpose of this study is to determine the importance of district-level variables in Missouri. Generalization to other states is limited because the data is specific to the state of Missouri. Additionally, this study is limited in that state achievement tests are the only outcome measure. Researchers such as Brooks-Gunn and Levanthal (2004) have questioned whether such achievement tests are useful outcome measures. Qualitative studies of literacy development suggest that literacy attainment is a highly nuanced process. Still, identifying significant variable relationships may offer the potential for future research and provide valuable information for policy-makers.

Finally, the data used here is cross-sectional rather than longitudinal. Therefore, the study results by grade-level are limited to the year studied. With these data sources, it is not possible to see how the relationships change over time.

**Looking Ahead**

This chapter has provided an introduction to this dissertation. Next, Chapter Two will review literature that informs this study of school composition, literacy, and local
context. Chapter Two will also review prior research conducted on the variables to be included in the research here. Chapter Three will then describe the research methods, including data sources, variables, and the modeling strategy. Chapter Four provides a summary of the results of the study, and Chapter Five offers a discussion and conclusions from these results.
Chapter Two: Literature Review

Over the past hundred years of universal schooling, literacy rates have served as a barometer of society such that illiteracy takes on symbolic significance, reflecting any disappointment not only with the workings of the educational system, but with the society itself. An assumption often expressed is that if educational institutions cannot manage the simple task of teaching basic decoding and encoding skills, they cannot prepare future generations to deal with more complex questions of technological change (Cook-Gumperz, 2006, p. 25).

Improving literacy achievement has long been of policy interest to the United States education system. Despite multiple policy initiatives, improving literacy achievement remains a challenge in the United States. This dissertation seeks to understand what school district composition factors affect literacy achievement and how those effects vary based on geographic location. In order to situate the dissertation within a large body literature on academic achievement, this chapter is organized into two sections. The first section provides the analytical framework for the proposed study by addressing the policy and scholarly approaches informing the work. This includes the significance ascribed to literacy achievement at all policy levels, the influences of local context, the affordances offered by a district-level analysis of the state of Missouri, and the rationale behind examining multiple grade levels. Sampson (2012) has written that local contexts are not just settings where individuals act out life, but rather “determinants of the quantity and quality of human behavior in their own right” (p. 22). Thus, the importance of place, and the role of the district, will be elucidated in the first section. The second section overviews relevant literature on factors found to have statistically
significant relationships with literacy achievement. This includes all the variables analyzed in the current study. The second section concludes by providing a review of the application of Geographic Information Systems (GIS) and geographic weighted regression (GWR) in the academic achievement literature. As will be demonstrated in this review, there is a paucity of geospatial analysis, and particularly GWR, in the academic achievement and literacy achievement literature. This void in the literature will be addressed by the research offered here.

**Literacy Achievement**

Until relatively recently, literacy was defined by simple tests such as the ability to sign one’s name or the number of grades completed in school. As society has grown increasingly complex, it has become progressively more difficult to define and measure literacy (Olson, 2006). Two generally accepted definitions of literacy are:

1. Conventional literacy: the ability to read and write, comprehend texts on familiar subjects, and understand whatever signs, labels, instructions, and directions necessary for every day life.

2. Functional literacy: the possession of skills perceived as necessary by particular people or groups to fulfill their self-determined objectives (Olson, 2006).

Using these two very broad definitions, it is possible to examine historical trends in literacy attainment and achievement. The modern era of literacy stems from the expansion of the printing press. Between 1600 and 1900, Western societies moved from restricted literacy to mass literacy (Kaestle, 1985). There is very little evidence of the extent of literacy in the United States before 1850 except for that provided by people’s
ability to sign documents like marriage registers and wills. However, there is evidence that literacy rates for colonial British America, restricted to white males, were quite high (Cook-Gumperz, 2006).

Much of what we know about literacy rates in the nineteenth century comes from the United States’ Census. From 1840 to 1930, the Census Bureau measured literacy by asking individuals whether they could read or write. Beginning in 1940, the Census Bureau collected data based on grade completion (Cook-Gumperz, 2006).

A study by Soltow and Stevens (1981) analyzed the aggregate rates in this census data, and then used samples of individual family schedules to investigate the correlation of literacy with other factors. The study demonstrated that, historically, economic development and population density were correlated with the provision of schools and an “ideology of literacy.” Literacy was correlated most strongly with schooling, and then family wealth and the population density of one’s community. Not surprisingly, the variables most highly correlated with literacy were found primarily in the North and in urban areas. This study demonstrates that historical literacy rates were influenced by context factors.

The early twentieth century saw a rapid expansion of literacy, particularly to immigrants and blacks (Kaestle, 1985). Still, the United States’ Army found that 25% of all draftees for World War I were functionally illiterate, leading to government sponsored literacy campaigns (Costa, 1988). The push for literacy continued, with a federal law passed in 1917 requiring all immigrants over age 16 to pass a literacy test. By 1918 all states had compulsory school attendance laws. Still, particularly in the South, people
living in poverty and people of color routinely received substandard educations, and obstructions to the objective of universal literacy continued (Cook-Gumperz, 2006).

While the last 80 years has seen numerous policy attempts to address the issue of literacy achievement, literacy and illiteracy still remain integral to policy stakeholders. Functional literacy is a particular concern of educators and policy-makers today, as the definition of functional literacy is constantly changing and evolving because of the advent of new technologies (Olson, 2006). As our economy becomes increasingly globalized and driven by these technologies, the skills needed to meet basic literacy objectives also change.

In a Senate hearing focusing on literacy, Senator Thomas Dodd noted:

Literacy is without a doubt one of the most fundamental and necessary skills that one can possess. It makes us good parents, good workers, and good citizens…unfortunately, however, for many of our citizens, (illiteracy) is a reality. Almost one quarter of our population, between 40 and 44 million Americans, lack basic literacy skills…How can this be in a country as rich in resources and human potential as ours? (US Senate Committee on Labor and Human Resources, 1998, p. 7)

Literacy achievement remains a focus for both federal and state policy. At the federal level, policies emphasize assessment and achievement, with the target of universal proficiency in literacy, as established by the Elementary and Secondary Education Act (ESEA), discussed in Chapter One. “Missouri’s Top 10 by 20,” goals also reflect the responsibility placed on districts to raise literacy achievement and emphasize the intention to hold districts accountable for literacy achievement in Missouri.
Still, National Assessment of Education Progress (NAEP) data demonstrates that states are far from achieving these ambitious objectives (McCombs, Kirby, Barney, Darilek, & Magee, 2006). Using both NAEP data and state proficiency data, a study by McCombs et al. (2006) found that in several states less than half of students met the state proficiency standards, and in no state did even half the students meet the NAEP national literacy standard of proficiency. Additionally, the study reported wide disparities in subgroup performance, particularly between white and African American students.

While literacy achievement is both a state and federal priority, there remain obstacles to meeting the established targets. The purpose of the research here is to attempt to illuminate factors affecting literacy achievement, but also to demonstrate whether the effects of those factors are geographically stationary.² This supplements the literature on literacy achievement as well as the policy discourse because geographic location is included in the actual model. One advantage of this research is that it will provide greater nuance and understanding than that offered by traditional ordinary least squares (OLS) regression. Of paramount importance to this new examination is the supposition that local context has a pivotal effect on literacy achievement.

**Literacy and Local Context**

There are multiple sources of influence that shape a child’s learning and development (Lee, 2012). These influences offer an ecological framework through which literacy development can be viewed. This suggests a complexity of community activity that calls for a deeper analysis of community ecology, moving beyond the idea of

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² As noted in Chapter One, stationarity means that a relationship is stable across a given geographic area; nonstationarity means that a relationship varies across a geographic area.
a bounded, homogenous community to one that allows organic qualities of communities to emerge (Gutierrez, 2012). Therefore, literacy development takes place in context. One seminal work on the ecology of literacy is Heath’s (1983) ethnographic study of three communities. This study demonstrated the dramatic effect context can have on literacy development. “Roadville” was a white working-class community of families who worked in textile mills; “Trackton” was a black, working-class, farming community, and these two communities were compared with “townspeople,” primarily middle-class citizens living in an urban area. Heath found that literacy and reading development were deeply influenced by the context, or community setting, in which that development occurred. Context here refers to factors associated with both location and environment. Heath (1983) found:

The patterns of language use of the children of Roadville and Trackton before they go to school stand in sharp contrast to each other and to those of the youngsters from townspeople families. Though parents in all three communities want to ‘get ahead,’ their constructions of social activities the children must engage in for access to language, oral and written, vary greatly. The sequence of habits Trackton children develop in learning language, telling stories, making metaphors, and seeing patterns across items and events do not fit the developmental patterns of either linguistic or cognitive growth reported in the research literature on mainstream children. Roadville children, on the other hand, seem to have developed many of the cognitive and linguistic patterns equated with readiness for school, yet they seem not to move outward from these basics to the integrative types of skills necessary for academic success (p. 324).
Other researchers have expanded upon the idea that literacy development occurs in context. For example, a study of a community of rural Appalachians in the Southeastern United States demonstrated illiteracy as a self-sustaining intergenerational cycle (Purcell-Gates, 1995). The enclave of illiterate, culturally identifying Appalachians living in this specific geographic area enabled and encouraged the perpetuation of illiteracy between multiple generations. In this way, the geographic location was directly related to the lack of literacy development. Context is key when understanding literacy achievement. For the study conducted here, that context is the state of Missouri.

**The State of Missouri as a Case Study**

As described in Chapter One, there are several reasons why Missouri is a useful context for this study. First, universal literacy is an established policy objective for the state of Missouri. Missouri Revised Statute § 167.645 calls for early assessment of students’ reading skills and requires school districts to intervene with students who are reading below grade level. This law requires reading level assessment of all students in grades three through sixth and requires the district to intervene with students who are reading below grade level. Students who are substantially below grade level are required to follow individualized “Reading Improvement Plans” and may be retained in grade 4 if they are reading below a third grade level (Missouri Department of Elementary and Secondary Education, 2012).

Missouri also offers a favorable context in that the state is geographically diverse and maintains an urban/rural dichotomy:

(The state) features the westernmost “eastern” city, St. Louis, a decidedly rustbelt town that still makes cars, jets, and beer but now only supervises the production
of shoes and clothing made elsewhere. St. Louis remains a labor town where unions representing pipefitters, carpenters, autoworkers, and machinists still have clout...Kansas City, once a destination for cattle drives, is the nation’s easternmost “western” city and has an electorate about half the size of the St. Louis region. Beyond the two big metropolitan areas, Missouri is a jumble of rural America. Northern Missouri shares the features of slowly declining Iowa. Southeastern Missouri is a gateway to the Mississippi delta. Southwest Missouri, staunchly Republican since the Civil War, is the state’s most vigorously growing region (Robertson, 2004, p. 4).

Another facet of this discussion of the rural/urban dichotomy is that of a declining agricultural economy. As Robertson (2004) noted, Missouri’s agriculture economy, like that of other farming states, is in decline. Paul, Nehring, Banker, and Somwaru (2004) found that the structural transformation of agriculture has led to an inability of small family farms to compete with large, corporate farms. This exhibits a changing economy for states like Missouri, which have traditionally relied on small family farms for a large portion of the state’s economy. In turn, this changing economy puts more pressure on metropolitan areas to maintain a growing proportion of the state’s economy. This, in part, fuels the push for more literate workers with the skills seen in the state’s education goals.

Also important to this research is that Missouri is considered a border-southern state. The historical understanding of Missouri as a border-southern state extends to the Missouri Compromise of 1820, in which slavery was banned north of the parallel 36°30' north, and allowed for Missouri to be admitted to the Union as a slave state. The special
slave-state status ascribed to Missouri by the Missouri Compromise ensured its role as a Southern state. Morris and Monroe (2009) wrote that the US South is “critical to understanding the dynamics of the achievement gap facing Black students” (p. 21). Because race and ethnicity are central variables to this dissertation, Missouri offers a compelling context. Population trends demonstrate that the majority of Black Americans still live in the United States’ South, which includes Missouri. This pattern holds true for Missouri, which has a significant African American population. Missouri is essentially a racially binary state, composed primarily of African Americans and whites.

Missouri has long been considered a bellwether state (Robertson, 2004). Robertson (2004) wrote that Missouri is a “microcosm for completely unromantic reasons: it is a relentlessly average state” (p. 2). Missouri’s demographics and economy are similar to the United States in general, though slightly less diverse, due to “Midwestern insularity” (Robertson, 2004, p. 2). Missouri faces many of the same trends and problems as other states. This includes a struggling economy, tensions between rural and urban residents, and poor educational achievement, particularly in urban areas. Missouri therefore offers a compelling context for the current study. Another significant aspect of that context is the school district, the level of analysis for this research.

**District-level Analysis**

Districts were selected as the unit of analysis for several reasons. First, the state of Missouri grants authority to school districts to implement state education laws in Missouri Revised Statutes § 160 and § 162. These state statutes define a school district and provide extensive provisions for the management of public elementary and secondary education. The responsibility for the implementation of these provisions falls to the
districts. Missouri Revised Statute § 167.645 requires districts to assess student literacy achievement and to intervene if the student does not meet certain state standards. Therefore, the state itself legitimizes the significant role of the school district.

Second, parents and other stakeholders engage in education issues primarily through schools within the district. Local school board meetings are easily accessible, and issues not resolved at the school-level are often appealed to the district level. For this reason, school districts act as the primary point of access for parents and stakeholders with an interest in education issues (Desforges & Abouchaar, 2003).

Third, use of school districts is present in the existing academic achievement literature, both as a unit of analysis and at the implementation level. In particular, studies have demonstrated that public-use data aggregated at the district level, as is used in this study, is particularly useful in addressing a wide range of policy issues (Jacob, Goddard, & Kim 2013). Furthermore, recent studies have demonstrated that a district-level reform model can have positive effects on reading outcomes (Slavin, Cheung, Holmes, Madden, & Chamberlain 2013). This demonstrates that the district can be a useful level of analysis both in the research and implementation phases.

Finally, the district offers a suitable unit of analysis for GWR. The purpose of GWR is to examine local spatial statistics (Fotheringham, Brundson, Charlton, 2002). The district until is small enough to allow local variations to emerge, but large enough so that the number of data points is not overwhelming, as would be the case with a smaller unit such as schools. Because of all of these factors, districts are an effective and appropriate unit of analysis.
Grade Levels

In addition to being conducted at the district level, this research includes three grade levels within each district: fourth, eighth, and high school. These three grade levels encompass the three traditional level of schooling: elementary, middle, and high school. These three grade levels also encompass three broad literacy levels. Significant to this discussion are the developmental milestones anticipated for each grade level. To that end, the developmental appropriateness of the grade level expectations the state test is designed to measure is also compelling. To advance this discussion of developmental appropriateness, this section provides a comparison between the grade level expectations for the state of Missouri and the Common Core State Standards.

The Common Core State Standards (CCSS) were developed by the nation's governors and education commissioners, through their representative organizations, the National Governors Association Center for Best Practices (NGA) and the Council of Chief State School Officers (CCSSO). The Common Core is a set of academic standards in mathematics and English language arts/literacy (ELA). These learning goals outline what a student should know and be able to do at the end of each grade. The standards were created to ensure that all students graduate from high school with the skills and knowledge necessary for college and career readiness. Forty-four states and the District of Columbia have voluntarily adopted and are moving forward with the Common Core (“Common Core,” 2014). The CCSS offer a particularly useful comparison for Missouri’s grade level expectations, as it is a stated goal of the state for all students to graduate high school college and career ready.
First, the CCSS contain very broad anchor standards, which are then applied at each grade level to offer a set of reading and writing goals, indicating that a student is on-track in terms of college and career readiness. For the research presented here, these grade-level goals was compared with Missouri’s grade level expectations (GLEs) and course level expectations (CLEs) for reading and writing, where GLEs are used for fourth and eighth grade and CLEs are used for English II. These GLEs and CLEs inform the MAP tests, and the state has worked to establish the validity of the MAP in terms of these GLEs, as discussed in Chapter Three. Because Missouri does not have separate standards for “Language” the CCSS for “Language” will be compared with the Missouri writing standards. Finally, both the state of Missouri and the CCSS offer standards for listening and speaking. As those standards are not measured by the MAP test used in this study, those GLEs and CCSS are not relevant to the data presented here.

The CCSS for English Language Arts are divided into four categories: reading, writing, speaking and listening, and language. Reading standards are focused on text complexity and the growth of comprehension. Writing standards focus on text types, responding to reading, and research. Language standards delineate goals for conventions, effective use, and vocabulary. For the purposes of this study, each individual goal as set by the CCSS will be compared to the GLEs or CLEs for each grade level included in this study. First, a general overview of the developmental expectations for each grade level will be presented. Next, the GLEs or CLEs will be described in detail. Finally, the CCSS for each grade level will be described, with comparisons to GLEs and CLEs elucidated. This is not meant to be an analysis of whether the Missouri standards align with the CCSS, as that would be beyond the scope of the research conducted here.
Rather, the point is to examine what is expected from students at each of the three grade levels, and then to analyze whether those expectations are generally aligned with the Common Core State Standards.

**Fourth grade.** We begin first with an examination of the grade level expectations at the fourth grade level. First, the fourth grade assessment offers a test of basic reading comprehension skills, including basic phonics, fluency, vocabulary and basic comprehension (Whitehead, 2009). The early elementary grades are primarily focused on teaching reading skills, while grades three and four begin to concentrate on developing and applying skills and strategies to develop an effective reading process (Reutzel & Cooter 2006). The early grades are primarily concerned with learning to read. Writing development primarily emphasizes using the writing process and developing a fluent writing style.

The Missouri GLEs for fourth grade Communication Arts reflect these general goals. The first stand of GLEs is for reading. The GLE reading standards include basic skills like phonics and fluency, as well as more advanced skills like literary techniques and making text connections.

In terms of basic reading skills, Missouri fourth grade students are expected to apply decoding strategies to unknown words and be able to read grade-level texts fluently. Students are expected to develop vocabulary through text. Students are expected to apply pre-reading, during reading, and post-reading strategies that include tasks such as summarizing, clarifying, paraphrasing, and drawing conclusions. Students are also expected to identify text features such as the title, table of contents, etc., as well as be able to locate and recognize the features of fiction, poetry, and drama.
In terms of more advanced skills, students are expected to explain relevant text-to-text, text to self, and text to world connections. In addition, fourth grade students are expected to be able to identify and provide examples of sensory details, sound devices, and figurative language in text. Fourth grade students are also expected to use details from fiction texts to identify cause and effect and author’s purpose, as well as to identify the setting, character traits, problems and solutions, and story events. Similarly, students are expected to analyze nonfiction texts and to be able to use figures to comprehend that text. Finally, students are expected to read and follow three to four step directions to complete a task.

For writing, fourth grade students are expected to follow a writing process to compose a text that shows awareness of audience and format. This text is expected to have a clear, controlling idea and relevant details. The text is expected to have a beginning, middle, and end and to follow a logical sequence. In addition, written text is expected to follow conventions for capitalization, comma usage, and spelling. Students are expected to compose narrative, descriptive, expository, and persuasive texts.

These GLEs align fairly well with the CCSS. In terms of the foundational skills of phonics and fluency, the standards align closely. The reading standards for literature and information texts are also similar, though they are presented in a more streamlined format. For example, both the GLEs and the CCSS require students to use details from the text to make inferences. In general, the Missouri GLEs for fourth grade appear to be developmentally appropriate when compared with the CCSS. The complete Missouri GLEs and CCSS are available in Appendix D.
Eighth grade. From fourth through eighth grade, the emphasis shifts from comprehension to analyzing and evaluating different types of text, including fiction, poetry, and drama. Students are now reading to learn (Reutzel & Cooter, 2006). This includes more advanced concepts like dialect, jargon, hyperbole, and symbolism. Additionally, there is a greater focus on analyzing nonfiction, including technical manuals. By eighth grade, writing a well-developed text is a fundamental focus of literacy courses.

The eighth grade GLEs are very similar to the grade 4 GLEs, especially in terms of basic skills. Eighth graders in the state are still expected to decode and read fluently. The pre-reading, during reading, and post-reading skills are also identical. However, when making text connections, eighth grade students are expected to compare, contrast, and analyze connections, rather than just identify connections as in fourth grade. Eighth grade students are also expected to identify more advanced literary techniques such as jargon, dialect, slang, and symbolism. Students in the eighth grade are also expected to use details from text determine foreshadowing, interpret behaviors of characters, and to evaluate the effectiveness of solutions. Rather than simply identifying a text’s features, as in fourth grade, students are expected to evaluate whether those features are used effectively.

As with reading, the writing GLEs for eighth grade are extensions of the fourth grade GLEs. For example, students are expected to use a writing process, but not only are they expected to have a strong controlling idea and relevant details, they are also expected to exhibit complex ideas and freshness of thought. In addition, students are expected to use writing techniques such as figurative language, sensory detail, and
purposeful dialogue. As with the grade 4 standards, students are expected to use appropriate conventions.

When compared with the CCSS, the eighth grade GLEs do appear to be developmentally appropriate. Again, most, if not all, of the CCSS appear to be included in the state standards.

**High school.** High school literacy courses again attend to skills and knowledge necessary to evaluation a variety of texts. This includes an emphasis on plot, setting, theme, tone, and author’s point of view. Texts are generally more complex. Writing instruction focuses on composing well-developed texts, including research papers. At the high school levels, these skills are constructed to predict college and career readiness (MODESE, 2012).

The course-level expectations for English II are similar to those for fourth and eighth grade students. The English II standards do include more advanced literary analysis, including allusion, parallelism, and analysis of tone. Apart from those differences, the reading CLEs for English II are very similar to the GLEs for eighth grade.

In terms of writing, the CLEs are also very similar. The English II writing CLEs do include the use of active voice and varied sentence structure, which is different from the eighth grade GLEs. The English II CLEs also require precise and vivid language, again an extension from the eighth grade expectations.

Again, the state standards appear to be aligned with the CCSS. However, the CCSS are much more specific in terms of the individual skill goals to be reached for high school students. Many of the standards for English II read, “Access prior knowledge”
without stating what that specific knowledge may be. For that reason, it is not totally clear whether all of the CCSS are included in the state standards. At the same time, the level of rigor appears to be similar. Again, this is not meant to be a comprehensive comparison of how well the state GLEs and CLEs align with the CCSS. Rather, this discussion is only meant to assess the developmental appropriateness of those expectations. Given the similarities between the state GLEs and CLEs and the CCSS, the state GLEs and CLEs do appear to be developmentally appropriate.

Focusing on these three grade levels, then, will capture the development of literacy skills from basic comprehension through advanced analysis and evaluation techniques. It is important to note, as well, that each of these stages of literacy development takes place in context. This means that all of the factors defining the context—the ecology of literacy—are also moderating literacy development. The school district composition variables included in this context will be reviewed in the next section, with the effects at each grade level described.

While the data are cross-sectional, each of the variables was investigated at all three levels. From a policy standpoint, this will allow for consideration of the effects at all three levels. Furthermore, this augments the literature, which often examines only one grade-level outcome measure (Scherrer, 2013; Rumberger & Palardy, 2005; Konstatopoulos & Chung, 2011). The grade levels included here are not meant to be comparative, as the data is cross-sectional. Rather the different grade levels merely provide multiple lenses through which to view the relationships. The factors examined at each grade level are discussed in the next section.
School District Composition Factors

It is because of this complexity that incorporating location into an analysis can be very valuable. The geospatial context of location may serve as a proxy variable to represent the effects of many factors and their complicated interactions. If schools differ by location, it may be that the local or neighborhood contexts in which the schools exist have an important influence on the student, teacher, and school variables and outcomes. The local context may moderate the school context and affect how the student and teacher variables are related. (Hogrebe, 2012, p. 152).

Because literacy takes place in context, it has the potential to be impacted by the factors that define that context. This section of the literature review examines a variety of school district composition factors are found in the literature to have significant relationships with literacy achievement. Still, much ambiguity about these variables remains. For example, the variables of socioeconomic status and race have inherent geospatial importance, yet geographic location is rarely included in models examining poverty and race effects on literacy achievement. Because of this, the review begins by establishing the geospatial nature of SES and race. Next, the review turns to the other variables selected for the study, providing the rationale and significance of each. The selected variables are limited to Missouri accountability measures. The variable selection itself is evaluative because the research conducted here will help determine if specific Missouri state accountability indicators are significant in terms of literacy achievement. In addition, the study will estimate the nature and extent of geographic variation, or
stationarity, of these accountability measures, using literacy achievement as an outcome variable.

**Socioeconomic Status**

Poverty, and particularly childhood poverty, has been demonstrated to have a significant effect on academic achievement outcomes. This is likely due to a variety of factors. First, childhood poverty has specific associations with a particular profile for neurocognitive strengths and weaknesses, particularly in terms of disparities in working memory, cognitive control, and language and memory (Farah et al., 2006). There is also evidence that poverty actually impedes cognitive function, possibly because poverty itself reduces cognitive capacity (Mani, Mullainanathan, Shafir & Zhao, 2013). This is likely because poverty is associated with certain stressors that require the use of neurocognitive resources, thus reducing remaining cognitive capacity. The contributing factors of poverty are widespread, with factors as disparate as nutrition, stress and cortisol levels, and even gene expressions all impacted by poverty (Heckman, 2006). The factors can all lead to a reduction in cognitive capacity. This reduction in cognitive capacity is one possible explanation for the income achievement gap, whereby poor students perform significantly worse on achievement tests than students not living in poverty.

Additionally, the income achievement gap appears to be growing (Reardon & Bischoff, 2011). The income achievement gap is now more than twice as large as the black-white achievement gap. This appears, in part, to be a factor of growing income disparities in the United States. What those growing disparities mean in terms of income segregation and geospatial distribution is less clear.
Important to this research is that poverty has a strong geospatial component, with income segregation common across the United States (Kahlenberg, 2012). Poverty concentrations appear to be growing, with the proportion of high-poverty schools rising significantly from 1999 to 2008, from 34 percent to 47 percent (Kahlenberg, 2012). Significant to this research, students living in poverty are highly segregated between districts, with certain districts having a concentrated number of low SES students.

Furthermore, the geospatial location of SES segregation appears to be changing, with the potential to have a profound impact upon schools. Much concentrated poverty is now located in suburban areas (Kahlenberg, 2012). This dissertation seeks not only to illuminate where there are low SES communities, but also to determine whether the relationship between SES and literacy achievement varies by geographic location. In this way, it will be possible to understand if the relationship between SES and literacy achievement varies between urban, suburban, and rural areas. The research here therefore builds on existing research that demonstrates a relationship between income inequality and income segregation and education outcomes by allowing for geographic variation, a logical extension given the geospatial nature of SES.

Although SES is used extensively in education research, there is disagreement about its conceptual meaning and empirical measurement in studies conducted with children and adolescents (Bornstein & Bradley, 2003). This disagreement arises largely from the SES measure utilized. This is because SES has been operationalized in a number of ways including family income, parent education level, and parent occupation, with roughly comparable results (Sirin, 2005, Reardon & Bischoff, 2011). There is little
consensus about one “best” measure, which is why a composite measure, described below, was used in this study.

The socioeconomic status (SES) of a child’s parents has long been one of the strongest predictors of a child’s academic achievement (Reardon, 2011). Almost fifty years ago, The Coleman Report (Coleman, et al., 1966) determined the most powerful predictor of academic achievement to be the socioeconomic status of a child’s family, and the second most important predictor the socioeconomic status of the classmates in that student’s school. Both being poor and attending a school with other poor children have significant negative relationships with academic achievement.

Later re-analysis of the same data, however, found considerable and significant between-school variance in literacy achievement (Konstantopoulos & Borman, 2011). This means that schools do, in fact, make a difference in student achievement and student achievement variations cannot be solely attributed to family background. The results of the re-analysis provided clear indications that both racial and SES segregation are associated with poorer academic performance. However, it is not clear how the school effects and neighborhood effects are partitioned. The geospatial model used here elucidates these effects by demonstrating whether there is variability, that is, nonstationarity, across districts.

For this dissertation, SES was operationalized as a composite measure of percent free and reduced price lunch (FRL) and median household income (MHI) in order to capture poverty effects on literacy achievement. FRL is defined as students from families with incomes at or below 130% of the poverty level who are eligible for free meals. Those with incomes between 130% and 185% of the poverty level are eligible for
reduced-price meals. Therefore, FRL captures parental income. Similarly, MHI is an aggregate measure that captures the median income per household in the district. Adding MHI, which is collected by the United States Census, thus broadening the measure, therefore increases the explanatory power of the poverty effect measure. MHI provides a wealth context for the district while the FRL describes the wealth of the public school population. Because this research examined literacy achievement at the district level, the aggregate measures of district level FRL and district MHI were used. The composite measure, then, seeks to capture the concentration of low-SES in certain areas, while the use of GWR will examine whether there are variable effects associated with those concentrations.

Because this is essentially a study of school composition factors, district SES is an appropriate measure. The contribution of this measure is that it is a joint indicator. In reality, there is no single effective measure of poverty, and certainly none collected by the state. Researchers are still engaged in investigations to determine the best SES measure (Sirin, 2005; Kahlenburg, 2012; Mani, et al., 2013).

**Race and Ethnicity**

While poverty demonstrates social separation, it is difficult to isolate poverty from race (Orfield, 2002). For example, blacks and Latinos are twice as likely to attend high-poverty schools than are whites (Matel, Perkins & Aberger, 2012). There is little doubt as to the extent of racial disparities in literacy achievement (Hallinan, 2001; Jencks & Philips, 1998; Rumberger & Palardy, 2005; Logan & Oakley, 2012). Additionally, there appears to be a strong link between concentrations of African Americans and poverty in urban areas (Logan & Oakley, 2012). The underlying mechanisms leading to
lower literacy achievement, however, are less clear. Important to the research here is the geospatial nature of the effects of racial segregation on literacy achievement. Many studies regarding race and literacy achievement lack geospatial insight. While research has indicated that racial and social segregation appear to be spreading to suburban areas, there is a paucity of literacy research regarding whether the effects of this segregation on literacy achievement are equal.

In the late twentieth century, research by Wilson (1987), and Massey and Denton (1993) and Briggs (2005), examined the importance of race and geography. Wilson (1987) argued that social transformations of the 70’s and 80’s led to a concentration of the “truly disadvantaged” in urban areas. Massey and Denton (1993) came to similar conclusions as Wilson, but focused on racial segregation as the primary causal variable. Briggs (2005) called the phenomenon of segregation by race and income “the geography of opportunity.” But while scholars have written about the significance of this segregation, there is little research in education that gives adequate attention to how contextual factors, including geographic location, influence the achievement gap (Morris & Monroe, 2009). Therefore, the research conducted here extends existing research in that it accounts for the inherent geospatial nature of these constructs when examining the variable effects on literacy achievement.

High levels of SES and racial segregation are seen in both St. Louis and Kansas City (Robertson, 2004). In St. Louis this segregation is due in large part to housing policies including restrictive covenants as well as policies regarding FHA loans that restricted where African Americans were allowed to buy houses (Gordon, 2008). This racial segregation is fundamental to this geospatial research.
Beyond SES and race, a number of other context variables appear widely in the literacy achievement literature. Each of those variables was examined using GWR first to determine whether a significant relationship with literacy achievement existed, and next to see if those relationships are different when controlling for SES and race.

**Mobility**

Residential mobility is significantly related to academic and literacy achievement (Leventhal & Brooks-Gunn, 2004). Mobility is also related to other factors associated with literacy achievement, including poverty. Families experiencing economic distress are more likely to have unstable housing.

Student mobility acts as both a predictor and moderator on reading achievement outcome measures (Scherrer, 2013). Furthermore, latent growth-curve modeling has demonstrated that there are longitudinal effects of residential mobility on reading achievement (Voight, Shinn, & Nation, 2012). The movement from one school to another causes a disruption in learning. Because curriculum varies from school to school, the lack of a cogent learning experience creates gaps and deficits that impact a student’s overall achievement. Furthermore, the negative effects of student mobility occur across the grade spectrum, from elementary through high school (Rumberger, 2003).

The existing literature demonstrates that mobility has a strong correlation with literacy achievement. Still, while mobility would intuitively seem to be an inherently geospatial construct, as it involves relocating geographically, research on mobility effects lacks any geospatial consideration. It is not clear if mobility rates in urban, suburban, and rural areas vary, or whether the effects of the rates in those areas vary.
Dropouts

Related to residential mobility is student dropout rate (Lee & Burkam, 2003). Like mobility, dropping out is associated with poverty. In addition, dropping out is also related to school environment and quality. Dropping out also is associated with high level of other kinds of dysfunction in schools, including academic achievement outcomes. Schools with high levels of dysfunction, including high dropout rates, are associated with lower literacy achievement outcomes. In addition, other factors associated with dropping out such as grade retention and failing grades are also correlated with lower literacy achievement (Rumberger & Palardy, 2005). This relationship has largely been examined at the high school level, so the current research investigated whether district-level dropout rates are correlated with lower literacy achievement in fourth and eighth grade as well as in high school. This could potentially signal dysfunction across the district, leading to both higher drop out rates and low literacy achievement.

Important here, as well, is the variability of this relationship (Rumberger & Palardy, 2005). Rumberger and Palardy’s (2005) multi-level model did not include geographic location, but did find dropout rates to be highly variable between schools. It is possible that geographic location has a significant effect on the relationships, a finding that would be an extension of the literature on student dropout rates.

School Discipline Rates

One set of factors associated with an increased drop out rate is suspension or expulsion from school (Rumberger & Palardy, 2005). High levels of school suspension or expulsion are also associated with lower literacy achievement at the school level (Gregory, Skiba & Noguera, 2010). School discipline is also related to race and SES
Poverty, race, and out-of-school suspensions were all found to be predictors for school passing rates on the Indiana state achievement test in both reading and math (Rausch & Skiba, 2004). Additionally, African Americans were much more likely to experience the negative outcomes of suspension or expulsion than students in other racial categories. This was true at both the elementary and secondary levels, though the relationship was stronger at the high school level. These factors are all a reflection of the overall school environment, which has a direct impact on school quality. Suspension or expulsion also removes a student from the learning environment, thus eliminating the opportunity to learn. Like mobility, this causes a disruption in learning that can lead to deficits and gaps, impacting later literacy achievement outcomes.

Finally, the location of the school appeared to play a role in the rates of suspension and expulsion. Rausch and Skiba (2004) found that the greatest disproportionality of discipline occurred in suburban schools. While this study did note that location appears to be important, geographic place was not included in the model. Therefore this dissertation has the potential to expand upon the role location plays in moderating this relationship by including place in the model.

**Class Size**

The effects of class size on academic achievement have been studied for decades (Nye, Hedges & Konstantopoulos, 2000). One of the largest studies of class size effects ever conducted, Tennessee’s Project STAR, found wide and consistent positive effects for smaller class sizes across all academic disciplines for kindergarten through third grade. The positive effects of class size were not differential—that is, smaller classes were beneficial to all students and there were not differential effects seen based on race.
or SES. The study noted that smaller class sizes would appear to be a reasonable investment to improve academic achievement (Nye, Hedges & Konstantopoulos, 2000).

More recently, Shin and Raudenbush (2011) used a simultaneous equation model to attempt to determine the causal effects of reduced class size on academic performance in grades 1-3. Using data from a statewide project to reduce class size, the study reported that reducing class size improved test scores for reading, mathematics, listening, and word recognition tests. Both of the studies, however, focus on achievement only up to grade three. With the proposed study, class size effects will be examined across the districts at fourth grade, eighth grade, and high school, providing a broader picture of the class size effects.

Smaller class sizes are likely correlated with higher literacy achievement scores because of an improvement in the classroom environment and more individualized attention from teachers allowing for greater differentiation and opportunity to learn. Class size may also be a reflection of the broader school environment.

It is also not clear from the existing research if the effects are consistent across types of schools. By examining class size in a model that includes each of these factors, some of the nuance of this factor is elucidated.

**Teacher Characteristics**

Another frequently examined factor related to literacy achievement is that of teacher characteristics. Teachers are a considerable resource of a school district, and teacher salaries occupy the largest share of K-12 budgets (Wayne & Young, 2003). The accountability movement resulting from the No Child Left Behind (NCLB) Act requires that all schools employ “highly qualified” teachers, defined as holding full state
certification, holding a bachelor’s degree, and certified in the subject area taught. Previous research has found that districts with a high percentage of low socioeconomic status (SES) students have a lower percent of highly qualified teachers (Clotfelter, Ladd, & Vidgor, 2005; 2006; Hill & Lubienski, 2007; and Lankford, Loeb, & Wyckoff, 2002). This stands in contrast to the NCLB legislation which directs states “to ensure that poor and minority children are not taught at higher rates than other children by inexperienced, unqualified, or out-of-field teachers” (NCLB, 2002). Percent highly qualified teachers per state is one teacher characteristic variable that was included in this study. In addition, two other teacher characteristic variables were examined. First, teacher salary was studied, and second, percent of teachers holding a masters degree was analyzed.

Teacher characteristic variables have produced somewhat ambiguous results in previous research. First, in terms of teacher salary, Hanushek’s (1997) metanalysis of school resource research reported that only 20% of studies found a significant and positive relationship between teacher salary and academic outcomes. Still, identifying where these significant relationships occur could be informative to policy in that location will show where salary does appear to have a positive impact on student achievement outcome measures.

In addition to teacher salary, percent of teachers holding master’s degrees was studied. A study by Croninger et al. (2007) indicated that both teacher coursework and an education degree were associated with significant positive effects on reading achievement. General measures of teacher qualification, such as certification status and advanced degrees, were not associated with student achievement. Conversely, a
longitudinal study by Clotfeltler, Ladd, and Vigdor (2007) found a significant relationship between advanced degree and reading achievement.

There is a great deal of research that shows a strong positive effect of effective teachers on student achievement. Konstantopoulous and Chung (2011) have examined teacher effects on female, minority, and low-SES students’ achievement in Grade 4. The researchers used multilevel modeling to examine data from a randomized experiment. Effective teachers were identified by the improvement students made on achievement tests over the course of several years, with each year comprised of a different group of students. The authors estimated that teacher effects for Grade 3 positively impact Grade 4 achievement in reading, mathematics, and science. In reading and science, the teacher effects were similar in magnitude to the race gap. However, the study concluded there was no evidence of differential teacher effects on student achievement. That is, minority and disadvantaged students did not appear to benefit more from effective teachers than other students.

None of these studies, though, took into consideration potential geographic variation of the relationships. This dissertation builds on these findings by also including geographic location in the design.

**School Resources**

Closely related to effective teachers is the issue of school resources and funding. School resource measures include variables such as teacher-per-pupil ratio and per-pupil spending (Hanushek, 1997). In a meta-analysis of school resource literature, Hanushek (1997) found that in terms of real classroom resources, only nine percent of studies considering the level of teachers’ education and fifteen percent of studies investigating
teacher-pupil ratios found positive and significant effects on student performance. When considering teacher salary, twenty percent of studies were positive and significant. Hanushek (1997) found that there was no strong or consistent relationship between school resources and student performance at either the elementary or the secondary school level.

Unnever, Kerckhoff, and Robinson (2000) examined district variations in educational resources and student outcomes. Using district-level data from the state of Virginia, the researchers examined educational resources using the measures of the percentage of instructional personnel holding postgraduate professional certificates, per pupil expenditures, and the total amount of money each district reported spending on special education. Using basic multiple regression analysis, the study determined that there is great variation in the educational resources available to school districts and that this variation is associated with the socioeconomic context of the school district. However, of the variables examined, none was significantly correlated with reading achievement test outcomes.

School resources would seem to be linked to school environment and community investment in schools, so it is unclear why school resources are not correlated with literacy achievement. What these studies do make clear, however, is that there is a great deal of variation in school resources, and particularly variation between districts. This study elucidates whether geographic variation is a significant moderator of these relationships. As with Hanushek’s (1997) review, this study examined the effects of school resources at multiple grade levels, providing further insight to the potential effect.

**Place as a Contextual Factor**
Sirin (2005), in his meta-analysis of school effects and academic achievement literature, discussed the multiple interacting systems that moderate the SES and academic achievement relationship. These interacting variables included grade level, minority status, and school location. While most of these factors have been studied extensively, location has not. Sirin (2005) noted that there are significant differences between urban, rural, and suburban schools, a finding that holds significance for this research.

Place and the geography of opportunity are well established in the literature, and mapping of those spaces has been used to study the geography of opportunity (see Tate, 2008; de Souza Briggs, 2005; Jargowsky, 1997; Gordon, 2008). Geographic effects on academic achievement and educational outcomes, though, remain under-researched (Zhang & Cowen, 2009). Mapping provides a technique by which spatial patterns and variances can be made clear (Sanders, Kajs & Crawford, 2002).

Even less common in academic achievement research than descriptive mapping is the use of geographic weighted regression (GWR). This modeling technique provides a new and different analytical lens to the variables examined in this literature review. The studies reviewed here all focused on the relationship between independent variable (i.e. school mobility, dropout rates, etc.) and academic achievement. While some of these studies do use multilevel modeling, none of the studies include place as an contextual variable. That is, the studies presented here do not examine the geographic stationarity of the relationships. Though the literature reviewed here establishes the importance and significance of each variable, an unexplored area is how the relationships between the independent variables and outcome measures vary as a function of place.
While some education research does include GIS analysis in a descriptive form, GWR is rarely used (Kerski, Linn, & Gindele, 2005). Hogrebe and Tate (2012) provided one example of the use of GWR. The study used GWR to analyze the effect of place as a contextual factor for Algebra I outcomes. The study examined the relationships of a variety of school composition factors with Algebra achievement and performed GWR to determine how these relationships varied across the state of Missouri. The study demonstrated that the relationships differed across the state. This is a significant finding when thinking about academic achievement because it demonstrates that certain factors are more important to specific locations. For example, percent free and reduced lunch had a much higher $R^2$ value for locations closest to the Kansas City and St. Louis metropolitan areas and lower $R^2$ values for rural parts of the state. The relationship is not stationary; it varies across the state.

This technique clearly offers new opportunities for educational research but has not been widely applied, thus supporting the additive nature of the research here. The use of GWR to study the variables described in this chapter, as well as the specific variables and models to be applied, is described in the next chapter.

**Looking Ahead**

The research presented here has demonstrated the framework of the proposed study. Literacy achievement has been established as a clear policy goal. The importance of place and the suitability of the state of Missouri have been elucidated. Research on each variable was presented, and the informative nature of the research described. The next chapter, then, will describe the specific methods to be used to examine each of the proposed relationships.
Chapter Three: Methodology Overview

Literacy attainment, most basically the ability to read and write, is critical to a democratic society, future achievement in all subject areas, and the ability to function in modern society (Agnet, 2008). While prior research has identified numerous variables that have significant relationships with academic achievement and, specifically, literacy achievement, these studies fail to consider the contextual factor of place. While studies of neighborhood effects have clearly demonstrated that neighborhood and place have great influence in the lives of individuals, place and location are rarely examined in studies of academic achievement. This chapter will describe the data to be examined with the proposed study. Next, the methods used will be explained. Finally, the research questions will be presented. The purpose of this chapter is to describe the methods used in the proposed study.

Data Sources and Variables

The data set for this study included school district composition factors and literacy achievement outcome measures for 565 school districts in the state of Missouri. The analyses focused on the 2011-2012 school year. Data from this school year was the most up to date available from the Missouri Department of Elementary and Secondary Education. The research examined the relationships of demographic and socioeconomic variables with literacy achievement outcome measures. The academic outcome measures were comprised of MAP scale scores for three grade levels: 4th grade, 8th grade, and the high school English II end-of-course exam given in high school. These three grade levels are not longitudinal, but rather afford a look at the relationships from three school levels, elementary, middle and high school. The English II end-of-course exam replaced the
original 10th grade MAP assessment. The MAP test is the only standardized measure of literacy attainment administered across the state and is required for all Missouri public school students. The test includes multiple-choice questions and a performance event, which is a longer and more demanding writing task (Missouri Department of Elementary and Secondary Education, 2013a). CTB/McGraw-Hill uses the students’ correct responses to derive a MAP scale score. The scale score describes achievement on a continuum. The MAP scale score is also used to determine a student’s achievement level.

The MAP was originally designed as grade-span tests to measure Missouri’s Show-Me Standards. The MAP originated with the 1993 Outstanding Schools Act. This act required that Missouri create a statewide assessment system that measured challenging academic standards. From this act, grade-span assessments were created to measure proficiency of Missouri’s Show-Me standards (MODESE, 2013b).

In 2001 the federal No Child Left Behind (NCLB) legislation was enacted, requiring states to develop grade-level tests in both reading and mathematics to be administered in Grades 3 through 8 and once in Grades 10 through 12. In response to these new requirements, MODESE contracted with CTB/McGraw-Hill in 2003 to expand the testing program to grade-level testing for Communication Arts and Mathematics. The MAP is designed to measure how well students acquire the skills and knowledge described in Missouri’s Grade-Level Expectations (GLEs). The assessments yield information on academic achievement at the student, class, school, district, and state levels (MODESE, 2013b).
MAP Psychometrics

MODESE first established the validity of MAP scores as indices of proficiency relative to the Show-Me Standards by using methodical and rigorous test-development procedures.³ CTB and MODESE have developed MAP assessments in accordance with accepted procedures and criteria (as articulated, for example, in Standards for Educational and Psychological Testing, AERA, APA, NCME, 1985), including intentionally aligning MAP assessments to the specific Show-Me Standards being measured at that grade level and subject area (MODESE, 2013b).

For each assessment, content experts determined that the Terra Nova items for that grade and subject measure the appropriate standards, and Missouri educators wrote constructed-response items and performance events that match the designated standards. Then, groups of Missouri educators reviewed the alignment of each item with the content being assessed. This provided evidence for the content validity of MAP scores (MODESE, 2013b).

Validity of MAP scores was further established by investigating the underlying psychological traits or constructs that a given assessment item measures (MODESE, 2013b). CTB and MODESE continue to routinely examine how performance on individual items is related to performance on other items and how performance on an individual item relates to performance on the entire assessment. The various item- and score-pattern analyses conducted on MAP results show that each assessment is measuring the traits it is intended to measure (e.g., communication arts assessments measure reading

³ Operational data analysis will be included in Appendix A
and writing skills) and does not measure unrelated constructs (MODESE, 2013b). Additional information on validity is included in Appendix A.

**Reliability of MAP scores**

Score dependability or reliability is built into the test-construction process by MODESE. All educational test scores reflect some degree of error and no measurement is perfect. Error can come from a variety of sources: the instrument itself, the examiner, the assessment environment the scoring process, and, in the case of assessments like the MAP, in the process of establishing cut-point scores for the various achievement levels. Reliability refers to the consistency of the students’ test scores on parallel forms of a test. A reliable test produces scores that are expected to be relatively stable if the test is administered repeatedly under similar conditions. Often, however, it is impractical to administer multiple forms of the test, and reliability is estimated on a single administration of the test. This type of reliability, known as internal consistency, provides an estimate of how consistently examinees perform across items within a test during a single test administration (Crocker & Algina, 1986). Reliability is a necessary but not sufficient condition of validity. The reliability of raw scores on the MAP tests was evaluated using Cronbach’s (1951) coefficient alpha, which is a lower-bound estimate of test reliability. The reliability coefficient is a ratio of the variance of true test scores to the variance of the total observed scores, with the values ranging from 0 to 1. The closer the value of the reliability coefficient is to 1, the more consistent the scores, where 1 refers to a perfectly consistent test. As a rule of thumb, reliability coefficients that are equal to or greater than 0.8 are considered acceptable.

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4 Complete details of validity measures provided in Appendix A
Cronbach’s coefficient alpha considers the consistency (reliability) of performance over all test questions in a given form. The results suggest how well the questions measure the content domain and continue to do so over repeated administrations. The number of items in the test influences these statistics; a longer test can be expected to be more reliable than a shorter test.

**Table 3.1: Reliability of Communication Arts Exams**

<table>
<thead>
<tr>
<th>Grade/Test</th>
<th>Cronbach’s coefficient alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.91</td>
</tr>
<tr>
<td>8</td>
<td>0.91</td>
</tr>
<tr>
<td>English II</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Table 3.1 reports Cronbach's coefficient alpha for the three Communication Arts exams. As all of these coefficients are above the rule-of-thumb cut-off of 0.8, the MAP tests in communication arts for these grades are considered reliable.

**Description of variables**

All predictor variables were aggregated to the district level since this study examines the large geographical area of the state. In addition, the area of the district was assumed to approximate a reasonably homogenous local context with the understanding that the underlying processes operate on a spatial continuum (Hogrebe & Tate, 2012). The variables and measures are listed in Table 3.2 and described below.
Table 3.2: Variables and Measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literacy achievement</td>
<td>Grade 4 Communication Arts MAP scale score</td>
</tr>
<tr>
<td></td>
<td>Grade 8 Communication Arts MAP scale score</td>
</tr>
<tr>
<td></td>
<td>English II MAP scale score</td>
</tr>
<tr>
<td>SES</td>
<td>Composite measure including: Free/reduced-price lunch and median household income</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>Percent minority students</td>
</tr>
<tr>
<td>Mobility</td>
<td>Mobility rate for academic year</td>
</tr>
<tr>
<td>Dropout rate</td>
<td>High school dropout rate</td>
</tr>
<tr>
<td>School discipline rate</td>
<td>Discipline incident rate</td>
</tr>
<tr>
<td>Class size</td>
<td>Student-to-teacher ratio</td>
</tr>
<tr>
<td>Teacher Characteristics</td>
<td>Highly-qualified course percentage; teacher salary; percent teachers with master’s degree</td>
</tr>
<tr>
<td>School resources</td>
<td>Per student expenditure</td>
</tr>
</tbody>
</table>

*MAP scale scores:* A scale score indicating a student’s total performance is determined for each content area on the MAP. The overall scale score for a content area quantifies the achievement being measured by the Communication Arts or English II exam. In other words, the scale score represents the students’ level of achievement. Thus, the scale score defines achievement operationally.

*SES:* Composite of *Free/reduced-price lunch:* Percentage enrollment receiving free or reduced-price lunch and *Median Household Income:* Median income at the household level, aggregate for the district from US Census data.

*Minority student percentage:* Percentage of the district enrollment consisting of the total number of students in the following minority groups (Minority pct.): African American, Hispanic, Asian, and American Indian.
*Mobility rate for the academic year:* For the district, the number of students who transfer in or out divided by the total enrollment.

*High school dropout rate:* Number of dropouts divided by total September enrollment, plus transfers in, minus transfers out, minus dropout, added to September enrollment, then divided by 2:

\[
\text{Number of dropouts/((Total September enrollment + (Transfers in [minus] Transfers out [minus] Dropouts)/2)}
\]

*Discipline incident rate:* Number of incidences reported divided by total enrollment. An incident was reported when a student was removed from the traditional classroom setting for 10 or more consecutive days. Multiple short sessions (cumulative removals adding up to 10 days) not included.

*Student-to-teacher ratio:* The ratio of students to regular classroom teachers, excluding special education, remedial reading, Title I, and vocational teachers.

*Highly qualified courses percentage:* Percentage of courses taught by highly qualified teachers. A highly qualified teacher will be defined as an individual with the appropriate teaching certification for his or her teaching assignment. A highly qualified teacher has at least a bachelor’s degree, demonstrated content expertise by passing a state-approved test or completing an academic major or coursework equal to an academic major, and who holds full certification for his or her current teaching assignment. This also includes all subjects, not just English and Communication Arts.

*Average salary:* The average regular-term salary of teachers in the district, excluding fringe benefits.
Teacher with master’s degree percentage: Percentage of teachers in a district with a master’s degree in any field.

Per student expenditure: Average per student expenditure by district, indicating funding level of school.

Methodology

This study consisted of data analysis using Geographic Weighted Regression (GWR). This technique was employed to investigate relationships and effects of district composition factors. With this technique, relationships vary across groups, but it also takes into account the underlying spatial continuum that MLM ignores (Fotheringham, Brunsdon & Charlton, 2002). In this section, the data analysis techniques used in the study will be examined.

Geographic Weighted Regression

Variable relationships were defined and tested using Geographic Weighted Regression (GWR). Once this analysis was completed, local $R^2$ values and statistically significant beta coefficients from the GWR were given spatial perspective by mapping them with ArcMap (ESRI, 10.1). ArcMap is a geographic information system (GIS) software that integrates spatial and non-spatial data to produce maps and analyze spatial relationships.

This technique demonstrates the importance of location in variable relationships by demonstrating their spatial dependence. GWR reflects geographically clustered data as a continuous spatial pattern. One of the assumptions of regression analysis is that the observations are independent of one another. With spatially autocorrelated map distributions, however, units are spatially dependent by definition (Meade & Emch,
2010). This is based on Tobler’s first law of geography (Miller, 2004): “Everything is related to everything else, but near things are more related than distant things” (p. 284). For the current study, this suggests that districts that are closer geographically to one another are more related than districts that are far from one another. Similarity based on geographic location is best represented on a continuum, without strict differences based on geographic boundaries such as district lines. The nature of these relationships is estimated by GWR. These models show spatial relationships vary in space, in this case across the state of Missouri. Creating a visual map using Geographic Information Systems (GIS) provides an opportunity for visual analysis of whether variable relationships are constant across districts or whether they change as a function of location. A geographic variation in the regression relationships is referred to as “nonstationarity” (Fotheringham et al., 2002). This means that the relationships vary across space. Relationships that are significant in one location or part of the state may not be significant in another location. GWR includes the local spatial relationships in the analysis. Unlike in multi-level analysis, the coefficients in GWR are not random, but are a direct function of their spatial location as determined by the geographic weights (Fotheringham et al., 2002).

GWR uses a spatial kernel process to weight data points according to their proximity to a specific location. Data points are not equally weighted based on the observations, so the data points vary by location (see figure 3.1). Data points closer to the specific location are more heavily weighted than more distant points, and through this process of differential weighting by location, GWR calculates an optimum number of
“nearest neighbors.” These “nearest neighbors” are then used to derive each local regression model.

**Figure 3.1: Adaptive Spatial Kerning for Single Data Points (Hogrebe & Tate, 2012)**

Through this process, GWR modifies the standard regression equation to include a geographic weight \((u_i, v_i)\). This geographic weight represents the coordinates of the point \(i\) in space. The weights represent the proximity of each data point to the location of \(i\) so that points closer have more weight in the parameter estimation for location \(i\) (Fotheringham et al, 2002). Incorporating geographic weights, the regression equation for GWR is:

\[
y = \beta_0(u_i, v_i) + \beta_1(u_i, v_i)x_{i1} + \beta_k(u_i, v_i)x_{ik} + \varepsilon
\]

A local regression equation is computed for each district based on the data from that district and the group of its nearest neighbors. For this study, the district polygons were the data points and the spatial kerning is adaptive. The size of the kernel changes as a
function of the number of districts or density of districts in an area. Using the Akaike Information Criterion (AICc), the adaptive spatial kerning process determines the optimal number of nearest neighbors for each district, resulting in the best fitting local regression equation.

For the current study, the relationship between each variable and the MAP scale scores was calculated separately using GWR. Like traditional OLS regression, GWR produces $R^2$ and adjusted $R^2$ values, both of which measure goodness of fit. The $R^2$ value varies from 0.0 to 1.0, where higher values are preferred. The coefficient is interpreted as the proportion of dependent variable variance accounted for by the regression model. The denominator for the $R^2$ equation is the sum of squared dependent variable values. Therefore, adding an extra explanatory variable to the model does not alter the denominator, but does alter the numerator. This then gives the impression of improvement in model fit. Because of this, the adjusted $R^2$ value is a better measure when there is more than one explanatory variable included in the model, as when controlling for SES and race in this study. The adjusted $R^2$ value calculations normalize the numerator and denominator with their respective degrees of freedom. which compensates for the number of variables in a model. Because of this, the adjusted $R^2$ value is almost always smaller than the $R^2$ value. However, in making this adjustment, you lose the interpretation of the value as a proportion of the variance explained. In GWR, the degrees of freedom is a function of the bandwidth so the adjustment may be substantial in comparison to a global model like OLS. For this reason, the Akaike Information Criterion (AICc) is preferred as a means of comparing models. The AICc is a measure of model performance and can be useful when comparing different regression
models. The model with the lower AICc value provides a better fit to the observed data. This is not an absolute measure of goodness of fit, but is useful for comparing models with different explanatory variables as long as they apply to the same dependent variable. If the AICc values for two models differ by more than 3, the model with the lower AICc is considered to have a better fit. Comparing the GWR AICc value to the OLS AICc value is one way to assess the benefits of moving from a global model (OLS) to a local regression model (GWR) as well as to compare the fit of different regression models.

For the study conducted here, $R^2$ values, beta coefficients, and statistically significant relationships were mapped with ArcMap GIS software to show district variation in local regression models across the state. In order to control for the high family-wise Type I error rate, the Benjamin-Hochberg correction for multiple comparisons was applied (Thissen, Steinberg & Kuang, 2002). This technique provides much greater power than the widely used Bonferroni technique that limits the family-wise Type I error rate. Additionally, for the English II models, areal interpolation was used to perform polygon-to-polygon estimates for the districts without high schools. Because the students still live in the district without a high school, the underlying spatial continuum needs to be preserved by accounting for these students. The best estimate of these students’ scores comes from the surrounding districts, as the students would be attending high school in those districts. The values for the districts without high schools, represented as null values in the data set, can be estimated using the values of surrounding districts, given Tobler’s first law of geography.

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5 A Type I error is the incorrect rejection of the null hypothesis when it is true. Usually a type I error leads one to conclude that a supposed effect or relationship exists when, in fact, it doesn't.
Next, to better understand the influences of SES and minority percent on the variables in the final model, each model was examined while controlling for SES and race. This was again done for each grade level or test, still using GWR so that location is included in the model. Given the risk of multicollinearity associated with multiple regression, the condition number provided by the GWR for each model was examined. Condition numbers higher than 30 indicate multicollinearity, so each condition number was examined to ensure that none fell above 30.

While school composition research makes clear the important role that geographic location has on academic outcomes, GIS and, particularly GWR have not been widely used to examine education related outcomes. By using a GWR model that includes location, the data take on new and different meanings, and potentially offer implications for policy stakeholders. This analytic approach therefore informs the research questions answered by the research: First, which, if any, of the school composition variables are related to MAP Communication Arts scale score outcomes when location is included in the model? Relationships between each of the district composition variables and the outcome measure will be examined using GWR. Second, do these relationships change when controlling for SES and race? Each of the significant relationships from the prior question was examined with the SES and percent minority student variables. Again, GWR analysis was used to look for significant effects.

Finally, implicit in the prior two questions is whether variable relationships differ across contexts as a function of geographic location. OLS regression was used to replicate the SES and race relationships without accounting for location as a contextual variable, as with Hogrebe and Tate (2010), and this was used on a comparison basis to
demonstrate the impact of including location in the model. Most significantly, the current study is an extension of the current literature on literacy achievement as well as policy discussions by addressing how relationships vary when geographic location is included as a contextual variable.

By using a new technique and offering a different analytical lens, the research presented here attempts to exhibit some of the nuances that exist in literacy achievement scores. Examining the stationarity of these variable relationships allows this research to potentially offer policy stakeholders new and different approaches to academic achievement and education policy.

**Looking Ahead**

Chapter Four provides the results and maps while Chapter Five provides discussion and conclusions of those results.
Chapter Four: Results

This chapter will provide the results of the analysis conducted in this study. First, each relationship was examined using GWR. After conducting the appropriate tests for independence and significance noted in Chapter Three, the results of the GWR were mapped using GIS to demonstrate how the relationship between literacy achievement on state standardized tests and school district composition variables differed across districts throughout the state of Missouri. Those results will be presented in this chapter.

This chapter is organized by research question. The results for the first research question, “Using the GWR model, which, if any, of the district-level composition variables are significantly related to MAP Communication Arts scale scores for each grade?” will be presented for the fourth, eighth, and English II MAP tests. Next, results for the research question, “How do SES and race/ethnicity moderate these school district composition variable relationships with the GWR?” will be presented. Finally, the results of the final question, “Do the relationships vary across districts as a function of geographic location,” will be discussed.

For each question, the overall R² values for each grade level relationship will be discussed. The overall R² value for each variable can be understood conceptually as the squared correlation between the observed test score and the predicted scores based on the local models. The global R² provided by the GWR, as well as the Akaike Information Criterion (AICc), provide an indication of overall model fit. While AICc is not an absolute measure of good of fit, it provides an index to compare models with different explanatory variables as the apply to the same dependent variables. Lower AICc values
suggest a better model fit, and tend to reflect higher $R^2$ values. Higher $R^2$ values indicate a better model fit and stronger correlation between the variables.

Next, the maps will be presented so that it will be possible to assess the stationarity of the districts. The maps display the local $R^2$ values for each district as well as where those $R^2$ values are significant. Finally, maps of the beta coefficients for each relationship will be presented. These coefficients will show the direction of the relationship, which offers further interpretive value. I begin with the fourth grade results.

**Fourth Grade Results**

The first research question for this study was, “Using the GWR model, which, if any, of the district-level composition variables are significantly related to MAP Communication Arts scale scores for fourth grade?” To answer this question, first, the overall $R^2$ values for each variable will be presented. These values, with the AICc give an estimate as to the overall fit of the model. Next, maps for each variable will be examined to determine whether the relationships are stationary and where the significant relationships exist. Finally, maps the $t$-values for each variable will be discussed, as this demonstrates the direction of the relationship.

The overall $R^2$ values are presented in Table 4.1. Also presented in Table 4.1 are the adjusted $R^2$, the AICc criterion, and the $R^2$ for the OLS regression that was conducted for SES and percent minority students. These overall $R^2$ values and AICc demonstrate the strength of the model fit. A lower AICc and higher $R^2$ generally reflect a stronger model fit. As seen in Table 4.1, the strongest models for the 4th grade MAP test using the AICc were dropout rate and discipline rate. The highest $R^2$ values were found for student to teacher ratio and per student expenditure. Conversely, the highest AICc value and the
lowest overall $R^2$ value was found for highly qualified teachers, with an $R^2$ of just 0.0023.

When compared with the OLS $R^2$, the additional explanatory power of the GWR becomes apparent, as the overall $R^2$ values for both SES and percent minority students are substantially higher for the GWR than for traditional OLS regression. The overall $R^2$ values are informative in terms of model fit, but a more comprehensive picture emerges when we turn to the maps.

**Table 4.1: Grade 4 Overall $R^2$**

<table>
<thead>
<tr>
<th></th>
<th>$R^2$</th>
<th>Adj. $R^2$</th>
<th>AICc</th>
<th>OLS $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SES</td>
<td>0.05363</td>
<td>0.03262</td>
<td>4233.591</td>
<td>0.011432</td>
</tr>
<tr>
<td>Minority %</td>
<td>0.110678</td>
<td>0.075037</td>
<td>4212.7041</td>
<td>0.036531</td>
</tr>
<tr>
<td>Mobility Rate</td>
<td>0.097907</td>
<td>0.07165</td>
<td>4211.94533</td>
<td>0.036531</td>
</tr>
<tr>
<td>Dropout</td>
<td>0.116332</td>
<td>0.089127</td>
<td>4201.351045</td>
<td>0.036531</td>
</tr>
<tr>
<td>Discipline Rate</td>
<td>0.092148</td>
<td>0.060133</td>
<td>4206.443898</td>
<td>0.036531</td>
</tr>
<tr>
<td>Student/Teacher Ratio</td>
<td>0.144548</td>
<td>0.063815</td>
<td>4217.364636</td>
<td>0.036531</td>
</tr>
<tr>
<td>HQT</td>
<td>0.002286</td>
<td>0.000477</td>
<td>4233.148606</td>
<td>0.036531</td>
</tr>
<tr>
<td>Average Salary</td>
<td>0.01552</td>
<td>0.013735</td>
<td>4225.724192</td>
<td>0.036531</td>
</tr>
<tr>
<td>%Masters</td>
<td>0.033159</td>
<td>0.01403</td>
<td>4228.873361</td>
<td>0.036531</td>
</tr>
<tr>
<td>Per Student Expenditure</td>
<td>0.124876</td>
<td>0.068184</td>
<td>4223.8399</td>
<td>0.036531</td>
</tr>
</tbody>
</table>

**Socioeconomic status.** I begin first with socioeconomic status at the fourth grade level. As shown with Figure 4.1, for SES at the fourth grade level, the highest $R^2$ values were found in northwestern Missouri, and in the bootheel of the state. Of these values, the largest cluster of statistically significant values stretches from the Kansas City metropolitan area through northwest Missouri, (Figure 4.2). Statistically significant relationships occur despite local $R^2$ values below 0.10. As seen in Figure 4.3, the statistically significant beta coefficients are negative, meaning that the relationship is negative in that districts with a larger low-SES measure are correlated with lower fourth grade MAP communication arts scores.
**Percent minority students.** For percent minority students, the highest local $R^2$ values were seen in the two metropolitan areas of Kansas City and St. Louis, with higher $R^2$ values in the St. Louis area (see Figure 4.4). The statistically significant beta coefficients, seen in Figure 4.5, were found in the two metropolitan areas extending well
into suburban and rural areas. The highest local $R^2$ values were found in the Kansas City and St. Louis areas, with a high value of 0.33. As seen in Figure 4.6, the beta coefficients ranged from -5.72, a strong and statistically significant negative relationship, to 1.68. The positive coefficients were not statistically significant.

**Figure 4.4**
% Minority, 4th MAP ($R^2$)

**Figure 4.5:**
% Minority, 4th MAP (significant beta coefficients)
Figure 4.6
% Minority, 4th MAP (beta coefficients, t-test values)

**Mobility.** Statistically significant local $R^2$ values for mobility were seen in the Kansas City and St. Louis metropolitan areas, as well as in the bootheel of the state (see Figure 4.8). The highest local $R^2$ values were 0.18, as demonstrated in Figure 4.7. The statistically significant beta coefficients were negative, meaning that a higher mobility rate was associated with lower MAP scores (see Figure 4.6).
Dropout rate. The strongest relationships for dropout rate were in the eastern and western portions of the state (see Figure 4.10), with a large number of statistically significant coefficients clustered around the Kansas City and St. Louis metropolitan areas and spreading along both the eastern and western borders as well as across the middle of
the state (see Figure 4.11). The highest local $R^2$ values were near 0.25, as shown in Figure 4.10. The statistically significant beta coefficients were all negative, indicating that a higher dropout rate is correlated with lower MAP scores (see Figure 4.12).

**Figure 4.10**
Dropout, 4th MAP ($R^2$)

**Figure 4.11**
Dropout, 4th MAP (significant beta coefficients)

**Figure 4.12**
Dropout, 4th MAP (beta coefficient, t-test value)
**Discipline rate.** The strongest relationships for discipline rate and fourth grade MAP communication arts scores were found in the two metropolitan areas and across the central part of the state, as seen in Figure 4.13. The highest local $R^2$ values were found in these areas, with values of 0.19. As Figure 4.14 indicates, statistically significant $R^2$ coefficients were found for areas extending north and south of both Kansas City and St. Louis. Both negative and positive relationships were found to be statistically significant (Figure 4.15). As Figures 4.15 demonstrates, the negative relationships were found primarily in the two urban areas, while the positive relationships were found in northern rural Missouri.

**Figure 4.13**  
Discipline, 4th MAP ($R^2$)  
**Figure 4.14**  
Discipline, 4th (significant beta coefficients)
Student-to-teacher ratio. Statistically significant relationships were found for student-to-teacher ratio, with a few small clusters of statistically significant relationships scattered through the state (Figure 4.17). The three largest clusters were in north-central Missouri, the St. Louis metropolitan area, and the bootheel (Figure 4.17). Of these, the highest $R^2$ values of 0.24 were found in the St. Louis area and the bootheel (Figure 4.16). As seen in Figure 4.18, the statistically significant beta coefficients were negative.
Figure 4.16
Student-Teacher Ratio, 4\textsuperscript{th} MAP (R\textsuperscript{2})

Figure 4.17
Student-Teacher Ratio, 4\textsuperscript{th} MAP (significant beta coefficients)

Figure 4.18
Student-Teacher Ratio, 4\textsuperscript{th} MAP (beta coefficient, t-test values)

Percent highly qualified teachers. None of the relationships for percent highly qualified teachers were statistically significant, and so those maps are not presented here. With local R\textsuperscript{2} values approaching zero, and no significant findings, examination of the outcomes is not appropriate and so those maps are not presented.
**Average teacher salary.** None of the relationships for average teacher salary were statistically significant and so those maps are not presented here. As with percent qualified teachers the non-significant results cannot be analyzed.

**Percent of teachers holding a master’s degree.** The strongest relationships for percent of teachers holding a master’s degree and fourth grade communication arts MAP scores were found in Kansas City, extending into, northwest Missouri and in the St. Louis area extending south (see Figure 4.19). Figure 4.20 demonstrates that those relationships were statistically significant primarily in the Kansas City area and extending northwest, with scattered significant relationships in the eastern part of the state. The $R^2$ values for these districts were quite small, with the highest $R^2=0.04$ (see Figure 4.19). While the statistically significant beta coefficients in the western and southern parts of the state were positive, the statistically significant coefficients in the northeastern corner of the state were negative, as shown in Figure 4.21. This means that a higher proportion of teachers with masters degree is actually associated with lower achievement in the northeast corner of the state, while a higher proportion of teachers with masters degrees is associated with higher achievement elsewhere in the state.
Per student expenditure. The highest $R^2$ values for per student expenditure mapped in Figure 4.22 were found in the northwestern and northeastern corners of the state (see Figure 4.23), as well as the bootheel. As shown in Figure 4.22, the highest $R^2$ values were near 0.25. Statistically significant coefficients, though, were found in clusters in
north central Missouri, and then for the Kansas City and St. Louis metropolitan areas (see Figure 4.23). Statistically significant clusters were found for both negative and positive coefficients (see Figure 4.24). As Figure 4.24 demonstrates, in the Kansas City area, higher per student expenditure is actually associated with lower student performance, while in north-central Missouri and the bootheel, higher per student expenditure is associated with higher MAP Communication Arts scores.

**Figure 4.22**
Expenditure, 4th MAP ($R^2$)

**Figure 4.23**
Expenditure, 4th
(significant beta coefficients)
Figure 4.24
Expenditure, 4th MAP (beta coefficient, t-test values)

Eighth Grade Results

This section will present the results for the second research question, “Using the GWR model, which, if any, of the district-level composition variables are significantly related to MAP Communication Arts scale scores for eighth grade?” First, the overall $R^2$ values for each variable will be presented. These values, with the AICc give an estimate as to the overall fit of the model. Next, maps for each variable will be examined to determine whether the relationships are stationary and where the significant relationships exist. Finally, the beta coefficient $t$-values for each variable will be discussed.

The overall $R^2$ values are presented in Table 4.2. Also presented in Table 4.2 are the adjusted $R^2$, the AICc, and the $R^2$ for the OLS regression that was conducted for SES and percent minority students. These overall $R^2$ values and AICc demonstrate the strength of the model fit. A lower AICc and higher $R^2$ generally reflect a stronger model fit.
For eighth grade MAP communication arts scores, the highest overall $R^2$ values were for per student expenditure, with $R^2=0.296$ and percent minority students, with $R^2=0.25$. The lowest $R^2$ values were for mobility rate and percent highly qualified teachers. For both SES and percent minority students, the over $R^2$ improved from the OLS regression, with SES improving from 0.011 to 0.091 and percent minority students improving from 0.09 to 0.25. This indicates that the GWR model is a better overall fit than the traditional OLS model. I turn now to an examination of each individual model for grade 8 communication arts scores.

**Table 4.2: Grade 8 Overall $R^2$**

<table>
<thead>
<tr>
<th>Variable</th>
<th>$R^2$</th>
<th>Adj. $R^2$</th>
<th>AICc</th>
<th>OLS $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SES</td>
<td>0.090781</td>
<td>0.045955</td>
<td>4191.4837</td>
<td>0.011432</td>
</tr>
<tr>
<td>Minority %</td>
<td>0.248546</td>
<td>0.153548</td>
<td>4142.8948</td>
<td>0.090487</td>
</tr>
<tr>
<td>Mobility Rate</td>
<td>0.092492</td>
<td>0.06207</td>
<td>4177.952316</td>
<td></td>
</tr>
<tr>
<td>Dropout</td>
<td>0.146808</td>
<td>0.103308</td>
<td>4156.458453</td>
<td></td>
</tr>
<tr>
<td>Discipline Rate</td>
<td>0.172639</td>
<td>0.114075</td>
<td>4140.96077</td>
<td></td>
</tr>
<tr>
<td>Student/Teacher Ratio</td>
<td>0.237399</td>
<td>0.108968</td>
<td>4167.198598</td>
<td></td>
</tr>
<tr>
<td>HQT</td>
<td>0.12082</td>
<td>0.096603</td>
<td>4141.196833</td>
<td></td>
</tr>
<tr>
<td>Average Salary</td>
<td>0.151483</td>
<td>0.066993</td>
<td>4175.204147</td>
<td></td>
</tr>
<tr>
<td>% Masters</td>
<td>0.241064</td>
<td>0.109993</td>
<td>4166.658259</td>
<td></td>
</tr>
<tr>
<td>Per Student Expenditure</td>
<td>0.295677</td>
<td>0.160991</td>
<td>4154.480325</td>
<td></td>
</tr>
</tbody>
</table>

**Socioeconomic status.** The two largest statistically significant clusters for socioeconomic status at the eighth grade level were in the Kansas City metropolitan area and the bootheel of the state, as seen in Figure 4.26. These two areas also represent the highest $R^2$ values of around 0.16 (see Figure 4.25). The beta coefficients for these statistically significant clusters were negative, indicating that more poverty was associated with lower scores on the eighth grade MAP assessment (see Figure 4.27).
Percent minority students. As Figure 4.28 shows, for the grade 8 test, the highest local $R^2$ for percent minority students were found in the St. Louis and Kansas City metropolitan areas and in southeastern Missouri, with local $R^2$ values as high as 0.58. The statistically significant beta coefficients were also found in those areas, with the
largest clusters of statistically significant values located in the two metropolitan areas as well southeastern Missouri (see Figure 4.29). The statistically significant beta coefficients which were negative indicate a higher percent of minority students is associated with lower eighth grade MAP scores.

**Figure 4.28**
% Minority, 8\textsuperscript{th} MAP ($R^2$)

**Figure 4.29**
% Minority, 8\textsuperscript{th} MAP (significant beta coefficients)
**Figure 4.30**
% Minority, 8th MAP (beta coefficient, *t*-test values)

**Mobility rate.** The largest $R^2$ values for mobility rate were found again in the Kansas City and St. Louis metropolitan areas (see Figure 4.31). The highest local $R^2$ values were 0.19, where statistically significant beta coefficients were found across the eastern and western parts of the state, where the statistically significant coefficients were all negative (see Figures 4.32 and 4.33). This demonstrates a negative relationship between mobility rate and grade 8 communication arts MAP scores.
**Figure 4.31**
Mobility, 8th MAP ($R^2$)

**Figure 4.32**
Mobility, 8th MAP (significant beta coefficients)

**Figure 4.33**
Mobility, 8th MAP (beta coefficient, $t$-test values)

**Dropout rate.** For dropout rate, the highest local $R^2$ values were found in the St. Louis area, where the largest $R^2$ values were 0.31 (see Figure 4.34). As Figure 4.35 demonstrates, statistically significant beta coefficients were clustered around the two
metropolitan areas. As Figure 4.36 shows, the statistically significant beta coefficients were negative throughout these clusters, indicating that a higher dropout rate is associated with lower MAP communication arts scores in the eighth grade.
**Discipline rate.** For discipline rate, the highest $R^2$ values were found in the Kansas City and St. Louis metropolitan areas, extending south through the bootheel, shown in Figure 4.37. The highest local $R^2$ values were 0.34 (Figure 4.37). The statistically significant relationships, which were negative, were found in and around the two metropolitan areas (see Figures 4.37 and 4.38). The negative relationships thus demonstrate that a higher discipline rate is correlated with lower MAP scores for statistically significant relationships.

**Figure 4.37**
Discipline, $8^{th}$ ($R^2$)

**Figure 4.38**
Discipline, $8^{th}$
(significant beta coefficients)
Figure 4.39  
Discipline, 8th (beta coefficients, t-test values)

**Student-to-teacher ratio.** For student-to-teacher ratio at the eighth grade level, the highest $R^2$ values of 0.54 were found in the St. Louis area and northeast of the St. Louis area, as seen in Figure 4.37. Statistically significant beta coefficients were found in large clusters around the Kansas City and St. Louis areas, extending along much of the eastern and western borders (see Figure 4.38). As Figure 4.39 demonstrates, the statistically significant beta coefficients were negative, indicating that a lower teacher-to-student ratio is correlated with higher MAP scores, and a higher student-to-teacher ratio with lower MAP scores. Again, the statistically significant relationships were found in large clusters around the two major urban areas of Kansas City and St. Louis (see Figure 4.38).
Percent highly qualified teachers. As Figure 4.43 demonstrates, for the relationship between highly qualified teachers and the eighth grade communication arts exam MAP, the highest $R^2$ values, near 0.34, were found in southern portion of the state. A large number of statistically significant beta coefficients, shown in Figure 4.44, were also
found in this area. The $t$-values for these statistically significant beta coefficients were positive, meaning that a larger percentage of highly qualified teachers in these districts is correlated with higher MAP scores (see Figure 4.45).

**Figure 4.43**
%Qualified, 8th MAP ($R^2$)

**Figure 4.44:**
%Qualified, 8th MAP (significant beta coefficients)

**Figure 4.45**
% Qualified, 8th MAP (beta coefficient, $t$-test values)
**Average teacher salary.** As seen in Figure 4.47, three distinct but small clusters of statistically significant relationships were found for average teacher salary and grade 8 MAP scores: northeast of the St. Louis area, the St. Louis area and extending south, and the bootheel. Local $R^2$ values for these clusters were as high as 0.32 (see Figure 4.46). Beta coefficients ranged from -4.24 to 3.24, with both negative and the positive values statistically significant (see Figure 4.48). This means that the direction of the relationship of average teacher salary to eighth grade MAP communication arts performance is dependent upon geographic location, where in some areas higher teacher salary is correlated with lower test performance, while in other districts the inverse is true. For the clusters of statistically significant relationships in northeastern and southeastern Missouri, the correlation was actually negative, with higher salaries associated with lower MAP outcomes. South of the St. Louis area, conversely, the relationships were positive, where higher average teacher salary was correlated with higher MAP outcomes (see Figure 4.48).
Percent of teachers holding a master’s degree. As Figure 4.50 demonstrates, statistically significant values for percent teachers holding a master’s degree were primarily found in the Kansas City and St. Louis metropolitan areas. Though local $R^2$ values as high as 0.29 were scattered in small clusters throughout the state, shown in
Figure 4.49, many of those values were not statistically significant. Only the positive beta coefficients were statistically significant, meaning that an increase in percent teachers holding a master’s degree is correlated with higher MAP scores (see Figure 4.51).

**Figure 4.49**
%Master, 8th MAP ($R^2$)

**Figure 4.50**
%Master, 8th MAP
(significant beta coefficients)
**Per student expenditure.** Statistically significant values for per student expenditure were found in the St. Louis and Kansas City metropolitan areas, extending along the eastern and western borders of the state, as seen in Figure 4.53. The highest $R^2$ values were found in several clusters across the state (see Figure 4.52), while only the clusters in the eastern and western parts of the state found to be statistically significant. The highest local $R^2$ values were 0.51, showing a strong relationship (Figure 4.52). Statistically significant relationships were found for both positive and negative $t$-values. In the two metropolitan areas, the relationship was negative, where higher per student expenditure was associated with lower MAP scores. In southeastern Missouri the relationship was positive, so that higher per student expenditure is associated with higher MAP scores (see Figure 4.54). This shows the effect that geographic location can have in examining this variable.
**English II Results**

This section will present the results for the English II end-of-course exam. First, the overall $R^2$ values for each variable will be presented. These values, with the AICc, give an estimate as to the overall fit of the model. Next, maps for each variable will be
examined to determine whether the relationships are stationary and where the significant relationships exist. Finally, the beta coefficient $t$-values for each variable will be discussed.

For the English II end-of-course exam, the highest $R^2$ values were found for percent minority students ($R^2=0.28$) and dropout rate ($R^2=0.22$). The lowest AICc values were also for minority percent and dropout rate, indicating that those two models had the best overall fit.

The comparison to the OLS models for SES and percent minority students indicate a better model fit for the GWR. For SES, the $R^2$ value improved from 0.000412 to 0.12 while for percent minority percent the $R^2$ improved from 0.058 to 0.28. Both of these comparisons show a substantially better model fit for the GWR models.

**Table 4.3: English II Overall $R^2$**

<table>
<thead>
<tr>
<th></th>
<th>$R^2$</th>
<th>Adj. $R^2$</th>
<th>AICc</th>
<th>OLS $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SES</td>
<td>0.12353</td>
<td>0.067294</td>
<td>3303.89094</td>
<td>0.000412</td>
</tr>
<tr>
<td>Minority %</td>
<td>0.284466</td>
<td>0.19441</td>
<td>3236.6884</td>
<td>0.057981</td>
</tr>
<tr>
<td>Mobility Rate</td>
<td>0.145131</td>
<td>0.099657</td>
<td>3281.208295</td>
<td></td>
</tr>
<tr>
<td>Dropout</td>
<td>0.224764</td>
<td>0.155959</td>
<td>3252.912294</td>
<td></td>
</tr>
<tr>
<td>Discipline Rate</td>
<td>0.2055227</td>
<td>0.132752</td>
<td>3258.685126</td>
<td></td>
</tr>
<tr>
<td>Student/Teacher Ratio</td>
<td>0.133015</td>
<td>0.082715</td>
<td>3281.25154</td>
<td></td>
</tr>
<tr>
<td>HQT</td>
<td>0.060315</td>
<td>0.034526</td>
<td>3302.898457</td>
<td></td>
</tr>
<tr>
<td>Average Salary</td>
<td>0.131651</td>
<td>0.080998</td>
<td>3282.415043</td>
<td></td>
</tr>
<tr>
<td>%Masters</td>
<td>0.195326</td>
<td>0.109422</td>
<td>3276.195672</td>
<td></td>
</tr>
<tr>
<td>Per Student Expenditure</td>
<td>0.127881</td>
<td>0.072132</td>
<td>3300.511765</td>
<td></td>
</tr>
</tbody>
</table>

**Socioeconomic status.** As shown in Figure 4.55, the highest local $R^2$ values for SES and the English II end-of-course exam were found in the bootheel, with the highest value approximately 0.36. While some of these values were statistically significant, there were few statistically significant relationships, with small clusters in the southern portion of the state, and one statistically significant district in northern Missouri (see Figure 4.56).
The $t$-values for the relationships were distributed so that the negative relationships were in the two metropolitan areas, extending into the bootheel, while a large number of non-significant positive relationships extended through the central part of the state (see Figure 4.57). Interestingly, one small significant cluster in the southwestern corner of the state did demonstrate a positive relationship, meaning that a higher proportion of poverty was associated with higher English II scores (see Figure 4.57).

**Figure 4.55**
SES, English II ($R^2$)

**Figure 4.56**
SES, English II (significant beta coefficients)
**Figure 4.57**  
SES, English II (beta coefficients, *t*-test values)

**Percent minority students.** The variable of percent minority students had the best model fit for the English II EOC with an overall $R^2$ of 0.28 (see Figure 4.58). As shown in Figure 4.59, the clusters of statistically significant beta coefficients were found around the Kansas City and St. Louis metropolitan areas, with the cluster extending well north and south of the St. Louis area. The local $R^2$ values were as high as 0.58, indicating a strong correlation (Figure 4.58). The statistically significant beta coefficients, found in the two metropolitan areas, were all negative, but the lowest *t*-values were found in the St. Louis metropolitan area, indicating a stronger negative relationship in that area (see Figure 4.60).
**Mobility rate.** As shown in Figure 4.61, the highest local $R^2$ values of 0.38 for mobility rate were found in the bootheel but were not statistically significant, while smaller $R^2$ values in other areas of the state were significant, with large clusters of statistically
significant values around the Kansas City and St. Louis metropolitan areas (see Figure 4.62). The areas with significant beta coefficients also demonstrated negative relationships (Figure 4.63).

**Figure 4.61**
Mobility, English II ($R^2$)

**Figure 4.62**
Mobility, English II (significant beta coefficients)

**Figure 4.63**
Mobility, English II (beta coefficients, $t$-test values)
**Dropout rate.** The strongest correlations for dropout rate were found in the Kansas and St. Louis areas, where the highest local $R^2$ values were 0.31 (see Figure 4.64). This is also where the statistically significant beta coefficients were clustered (see Figure 4.65). Strong negative relationships were seen in the St. Louis and Kansas City areas (see Figure 4.66).

**Figure 4.64**
Dropout, English II ($R^2$)

**Figure 4.65:**
Dropout, English II (significant beta coefficients)
Figure 4.66  
Dropout, English II (beta coefficients, $t$-test values)

Discipline rate. As Figures 4.67 and 4.68 demonstrate, while the statistically significant beta coefficients were found in the St. Louis and Kansas City metropolitan areas for discipline rate, the local $R^2$ values were the highest in the St. Louis metropolitan area, with $R^2$ values as high as 0.41. This is consistent with the $t$-values, shown in Figure 4.69, demonstrating a strong negative relationship. For the small cluster in the north-central area of the state, the relationship was actually slightly positive, indicating that a higher discipline rate was actually correlated with higher English II scores (see Figure 4.69). This is in contrast to the St. Louis and Kansas City clusters, where a higher discipline rate was correlated with lower test scores.
**Student-to-teacher ratio.** Figure 4.71 shows three distinct clusters of statistically significant values for student-to-teacher ratio and the English II exam. These include a large area in western Missouri, a small cluster in the St. Louis area, and a cluster in southeastern Missouri, not including the bootheel (Figure 4.71). The statistically
significant local $R^2$ values were only 0.13, again indicating that even a small $R^2$ value may be statistically significant (Figure 4.70). The picture becomes slightly more complicated when the beta coefficients, presented in Figure 4.72, are examined. While the $t$-values in the St. Louis area are negative and statistically significant, both of the other clusters represent $t$-values that are positive and statistically significant. This means that depending on geographic location, the relationship of student-to-teacher ratio and English II scores may actually be reversed.

**Figure 4.70**
Student-Teacher Ratio, English II ($R^2$)

**Figure 4.71**
Student-Teacher Ratio, English II, (significant beta coefficients)
Highly qualified teachers. The variable of highly qualified teachers had a very poor relationship with the English II EOC exam. Because of the very low local $R^2$ values and the lack of statistical significance, those maps are not included here.

Average teacher salary. While the highest local $R^2$ values for average teacher salary were just 0.18, statistically significant beta coefficients were found across the western part of the state along nearly the entire border (see Figures 4.73 and 4.74). In addition, statistically significant coefficients were found to extend through south central Missouri (Figure 4.74). The $t$-values associated with this large cluster of statistically significant values are all positive, indicating that there is a positive correlation between average teacher salary and English II exam scores (see Figure 4.75).
Percent of teachers holding a master’s degree. The largest cluster of statistically significant beta coefficients for percent of teachers holding master’s degrees was found in the Kansas City area, extending north to the Missouri/Iowa border, shown in Figure 4.77. Two additional clusters were found in and south of the St. Louis area, and in southeastern
Missouri, not including the bootheel (Figure 4.77). The highest local $R^2$ values were found in and north of the Kansas City metropolitan area, with the highest local $R^2$ values of 0.37 (Figure 4.76). All of the statistically significant beta coefficients were positive, meaning that a higher percentage of teachers holding masters degrees is associated with higher scores on the English II exam (see Figure 4.78).

**Figure 4.76**

%Master, English II ($R^2$)

**Figure 4.77**

%Master, English II
(significant beta coefficients)
Per student expenditure. For per student expenditure, the highest local $R^2$ values ($R^2=0.18$) were found in southeastern Missouri, including the bootheel (see Figure 4.79). Still, many of those relationships were not statistically significant, with only a few of the districts in that area having statistically significant beta coefficients (see Figure 4.80). In addition, smaller $R^2$ values, including some values under 0.10, were found to be significant in the Kansas City area and along the western Missouri border (see Figure 4.79). As Figure 4.81 shows, the two largest clusters, around the Kansas City area and in southeastern Missouri, showed a negative relationship, meaning that higher per student expenditure was associated with lower English II scores. Alternatively, the cluster in southwestern Missouri had a positive $t$-values, indicating that a higher per student expenditure was correlated with higher English II test scores.
Controlling for SES and Race

We turn next to the research question, “How do these variable relationships change when controlling for SES and race?” To address this question, the adjusted $R^2$ and AICc values for each model were examined. The $R^2$, adjusted $R^2$, and AICc values
for all relationships are reported below by grade level. In order to find which models showed improvement, the AICc and adjusted $R^2$ values were examined. Those values indicating an improved model fit, as indicated by higher adjusted $R^2$ and lower AICc are italicized below. As the table demonstrates, many of the relationships showed a higher overall adjusted $R^2$ value and lower AICc, which suggests a better model fit. Next, each of the relationships found to be a better model fit based on the overall adjusted $R^2$ and the AICc were examined for significant coefficients. Those maps are presented by grade level below. This chapter will review those results, while the results will be interpreted in context in the next chapter.

**Fourth Grade Models Controlling for SES and Race**

Upon examination of the local $R^2$ values and the statistically significant beta coefficients, several new insights emerge. For student-to-teacher ratio while controlling for SES, the highest $R^2$ values were found in the Kansas City and St. Louis metropolitan areas and the bootheel (see Figure 4.82). The statistically significant beta coefficients were found in the these two metropolitan areas and scattered across the central part of the state (Figure 4.83). The $t$-values for this model were all positive, so that when SES was controlled for, a higher student-to-teacher ratio was associated with higher scores on the fourth grade communication arts MAP exam (Figure 4.84).
Table 4.4: Fourth Grade Models

<table>
<thead>
<tr>
<th></th>
<th>R²</th>
<th>Adj. R²</th>
<th>AICc</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>0.097907</td>
<td>0.07165</td>
<td>4211.94533</td>
</tr>
<tr>
<td>Mobility+SES</td>
<td>0.107317</td>
<td>0.073798</td>
<td>4214.2091</td>
</tr>
<tr>
<td><strong>Mobility+Minority %</strong></td>
<td>0.135343</td>
<td>0.094526</td>
<td>4203.7295</td>
</tr>
<tr>
<td>Dropout Rate</td>
<td>0.116332</td>
<td>0.089127</td>
<td>4201.35104</td>
</tr>
<tr>
<td>Dropout+SES</td>
<td>0.115488</td>
<td>0.083044</td>
<td>4207.790167</td>
</tr>
<tr>
<td>Dropout+Minority%</td>
<td>0.130365</td>
<td>0.092835</td>
<td>4203.316873</td>
</tr>
<tr>
<td>Discipline Rate</td>
<td>0.092148</td>
<td>0.060133</td>
<td>4206.443898</td>
</tr>
<tr>
<td>Discipline+SES</td>
<td>0.101724</td>
<td>0.063757</td>
<td>4207.446886</td>
</tr>
<tr>
<td>Discipline+Minority%</td>
<td>0.10907</td>
<td>0.067636</td>
<td>4205.940189</td>
</tr>
<tr>
<td>Student/Teacher Ratio</td>
<td>0.144548</td>
<td>0.063815</td>
<td>4217.364636</td>
</tr>
<tr>
<td><strong>Ratio+SES</strong></td>
<td>0.168493</td>
<td>0.086201</td>
<td>4206.904553</td>
</tr>
<tr>
<td><strong>Ratio+Minority %</strong></td>
<td>0.247936</td>
<td>0.142193</td>
<td>4182.50447</td>
</tr>
<tr>
<td>HQT</td>
<td>0.002286</td>
<td>0.000477</td>
<td>4233.148606</td>
</tr>
<tr>
<td><strong>%HQT+SES</strong></td>
<td>0.051175</td>
<td>0.025382</td>
<td>4225.005268</td>
</tr>
<tr>
<td><strong>%HQT+Minority %</strong></td>
<td>0.086722</td>
<td>0.057117</td>
<td>4208.161366</td>
</tr>
<tr>
<td>Average Salary</td>
<td>0.01552</td>
<td>0.013735</td>
<td>4225.724192</td>
</tr>
<tr>
<td><strong>Salary+SES</strong></td>
<td>0.08191</td>
<td>0.058341</td>
<td>4205.930322</td>
</tr>
<tr>
<td><strong>Salary+%Minority</strong></td>
<td>0.139173</td>
<td>0.116801</td>
<td>4170.497005</td>
</tr>
<tr>
<td>% Teachers with Master's</td>
<td>0.033159</td>
<td>0.01403</td>
<td>4228.873361</td>
</tr>
<tr>
<td><strong>%Masters+SES</strong></td>
<td>0.075769</td>
<td>0.045871</td>
<td>4214.708537</td>
</tr>
<tr>
<td><strong>%Masters+%Minority</strong></td>
<td>0.132631</td>
<td>0.094925</td>
<td>4188.135105</td>
</tr>
<tr>
<td>Per Student Expenditure</td>
<td>0.122147</td>
<td>0.058006</td>
<td>4230.2195</td>
</tr>
<tr>
<td><strong>Expenditure+SES</strong></td>
<td>0.124876</td>
<td>0.068184</td>
<td>4223.8399</td>
</tr>
<tr>
<td><strong>Expenditure+Minority %</strong></td>
<td>0.203451</td>
<td>0.138088</td>
<td>4184.55104</td>
</tr>
</tbody>
</table>
The same appears to be true when percent minority students was controlled for in the fourth grade student-to-teacher ratio model. Again, the highest $R^2$ values were found in the Kansas City and St. Louis metropolitan areas, while the statistically significant beta coefficients did not appear to demonstrate a clear pattern (Figure 4.85). Rather,
statistically significant districts were scattered across the state (Figure 4.86). There were statistically significant districts with both negative and positive $t$-values, indicating that the relationship varies based on geographic location (Figure 4.87).

**Figure 4.85**
Student-Teacher Ratio +% Minority, 4th ($R^2$)

**Figure 4.86**
Student-Teacher Ratio +% Minority, 4th (significant beta coefficients)

**Figure 4.87**
Student-Teacher Ratio +% Minority, 4th (beta coefficients, $t$-test values)
When controlling for percent minority students, the maps for student to teacher ratio show the highest $R^2$ values to be located in the northwest and southeast corners of the state (Figure 4.88). Statistically significant beta coefficients, though, were found across the state, with statistically significant coefficients found throughout much of the state (see Figure 4.89). The $t$-values for these statistically significant coefficients were all positive (see Figure 4.90).

**Figure 4.88**
Salary+SES, 4th ($R^2$)

**Figure 4.89**
Salary+SES, 4th (significant beta coefficients)
When percent minority students was controlled for in the fourth grade model for average teacher salary, the highest $R^2$ values were again found in the metropolitan areas of the state (see Figure 4.91). As Figures 4.92 and 4.93 demonstrate, the statistically significant beta coefficients were scattered across the state, however the statistically significant $t$-values for this model were negative. So, when minority percent was controlled for, the relationship between teacher salary and fourth grade communication arts MAP outcomes actually became negative.
When SES was controlled for in the fourth grade average teacher salary model, the highest local $R^2$ values were found in the northwest corner of the state, as Figure 4.94 demonstrates. Statistically significant beta coefficients were found across northwestern Missouri, extending into the central and east-central portions of the state (see Figure
These coefficients were positive, representing positive relationships (see Figure 4.96)

**Figure 4.94**  
Master+SES, 4th ($R^2$)

**Figure 4.95**  
Master+SES, 4th  
(significant beta coefficients)

When percent minority students was controlled for in the fourth grade percent of teachers holding a masters degree model, the highest $R^2$ values were found along the
eastern and western borders of the state (see Figures 4.97 and 4.98). The statistically significant beta coefficients for these districts were positive (Figure 4.99).

**Figure 4.97**
\%	ext{Master}+\%	ext{Minority, 4}^{\text{th}} (R^2)

**Figure 4.98**
\%	ext{Master}+\%	ext{Minority, 4}^{\text{th}} (significant beta coefficients)

**Figure 4.99**
\%	ext{Master}+\%	ext{Minority, 4}^{\text{th}} (beta coefficients, \text{t}-test values)
As Figure 4.100 demonstrates, when percent minority students was controlled for in the per student expenditure model for fourth grade model, the highest $R^2$ values were found in the St. Louis metropolitan area as well north central Missouri. The statistically significant beta coefficients for these two areas varied from negative to positive $t$-values (see Figures 4.101 and 4.102). Therefore, the direction of the relationship is dependent upon the individual district.

**Figure 4.100**
Expenditure+$\%$Minority, 4$^{th}$ ($R^2$)

**Figure 4.101**
Expenditure+$\%$Minority, 4$^{th}$ (significant beta coefficients)
Eighth Grade Models Controlling for SES and Race

Next I turn to for the eighth grade MAP exam which controlled for SES and race. Again, the adjusted $R^2$ values and the AICc indicated that several models showed improved model fit. These include mobility rate when controlling for percent minority students, dropout rate while controlling for percent minority students, student-to-teacher ratio while controlling for minority students, percent of teachers holding a masters degree while controlling for SES, highly qualified teachers while controlling for minority students, average teacher salary while controlling for SES, average teacher salary while controlling for percent minority students, percent master’s degree while controlling for percent minority students, and finally per student expenditure while controlling for percent minority students. Of these models, all were statistically significant with the exceptions of mobility rate while controlling for percent minority students as well as average teacher salary and percent minority students. Each of the statistically significant models is presented below.
Table 4.5: Eighth Grade Models

<table>
<thead>
<tr>
<th>Grade 8</th>
<th>R²</th>
<th>Adj. R²</th>
<th>AICc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>0.092492</td>
<td>0.06207</td>
<td>4177.952316</td>
</tr>
<tr>
<td>Mobility+SES</td>
<td>0.098339</td>
<td>0.064345</td>
<td>4179.2096</td>
</tr>
<tr>
<td>Mobility+Minority %</td>
<td>0.132616</td>
<td>0.105917</td>
<td>4152.06379</td>
</tr>
<tr>
<td>Dropout Rate</td>
<td>0.146808</td>
<td>0.103308</td>
<td>4156.458453</td>
</tr>
<tr>
<td>Dropout+SES</td>
<td>0.12461</td>
<td>0.089339</td>
<td>4164.83212</td>
</tr>
<tr>
<td>Dropout+Minority%</td>
<td>0.152081</td>
<td>0.120327</td>
<td>4144.159058</td>
</tr>
<tr>
<td>Discipline Rate</td>
<td>0.172639</td>
<td>0.114075</td>
<td>4140.96077</td>
</tr>
<tr>
<td>Discipline+SES</td>
<td>0.162709</td>
<td>0.104413</td>
<td>4148.62389</td>
</tr>
<tr>
<td>Discipline+Minority%</td>
<td>0.17139</td>
<td>0.118652</td>
<td>4138.001198</td>
</tr>
<tr>
<td>Student/Teacher Ratio</td>
<td>0.237399</td>
<td>0.108968</td>
<td>4167.198598</td>
</tr>
<tr>
<td>Ratio+SES</td>
<td>0.183125</td>
<td>0.094838</td>
<td>4136.034441</td>
</tr>
<tr>
<td>Ratio+Minority%</td>
<td>0.263836</td>
<td>0.166446</td>
<td>4123.688796</td>
</tr>
<tr>
<td>HQT</td>
<td>0.12082</td>
<td>0.096603</td>
<td>4141.196833</td>
</tr>
<tr>
<td>%HQT+SES</td>
<td>0.133689</td>
<td>0.105484</td>
<td>4138.053769</td>
</tr>
<tr>
<td>%HQT+Minority%</td>
<td>0.207804</td>
<td>0.182028</td>
<td>4088.558526</td>
</tr>
<tr>
<td>Average Salary</td>
<td>0.151483</td>
<td>0.066993</td>
<td>4175.204147</td>
</tr>
<tr>
<td>Salary+SES</td>
<td>0.121754</td>
<td>0.061833</td>
<td>4173.312391</td>
</tr>
<tr>
<td>Salary+%Minority</td>
<td>0.151091</td>
<td>0.147998</td>
<td>4104.714206</td>
</tr>
<tr>
<td>% Teachers with Master's</td>
<td>0.241064</td>
<td>0.109993</td>
<td>4166.658259</td>
</tr>
<tr>
<td>%Masters+SES</td>
<td>0.119718</td>
<td>0.065304</td>
<td>4169.714111</td>
</tr>
<tr>
<td>%Masters+%Minority</td>
<td>0.181973</td>
<td>0.143562</td>
<td>4117.527815</td>
</tr>
<tr>
<td>Per Student Expenditure</td>
<td>0.295677</td>
<td>0.160991</td>
<td>4154.480325</td>
</tr>
<tr>
<td>Expenditure+SES</td>
<td>0.255994</td>
<td>0.131904</td>
<td>4170.040305</td>
</tr>
<tr>
<td>Expenditure+Minority %</td>
<td>0.33793</td>
<td>0.215495</td>
<td>4116.092208</td>
</tr>
</tbody>
</table>

For the eighth grade model of dropout rate while controlling for percent minority students, the highest R² values were found in the Kansas City area as well as along the eastern border of the state, extending into the bootheel, seen in Figure 4.103. Statistically significant beta coefficients were found for much of the eastern border, with those significant t-values showing a negative relationship (see Figures 1.104 and 4.105). That is, as dropout rate increases, while controlling for percent minority students, eighth grade MAP scores decrease.
For the model student per teacher ratio while controlling for percent minority students for eighth grade, the highest $R^2$ values were found in the Kansas City and St. Louis metropolitan areas, with values as high as 0.51, as shown in Figure 4.106.
Statistically significant beta coefficients were found in the two metropolitan areas, as well as in south central Missouri (Figure 4.107). The $t$-values for these significant areas were quite mixed, where both negative and positive values were found near one another (Figure 4.108). There does not appear to be a clear pattern as to where the relationship is positive versus negative.

**Figure 4.106**
Student-Teacher Ratio+\%Minority, 8\textsuperscript{th} ($R^2$)

**Figure 4.107:**
Student-Teacher Ratio+\%Minority, 8\textsuperscript{th} (significant beta coefficients)
As Figure 4.109 shows, when SES was controlled for in the model of highly qualified teachers for eighth grade communication arts exams, the highest local $R^2$ values, of up to 0.29 were found in southwestern Missouri. Statistically significant beta coefficients were found throughout much of southwestern Missouri, with an additional small cluster in northeastern Missouri. The $t$-values associated with those clusters were positive (Figure 4.111).
A similar pattern was seen when percent minority students was controlled for in the highly qualified teacher model for eighth grade. As Figure 4.112 demonstrates, the highest $R^2$ values were found along the southern border of the state. Again, the largest statistically significant cluster encompassed nearly the entire southern half of the state.
(Figure 4.113). Two small clusters of statistically significant values were found in northeastern and northwestern Missouri. For this model, the $t$-values for the southern part of the state were all positive, while there were statistically significant $t$-values for the northern two clusters that were negative (Figure 4.114). Again, geospatial location appears to impact the direction of the relationship.

**Figure 4.112**

%Qualified+$\%$ Minority, 8th ($R^2$)

**Figure 4.113:**

%Qualified+$\%$ Minority
(significant beta coefficients $^2$)
When SES was controlled for in the average teacher salary model for eighth grade, the highest \( R^2 \) values of 0.24 were found in the Kansas City metropolitan area and in the bootheel, as shown in Figure 4.115. Statistically significant beta coefficient clusters were found throughout northwest and southeast Missouri with a small cluster in the most southern portion of the bootheel (Figure 4.116). The \( t \)-values for the two statistically significant clusters in northwest and southeast Missouri were positive, while the \( t \)-values for the bootheel were negative (Figure 4.117). Again, this indicates that the direction of the relationship can vary based on geospatial location.
Next, for the model of percent of teachers holding a master’s degree, while controlling for percent minority students, the highest local $R^2$ values of 0.32 were found for the Kansas City metropolitan area, extending north, and the St. Louis metropolitan
area extending south (see Figure 4.118). Statistically significant beta coefficients were identified in the St. Louis and Kansas City areas, but not in the bootheel (Figure 4.119). When $t$-values were examined, the positive relationships in and around the two metropolitan areas were significant, while the negative relationships seen in the bootheel were not significant (Figure 4.120).

**Figure 4.118**

%Master’s+%Minority, 8th ($R^2$)

**Figure 4.119**

%Master’s+%Minority (significant beta coefficients)
Finally, for the per student expenditure while controlling for percent minority students, the strongest correlations were seen in the St. Louis and Kansas City areas, as shown in Figure 4.121, which is also where two large clusters of statistically significant beta coefficients were found, as shown in Figure 4.122. The $t$-values also indicate that this is a negative relationship (see Figure 4.123).
English II Models Controlling for SES and Race

Finally for this research question, I examined the English II models while controlling for SES and race. While several models were determined to be a better
overall fit, when the significance of these models was examined, none of the models were found to have significant beta coefficients. Therefore, the maps are not included here.

Table 4.7: English II Models

<table>
<thead>
<tr>
<th>English II</th>
<th>R²</th>
<th>Adj. R²</th>
<th>AICc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>0.145131</td>
<td>0.099657</td>
<td>3281.208295</td>
</tr>
<tr>
<td>Mobility+SES</td>
<td>0.188416</td>
<td>0.121737</td>
<td>3275.8742</td>
</tr>
<tr>
<td>Mobility+Minority %</td>
<td>0.275749</td>
<td>0.184377</td>
<td>3245.766794</td>
</tr>
<tr>
<td>Dropout Rate</td>
<td>0.224764</td>
<td>0.155959</td>
<td>3252.912294</td>
</tr>
<tr>
<td>Dropout+SES</td>
<td>0.219271</td>
<td>0.153327</td>
<td>3255.815418</td>
</tr>
<tr>
<td>Dropout+Minority %</td>
<td>0.269272</td>
<td>0.179271</td>
<td>3248.168933</td>
</tr>
<tr>
<td>Discipline Rate</td>
<td>0.2055227</td>
<td>0.132752</td>
<td>3258.685126</td>
</tr>
<tr>
<td>Discipline+SES</td>
<td>0.201515</td>
<td>0.128033</td>
<td>3263.8977</td>
</tr>
<tr>
<td>Discipline+Minority %</td>
<td>0.265519</td>
<td>0.168773</td>
<td>3246.319188</td>
</tr>
<tr>
<td>Student/Teacher Ratio</td>
<td>0.133015</td>
<td>0.082715</td>
<td>3281.25154</td>
</tr>
<tr>
<td>Ratio+SES</td>
<td>0.163382</td>
<td>0.100058</td>
<td>3276.71092</td>
</tr>
<tr>
<td>Ratio+Minority %</td>
<td>0.292288</td>
<td>0.197998</td>
<td>3227.184232</td>
</tr>
<tr>
<td>HQT</td>
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<td>0.034526</td>
<td>3302.898457</td>
</tr>
<tr>
<td>%HQT+SES</td>
<td>0.070119</td>
<td>0.039957</td>
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<tr>
<td>%HQT+Minority %</td>
<td>0.134161</td>
<td>0.106095</td>
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<tr>
<td>Average Salary</td>
<td>0.131651</td>
<td>0.080998</td>
<td>3282.415043</td>
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<td>Salary+SES</td>
<td>0.1287525</td>
<td>0.088731</td>
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<td>Salary+%Minority</td>
<td>0.2611882</td>
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<tr>
<td>% Teachers with Master's</td>
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<td>0.109422</td>
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<td>%Masters+%Minority</td>
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<tr>
<td>Per Student Expenditure</td>
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<td>Expenditure+SES</td>
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<td>Expenditure+Minority %</td>
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<td>3229.618413</td>
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</tbody>
</table>

Nonstationarity of Relationships

The final research question of this study asked which, if any, of the relationships were nonstationary. With the exception of the nonsignificant relationships, all of the relationships examined showed nonstationarity. The relationships varied in several ways: strength of correlation, significance, and direction of the relationship. The importance of
each of these findings will be discussed in more detail in the last chapter, but it is helpful to point out here that the relationships did exhibit nonstationarity.

**Looking Ahead**

The results provided here have demonstrated the importance of examining local $R^2$ values when analyzing variable effects on literacy achievement. Nonstationarity was seen in all of the models, suggesting that global $R^2$ values do not capture the geographic variation of the relationships. In the next chapter, these results will be discussed, with implications for policy offered.
Chapter Five: Discussion

Chapter Four provided the results of the analysis conducted in this study. This discussion will examine those results in greater detail. The purpose of this discussion is to consider the implications of this study both in terms of how the results contribute to the existing literature, as well as education policy in Missouri. The relationships will be described, and where possible, the effects will be explained. At the same time, certain inconsistencies in the results remain. Many of these inconsistencies are challenging to explain with the methods used in this study. These regional inconsistencies, when not explain by the data, provide new opportunities for regional case studies of literacy education.

This discussion will begin first with a reintroduction of the problem space, including a brief discussion of the implications from this study for literacy achievement, literacy in local context, and the state of Missouri as a research context. Next, the results of each research question will be discussed. First, the variables with significant relationships for the fourth grade MAP test will be discussed, followed by the eighth grade and English II results. Next, the models controlling for SES and race will be discussed. Finally, the implications for the nonstationarity seen in this study will be further examined.

Problem Space

I begin with a brief reintroduction of the problem space. Essential to this study is the importance of literacy achievement, as defined both by educational research and state and federal policy. This importance is further emphasized by the development of the Common Core State Standards, which emphasize literacy and math achievement. Those
standards hold additional relevance for the study here, because the grade level results can be discussed in terms of the skills that students should have gained at that grade level.

Though literacy achievement is a goal of state and federal policy, there remain obstacles to achieving full proficiency. The results here illuminate some of the factors affecting literacy achievement, as will be discussed by grade level later in this chapter. Because the results offered in Chapter Four demonstrate the geographic variation of factors related to literacy achievement, the role that local context has on literacy achievement begins to emerge.

Research has demonstrated that there are myriad factors that shape a child’s learning and development (Lee, 2012). The call for an ecological view of literacy achievement is not new, but new layers of nuance are added by the current study, where a visual representation of the geographic variation allows for a different picture of achievement to emerge. As the results in Chapter Four demonstrate, literacy achievement, at all grade levels, is far from stationary. These local variations offer important insight to policy stakeholders by showing which factors are most significant where.

The finding of nonstationarity is consistent with findings by Guitierrez (2012), Heath (1983) and Purcell-Gates (1995) demonstrating the importance of location to literacy development. As the findings presented in Chapter Four demonstrate, literacy achievement does vary by geospatial location. This reiterates the finding that context is key when understanding literacy development.

Finally, in terms of the problem space, the state of Missouri offered a useful context for the study. While universal literacy is an established policy goal for the state
of Missouri (Missouri Department of Elementary and Secondary Education, 2012), literacy proficiency is far from comprehensive across the state. Important to the research conducted here, the effects on literacy vary by geospatial location. As seen in Chapter Four, much of the geographic variation existed along the urban/rural dichotomy. This raises important questions for policy stakeholders in states with both urban and rural areas in terms of setting policy that addresses the issues facing both areas. The research conducted here indicates that statewide policy may not be an effective measure to address issues that vary geographically.

This nonstationarity is also important because of the changing economy seen in the state of Missouri (Paul et al., 2004). As the traditional agricultural economy continues to decline, additional pressure is placed on school districts to prepare students adequately for college or career opportunities. While many of the statistically significant relationships were found to be located in and around the two metropolitan areas of the state, the research conducted here also identifies key factors, such as mobility, that are also important to rural areas. Each of these relationships will be discussed in greater detail below, but important to the understanding of the problem space is that there are statistically significant relationships in both rural and urban areas, and that those relationships are nonstationary.

Additionally, because Missouri is a border-southern state, the study of race and education is particularly pertinent (Morris & Monroe, 2009). The significance of race in the state will become clear with the discussion of the grade level results, but because race was examined both as an explanatory variable, so those results are illuminating in that they address race in a border-Southern state.
Fourth Grade Discussion

This section will discuss the research question, “Using the GWR model, which, if any, or the district-level composition variables are significantly relationship to MAP Communication Arts scale scores for fourth grade?” A discussion of the results of this research question is provided here.

The fourth grade MAP exam tests basic reading skills that should have been developed during elementary school. Based on the Common Core State Standards (CCSS) and the Grade Level Expectations (GLEs) for the state, poverty in the significant districts may affect students’ basic reading abilities, including comprehension, making connections, and basic skills like summarizing, paraphrasing, and understanding author’s purpose. Where significant results occur, it is possible to see the school district composition factors affecting the attainment of these skills. I begin first with socioeconomic status.

Socioeconomic status. Socioeconomic status (SES), and particularly poverty, has been demonstrated to have a strong relationship with academic achievement, as discussed in Chapter Two. As seen in Chapter Four, the GWR model did provide a better fit for SES and fourth grade MAP than did the OLS model. Significant relationships for SES and grade 4 MAP were found across western and northwestern Missouri as well as in the boot heel. Interestingly, the relationships in the St. Louis metropolitan area were not significant. The local $R^2$ values were also quite small, with the highest value only 0.085. The $t$-values for the significant districts were negative, meaning that more poverty was related to lower test scores. This would make sense given the literature indicating that living in poverty results in diminished cognitive capacity (Mani, et al, 2013).
The significant findings at the fourth grade level are also consistent with the specific profiles of neurocognitive weaknesses, particularly in terms of working memory, cognitive control, and language (Farah et al., 2006). This reduced cognitive capacity may help explain lower scores on the MAP test. This is particularly important because developmental milestones measured at the fourth grade level predict learning outcomes and reading comprehension in later grades.

These findings also seem to support Kahlenberg’s (2012) supposition that the nature of SES segregation is changing. The results here show significant effects of poverty in urban, suburban, and rural areas. While past research (Reardon & Bischoff, 2011) has demonstrated a growing disparity in terms of income segregation, this research shows the actual pattern. At the fourth grade level, the poverty effects clearly have a geospatial component. This finding, then, is in concert with findings from Konstantopoulos & Borman (2011) denoting the significant amount of variance of poverty effects between schools. This is extended, however, to the entire district, showing that the effect is broader than between-school differences.

What this research cannot explain, though, are the specific cognitive stressors associated with poverty, such as nutrition, stress, and cortisol levels (Heckman, 2006). Because this research only uses the composite measure, it is not possible to parse out these specific effects.

**Race and ethnicity.** For this study, race and ethnicity were measured based on the percent minority students in a given districts. Overall, the GWR did produce a better model fit than the OLS model. Local $R^2$ values were much higher for race than for SES at the fourth grade level, with the highest local $R^2$ values near 0.33. There were two large
significant clusters in and around the two urban areas, and extending well beyond those two areas.

These results are consistent with the literature denoting the extent of racial disparities in literacy achievement (Hallinan, 2001; Jencks & Phillips, 1998; Rumberger & Palardy, 2005). Additionally, these findings are consistent with findings that there is a strong link between race and academic achievement in urban areas (Logan & Oakley, 2012). This study, though, offers additional insight into the geographic location of these effects. It is important to note that the significant districts are not restricted to urban areas, but rather extend well into suburban and even rural parts of the state. This is somewhat contradictory to the findings of Wilson (1987), Massey and Denton (1993) and Briggs (2005) in that the effects of race in this research extend well beyond the urban areas. At the same time, however, the research conducted here used a straightforward measure of race (percent of minority students in a given district) that does not capture the level of segregation in that district. Because of this, it is possible that the effects are related to segregation, as Briggs (2005) suggests. While it is established in the literature that a great deal of segregation exists in the two urban areas (Robertson, 2004; Gordon, 2008), there is virtually no research on segregation in suburban and rural parts of the state.

Finally, these results are helpful to policy makers in that they clearly demonstrate the effects of poverty and race are disparate across the state. While the underlying mechanisms of this relationship are not clear, the identification of the significant clusters demonstrates the importance of geospatial context.
**Mobility.** Significant effects of mobility rate were seen throughout large portions of the state for fourth grade. The $t$-values for these relationships were negative, indicating that a higher mobility rate is associated with lower overall test scores. While this is consistent with the literature finding that student mobility has a longitudinal effect on literacy achievement across grade levels (Voight, Shinn & Nation, 2012), this identifies the geospatial variation in the effects. These findings are consistent with Scherrer (2013) and Rumberger (2003), both of whom found strong negative effects on reading achievement across the grade spectrum. The research presented here extends these findings to show that, at the fourth grade level, mobility has a negative effect across the state. The significant relationships were found in urban, suburban, and rural areas, meaning that the effects occur across the state.

These statistically significant findings indicate a need for policy that limits the disruption in learning cause by high rates of student mobility. The CCSS are one attempt to address this issue, and future research could address whether the CCSS have reduced learning disruption and thus the negative effects of mobility rates. The large number of statistically significant relationships seen in these results indicates that mobility rate is a problem across the state, supporting arguments for the Common Core State Standards.

**Dropout rate.** A district’s dropout rate was found to have a significant relationship with fourth grade MAP tests across the state. With statistically significant clusters spanning much of the eastern and western borders of the state, and through the middle of the state, dropout rate was found to be a statistically significant predictor of fourth grade MAP outcomes for many districts.
These findings extend the current literature in several ways. First, as seen in the literature review, the negative effects of the dropout rate have been studied primarily at the high school level (Lee & Burkam, 2003; Rumberger & Palardy, 2005). The large number of statistically significant relationships found in this analysis indicates that a high district dropout rate has negative effects even in younger grades. This is likely because, as the literature notes, high dropout rate is an indication of greater overall school dysfunction (Lee & Burkam, 2003).

Second, this analysis identifies the districts where the relationship is statistically significant. These statistically significant beta coefficients are found in urban, rural, and suburban areas, indicating that the negative effects of the dropout rate are not limited to a certain geographic areas. This offers the opportunity for future research to better understand the underlying mechanisms of the dropout rate, perhaps more closely examining school district dysfunctions in these areas.

**Discipline rate.** For discipline rate, both negative and positive $t$-values were found to be statistically significant. In the majority of districts, the relationship was found to be negative, where a higher discipline rate was correlated with lower test scores. This is consistent with the literature indicating that high discipline rates are associated with lower literacy achievement (Gregory, Skiba & Noguera, 2010). However, in a few districts, the relationship was actually found to be positive. These positive relationships were found in the northeastern portion of the state. This may be due to differing rates of poverty and students of color, as the literature indicates a strong relationship between poverty, race, and discipline rates (Rausch & Skiba, 2004). This may also be an artifact of the data collection techniques. Because of the large number of very small districts in
rural Missouri, the variance is so small that even a few reported incidents could
demonstrate a significant effect. In this sense, the results may be more a function of the
small number of data points in those regions, rather than a true reflection of the
relationship.

What is clear from these findings is where these statistically significant
relationships occur. While previous research has indicated that the location of the school
appeared to play a role in the rates of suspension and expulsion, with a greatest
disproportion in suburban areas, the analysis here indicates that discipline rates have
significant effects in urban, suburban, and even rural areas. This is likely because
discipline rates are a reflection of overall school climate (Rausch & Skiba, 2004).

**Class size.** For the student-to-teacher ratio at the fourth grade level, very few statistically
significant relationships were identified. The largest two clusters of these were in north
central Missouri and in the St. Louis metropolitan area. Interestingly, the significant
relationships in the St. Louis area were actually positive, with a high student-to-teacher
ratio correlated with higher test scores. The inverse was true in the rural area of north-
central Missouri, where the relationship was negative.

The St. Louis findings are in contrast to the prior findings discussed in the
literature review, in which smaller class size was correlated with better overall
achievement for all students (Nye, Hedges & Konstantopoulos, 2000). One reason that
the findings here may not support previous findings is that the difference in student-to-
teacher ratio between districts is actually quite small, ranging from 12 to 18. This is
likely because districts report an overall student-to-teacher ratio for the district, and so
this may not be a true reflection of actual class size. Because the variance between
districts is so small, the significant results may not reflect the true relationship. This may indicate that the state needs to collect other or additional data to give a clearer picture of class size effects in the state.

Additionally, much of the research on class size has been done for early elementary grades (see Shin & Raudenbush, 2011), so the effects may not hold through later grades. This indicates a need for more longitudinal work in the area of class size effects.

**Teacher characteristics.** Three variables were analyzed for teacher characteristics: percent highly qualified teachers, average teacher salary, and percent of teachers holding a masters degree. At the fourth grade level, only the variable of percent of teachers holding a master’s degree had any statistically significant findings. Each of these variables will be discussed here.

First, for percent highly qualified teachers, none of the beta coefficients were found to be statistically significant, with $R^2$ values were approaching zero. This is likely because nearly all districts reported the percent of highly qualified teachers to be near 100 percent. Because of this, there was little variation in the variable. However, this does not explain why the results at other grade levels, discussed later in this chapter, were statistically significant.

Second, for average teacher salary, there were again no statistically significant findings. This is consistent with Hanushek’s (1997) meta analysis, which found only 20% of studies of teacher salary had statistically significant results. This may be because teacher salary is more a reflection of the overall standard of living than a real measure of teacher quality. What the lack of statistically significant findings of both these variables
indicates is that the state is not collected teacher characteristic variables that are informative about actual teacher quality.

The only variable with statistically significant findings was that for percent of teachers holding a master’s degree. While there were a number of statistically significant relationships along Missouri’s northwest border, the local $R^2$ values for these relationships were quite small, with the highest $R^2=0.04$. The cluster in the northwest portion of the state had a positive relationship, while the small cluster in the northeastern Missouri actually had a negative relationship. It’s not clear why this would occur.

These mixed findings are consistent with the mixed findings reviewed in Chapter Two. While Croninger et al. (2007) found no association between an advanced degree and reading achievement, Clotfelter, Ladd, and Vigdor found the opposite. The research conducted here, then, shows that these mixed findings may be due in part to the geospatial location of the district. Because the relationships are nonstationary, the statistical significance of the relationship varies by district. These findings add a new layer of nuance to these mixed results.

**School resources.** School resources for this study was defined as per student expenditure. The per student expenditure results at the fourth grade level were quite mixed. There were three distinct clusters of statistically significant findings. The highest local $R^2$ values of 0.24 for this relationship were found in the Kansas City area and the botheel. In the Kansas City area, higher per student expenditure was actually associated with lower test scores, while in the other two clusters the opposite was true.

Hanushek (1997) and Unnever, Kerckhoff, and Robinson (2004) found that there was no strong or consistent relationship between school resources and student
performance. The research conducted here, though, indicates that statistically significant relationships do exist in the state of Missouri. Furthermore, those statistically significant relationships are both positive and negative.

This variation may be because there is a great variation in the educational resources available to school districts, and this is likely associated with the socioeconomic context of the school district. In other words, these findings are beneficial because they identify where the relationships occur, but more research is needed to better understand the overall context of the districts. These findings, though, identify the districts that could be studied in greater detail to better understand those relationships. Rather than rejecting school resources as non-significant, the research presented here uses geospatial location to demonstrate that in some districts, per student expenditure does have a statistically significant correlation, whether positive or negative, with MAP scores.

Additionally, because of the strong regional component of these results, more research is needed to understand the underlying social factors that influence these relationships.

A few very general findings emerge from the fourth grade results. First, it is clear that most of the variables do demonstrate nonstationarity. This adds a new layer of analysis to traditional studies and shows that traditional studies do neglect an important factor of variation. This is also seen in how the direction of the relationship may vary by geospatial location. This is particularly important because the fourth grade MAP test is a reflection of basic reading and writing skills. As noted by the CCSS and the GLEs, fourth grade is focused on basic reading comprehension skills. Without these skills, it
will be difficult to gain proficiency in the more advanced skills in eighth grade and high
school.

**Eighth Grade Discussion**

I turn now to the eighth grade level. The results for each grade level are cross-
sectional, measuring different students, so the three grade levels cannot be compared with
one another. However, each grade level offers a separate snapshot of what significant
relationships are occurring at that grade level, for those students, in a given year.

By the end of eighth grade, the emphasis of the CCSS and the GLEs shifts from
comprehension to analyzing and evaluating different types of texts. These skills are a
vital stepping-stone between the early skills of basic comprehension, and the later skills
that represent college and career readiness.

This section will discuss the research question, “Using the GWR model, which, if
any, of the district-level composition variables are significantly relationship to MAP
Communication Arts scale scores for fourth grade?” This section will identify the
variables that have significant relationships with eighth grade MAP outcomes. This
means that the variables found to be significant in this study have a significant effect on
whether the CCSS and GLEs are met.

**Socioeconomic status.** The relationships of socioeconomic status and eighth grade MAP
performance were also found to be nonstationary. As was reported in Chapter Four, the
relationship was negative in that higher amounts of poverty were correlated with lower
MAP test scores, with the statistically significant values found in the Kansas City area
and in southeastern Missouri.
As with the grade 4 results, these findings are consistent with much of the literature denoting the significant negative impact poverty has on cognitive capacity (Farah et al., 2006; Mani et al., 2013). These findings are also consistent with Kahlenberg’s (2012) finding that income segregation has extended well into suburban areas. These findings, in fact, indicate that poverty effects are highly variable based on location, with urban, suburban, and rural areas all showing significant relationships. The identification of these areas then is beneficial in that it is clear that poverty effects are not restricted to urban or rural areas. This confirms findings by Konstantopoulos & Borman (2011) that there is considerable variance of poverty effects between geospatial areas. As with the other findings, these findings indicate to policy stakeholders where poverty is having a statistically significant effect on literacy achievement.

**Race and ethnicity.** The highest $R^2$ values for percent minority students were found in the Kansas City and St. Louis metropolitan areas, as well as in southeastern Missouri. The local $R^2$ values were as high as 0.58, indicating a strong correlation, further buttressing literature on race and literacy achievement (Hallinan, 2001; Jencks & Phillips, 1998; Rumberger & Palardy, 2005) For the two metropolitan areas, the relationship was negative, but for the cluster in southeastern Missouri, the relationship was positive, with a higher percentage of minority students correlated with better test scores. Further research is needed to determine why this positive relationship might occur. For example, this might be related to the strong link between poverty and race in urban areas (Logan & Oakley, 2012; Matel, Perkins & Aberger, 2012), which will be discussed further when the models controlling for SES and race are examined. Still, the findings for race at the
eighth grade level are additive in that they show where the statistically significant relationships occur as well as the direction of those relationships.

It is not surprising that negative relationships were seen in the Kansas City and St. Louis regions, where high levels of SES and racial segregation are found (Robertson, 2004; Gordon, 2008). This social isolation may be a driving factor in the relationship (Wilson, 1987; Massey & Denton, 1993), but further investigation is needed to understand whether segregation is an explanatory or moderating variable when thinking about race and literacy achievement. By identifying where those relationships occur, the analysis here offers the opportunity for future research to explore this phenomenon further.

**Mobility rate.** The largest local $R^2$ values for mobility rate, 0.19, were found along the eastern and western borders of the state, including the two major metropolitan areas. These two large clusters include urban, suburban, and rural areas. The beta coefficients for these statistically significant relationships were negative, meaning that a higher mobility rate is associated with lower test scores at the eighth grade level.

These findings are consistent with the literature that mobility rate has a negative effect on learning outcomes because of a disruption in learning (Scherrer, 2013; Voight, Shinn & Nation, 2012). These findings are also consistent with Rumberger (2003), which found that the negative effects of student mobility occur across the grade spectrum. Additionally, by demonstrating that these negative effects occur across large portions of the state, the research conducted here indicates that student mobility is an important issue in the state of Missouri.
In order to minimize the negative effects of mobility rate, then, the disruption in learning must also be minimized. This would mean that students across the state are working on the same standards at the same time, as with the CCSS.

**Dropout rates.** The strongest relationships for dropout rate at the eighth grade level were found in the St. Louis region, with statistically significant relationships found along much of the eastern and western parts of the state. These relationships were negative, where a higher dropout rate was associated with lower MAP performance. This extends findings of previous studies that indicate dropout rate is associated with negative academic outcomes at the high school level (Rumberger & Palardy, 2005).

While this research confirms previous findings indicating that dropout rate is correlated with lower literacy achievement, it also identifies the districts where these relationships are statistically significant. Because the dropout rate is thought to be correlated with other factors related to school dysfunction (Rumberger & Palardy, 2005), the identification of these statistically significant relationships offers the opportunity to study the districts in greater detail to better understand why this statistically significant relationship occurs. Additionally, policies to reduce both dysfunction and the dropout rate could be targeted toward these districts by state and district-level policy stakeholders.

**Discipline rates.** As with dropout rate, statistically significant findings for discipline rate were not limited to the two metropolitan areas. Rather, statistically significant relationships were found across the state, with the largest clusters on the eastern and western borders. This is consistent with prior research indicating that high levels of suspension or expulsion are associated with lower literacy achievement (Gregory, Skiba & Noguera, 2010). While Raush and Skiba (2004) found the highest disproportion of
discipline in suburbs, it is possible that the effects are seen across the region because the overall discipline rate is a reflection of overall school environment. Additionally, these overall negative effects may be seen because of the disruption in learning that suspension or expulsion causes. Finally, this research is also an extension of the existing body of literature in that it expands the findings to the eighth grade level, while the majority of research on the effects of the discipline rate has been conducted at the high school level.

The analysis here is additive in that it identifies school discipline rate at the eighth grade level as primarily a problem in urban and suburban areas. Future research could use the areas identified in this study to better understand the overall school environment to determine how and why discipline rates have a negative effect in these areas.

**Class size.** For eighth grade, statistically significant beta coefficients for student-to-teacher ratio were found across eastern Missouri and in a large cluster in west-central Missouri. These relationships were primarily negative, where a larger class size was correlated with lower achievement scores. However, in one small cluster in southeastern Missouri, this relationship was actually positive. These results are in contrast to the literature, which found strong positive effects for smaller class size (Nye, Hedges & Konstantopoulos, 2000; Shin & Raudenbush, 2011). This could be for several reasons. First, much of the prior research on class size is done with young children in grades 1-3. In addition to being much younger than the students in this study, elementary students generally only have one teacher throughout the day. Because the measure here is the average student-to-teacher ratio for the entire district, this may not capture the true nature of class size in the district. Because students in middle and high school attend several different classes during the day, the average student-to-teacher ratio variable does not
demonstrate the size of each individual class, so the variable may be skewed. It might be beneficial for the state to collect data on the average communication arts student-to-teacher ratio, for example, to more fully articulate what is actually happening in the classroom. Further examination of the statistically significant districts is needed to determine whether class size is a reflection of the overall school environment.

**Teacher characteristics.** Teacher characteristics showed interesting patterns at the eighth grade level. First, for percent highly qualified teachers, statistically significant and positive relationships were found throughout much of the southern half of the state. This positive relationship shows that highly qualified teachers were positively correlated with MAP results at the eighth grade level.

Second, three small clusters of statistically significant values were found for average teacher’s salary. Two of these clusters, the cluster north of St. Louis, and the cluster in the boot heel, were negative, meaning that higher teacher salary was correlated with lower test scores. Again, this speaks to the overall ambiguity of teacher characteristic variables. As seen in the literature review, the research on teacher characteristics is mixed, and this analysis does not offer clear conclusions.

Finally, for percent of teachers holding a master’s degree, the significant districts are somewhat scattered across the state. However, two small, positive clusters were found the Kansas City and St. Louis regions, indicating that in urban and suburban areas, at the eighth grade level, a higher percent of teachers with master’s degrees is correlated with better MAP outcomes on the Communication Arts portion of the exam.

This findings align with the mixed results shown in the literature review. While Federal policy emphasizes the need for well-qualified teachers (NCLB, 2002), prior
research has indicated that the correlation between positive teacher characteristics such as education and salary is quite poor, with only 20% of students reporting significant findings (Hanushek, 1997).

In general, these findings indicate a need for better measures of teacher effectiveness. The small number of significant findings in the literature, coupled with the multi-directionality of findings from this study, indicates that the measures the state of Missouri collects are not effective measures of teacher quality.

**School resources.** Finally for eighth grade is the school resources measure, per student expenditure. The strongest correlations for per student expenditure were found in the Kansas City and St. Louis areas. For the two largest clusters, the relationships were found to be negative, so higher per student expenditure was related to lower MAP performance. In the small cluster in southeastern Missouri, though, the relationship was found to be positive. While this may seem to be counterintuitive, the findings on school resources are consistent with the literature on school resources in that the relationship is not well understood (Hanushek, 1997). Many studies, in fact, have found no correlation between school resources and academic outcome measures (Unnever, Kerckoff & Robinson, 2000). Additionally, there are likely complex historical, social, and political reasons for why this relationship may occur. Future research could focus on a regional analysis of this relationship.

Again, this research is helpful in that it identifies where the statistically significant relationships occur, as well as the direction of these relationships. Previous research on school resources and school funding has not found a strong or consistent relationship between school resources and student performance (Hanushek, 1997). This research adds
further nuance to that argument. While statistically significant relationships were identified, those relationships were primarily negative.

These findings demonstrate the complex nature of the relationships examined with this research. While it is not always possible to reach a concrete conclusion about the effects of these variables or the variable relationship, what is important is that this research shows the geographic variation of these relationships. The effects of the variables are not stationary across the state, and this variation needs to be accounted for both in research and in policy.

**English II End of Course Exam Discussion**

I turn now to the high school end of course exam to answer the question, “Using the GWR model, which, if any, or the district-level composition variables are significantly relationship to MAP End-of-Course scale scores for the English II exam?” The English II exam, given in high school, is the last state-mandated literacy assessment given to students. To that end, it focuses on higher level thinking skills, including the analysis of complex texts. The CCSS and GLEs at this level are constructed to predict college and career readiness. Therefore, the analyses conducted here can provide insight and information into factors impacting college and career readings.

**Socioeconomic status.** Very few significant relationships were found for SES and the English II exam. This is somewhat surprising. If the cognitive effects of poverty are cumulative, as suggested by Main, et al (2013), then it would be expected that the effects of poverty would very strong in high school, when the effects had accumulated over time. However, that does not appear to be the case here. Of course, it is possible that those most impacted by poverty do not take the English II exam. This could be for a variety of
reasons. Students could have dropped out, be in a vocational or technical program, or be on a low-track that does not require English II.

**Race and ethnicity.** The statistically significant relationships for percent minority students and the English II exam were found primarily in the St. Louis and Kansas City regions. This is unsurprising given the research by Wilson (1987) and Massey and Denton (1993), which emphasize the link between race and geography. Additionally, the statistically significant findings in the two urban regions may also be due to the high levels of segregation found in those areas (Robertson, 2004; Gordon, 2008).

While these findings demonstrate that the statistically significant relationships are primarily found in urban and suburban areas, it would be beneficial to look at these significant relationships at the school level. That would allow a closer analysis of segregation and the effects of segregation. Because St. Louis, in particular, has a long history of racial segregation, by taking this research to the school level and adding segregation to the analysis, a clearer picture of the relationship will emerge. Still, this research does identify where the relationships occur, as well as the strength of the correlation and the direction of the relationship.

**Mobility rate.** For the English II exam and mobility rate, the highest $R^2$ values, 0.38, were found in the bootheel, while the significant relationships were in and around the Kansas City and St. Louis metropolitan areas. While the $R^2$ values for these statistically significant clusters were quite small, the $t$-values were negative, meaning that higher mobility rate was associated with lower English II exam scores. This is consistent with the literature, which suggests that a disruption in learning at any level has a negative effect on academic outcomes (Scherrer, 2013). Furthermore, this demonstrates that the
negative effects of mobility extend through high school, as prior longitudinal studies have found (Voight, Shun & Nation, 2012, Rumberger, 2003). It would be interesting to do a longitudinal study of this variable using GWR to see if the effects vary by location as a student ages.

**Dropout rate.** Dropout rate has been primarily examined at the high school level, where it has been demonstrated to have a strong, negative effect on the academic performance of a school or district (Rumberger & Palardy, 2005). For the analysis conducted here, these effects seem to be primarily limited to the metropolitan regions, including suburban areas. In the St. Louis region, the local R² values were as high as 0.52, showing a strong correlation. With the identification of these two clusters of statistically significant values, further research could examine dropouts as a school level variable to attempt to determine why this geographic variation occurs. While the ecology of the districts is not described in this analysis, by identifying the geographic location of significant relationships, the strength of the correlation, and the direction of the relationships, this analysis does demonstrate that the strong negative effects seen in the current literature appear to be limited to the metropolitan areas for the high school model. This could have significant policy implications in that research indicates the need for a review of policies and procedures associated with dropouts in the metropolitan areas of Missouri.

**Discipline rates.** While the statistically significant clusters for school discipline rates and the English II exam were fairly small, they are primarily clustered in the St. Louis and Kansas City areas, with the strongest correlation, R²=0.41, found in the St. Louis area. The relationships for both Kansas City and St. Louis were negative, though there was a small cluster of statistically significant values in central Missouri that were
positive. This may be because of the very small variance seen in rural school districts, which is a function of the overall small size of rural school districts.

While prior research has demonstrated that high levels of school discipline rates are associated with lower literacy achievement (Gregory, Skiba & Noguera, 2010), the research conducted here demonstrates that this relationship is not universally negative across the state of Missouri. It is not clear why a higher discipline rate would be associated with higher test scores in some districts, but it is possible that overall school environment is more important than this single indicator. Again, school environment is not fully captured here. However, the relationship is clearly negative in the two urban areas. This may reflect findings by Rausch and Skiba (2004) that there is a greater disproportionality of discipline in these areas. Nonetheless, locating these relationships geospatially could help influence discipline policy in those districts. As with dropout rates, the strong, statistically significant correlation in the metropolitan areas, particularly St. Louis, indicate the need for more assessment of discipline policies and procedures in those areas.

**Class size.** Much of the research on class size is limited to the early grades. In part, this is because small class size is believed to improve the classroom environment and offer the opportunity for more individualized attention for students, factors that are important in the younger grades (Nye, Hedges & Konstantopoulos, 2000). However, the analysis conducted here found that class size is correlated with English II exam scores. These statistically significant relationships were found in three main clusters: in the Kansas City area, in St. Louis and just north of St. Louis, and in southeastern Missouri.

Interestingly, while the relationship in St. Louis is negative, where a larger class size is
correlated with lower English II scores, for the two other clusters, the relationship is positive. That means that larger class size is actually correlated with higher test scores. It’s not clear why this relationship is positive, but one possible hypothesis is that larger class sizes are found in larger schools with better overall resources. Still, more research is needed of the identified districts to better understand the nature of these relationships and whether the smaller class size effects demonstrated in the literature (Nye, Hedges & Konstantopoulos, 2000; Shin & Raudenbush, 2011) extend to the later grades. While the literature suggests that reducing class size is a reasonable investment to improve academic achievement (Nye, Hedges & Konstantopoulos, 2000), the relationship was not found to be stationary in this research. This could have important policy implications in that allocating resources for small class sizes may not be the most effective use of funds.

Teacher characteristics. Two of the teacher characteristic variables, average teacher salary and percent of teachers holding a master’s degree, were found to have statistically significant relationships with English II exam performance. Percent highly qualified teachers did not have any statistically significant beta coefficients. While this data is cross-sectional and so the results cannot be compared, it is interesting to note that the only grade with significant results for the highly qualified teachers variable was eighth grade. Neither fourth nor English II had any statistically significant relationships.

Percent of teachers holding a master’s degree showed a positive correlation in the St. Louis and Kansas City areas, with a local $R^2$ value of 0.37 and a positive $t$-value. There was also a small cluster in south central Missouri that demonstrated a negative relationship. The positive relationships in the St. Louis and Kansas City areas demonstrate that teacher education does appear to be important in urban and suburban
areas. Still, the mixed results are consistent with the literature, where consistent teacher effects have not been found (Hanushek, 1997). At the same time, these findings are additive in identifying where the teacher characteristics are statistically significant effects on literacy achievement.

Average teacher salary is significant across the western border of the state and extending though central Missouri. It is not clear why this geospatial distribution occurs. Given the mixed results at other grade levels, it bears repeating that it does not appear the state of Missouri is collecting the best measures of teacher effectiveness.

School resources. The last variable for this research question is that of per student expenditure. Statistically significant relationships for per student expenditure were found in the Kansas City area as well as the boot heel. These relationships, with local $R^2$ values as high as 0.22, produced negative beta coefficients, leading to the counterintuitive conclusion that higher per student spending is correlated with lower test scores. Still, this is consistent with the mixed literature on school resources (Hanushek, 1997; Clotfeltler, Ladd & Vigdor, 2007). While this research is beneficial in that it identified where the significant relationships occurred, as well as the direction of those relationships, more research is needed to better understand why the relationships were negative.

These findings demonstrate the myriad factors that affect college and career readiness. While more research is needed in some areas, this research does demonstrate the following findings. First, most of the school composition variables do have statistically significant relationships with literacy outcomes in some districts. Second, these relationships are nonstationary. They vary across the state by geospatial location. Third, the relationships are significant across multiple age groups. While these
relationships cannot be compared because the data is cross-sectional, this does demonstrate the number of statistically significant findings at all grade levels, not just with early elementary school students. Much of the research presented in Chapter Two focused only a few grade levels. This research demonstrates the impacts these factors can have across grade levels. Finally, the last section of this discussion will examine the effects of controlling for SES and race on each of these relationships.

**Controlling for SES and Race**

Next, I will turn to the fourth research question, “How do these relationships change when controlling for race and SES?” I will begin first with the fourth grade level. While the model fit was often improved, it often resulted in fewer statistically significant districts than models without controlling for SES and race. Because of this, clear patterns do not always emerge from the maps of the models controlling for SES and race. Such is the case with many of the fourth grade models. Because it is difficult to draw any conclusions from these models, I will only discuss the models in comparison with the original models. Where possible, I will also draw conclusions about the direction of the relationship or where the statistically significant clusters occurred.

The fourth grade student-to-teacher ratio while controlling for SES model resulted in slightly more statistically significant beta coefficients, with statistically significant coefficients scattered across the central part of the state as well as clustered in the Kansas City and St. Louis regions. While the highest local $R^2$ values were found in the same general areas for the original model and the model while controlling for SES, the $t$-values for the model controlling for SES were all positive, whereas for the original model, some statistically significant coefficients were negative. This indicates that when SES is
controlled for, the relationship between student-to-teacher ratio and fourth grade MAP outcomes is positive. This is counter to findings by Nye, Hedges and Konstantopoulos (2000) indicating students of all socioeconomic backgrounds benefit from smaller class sizes. It is not clear why in my study that low-SES students do better in larger classes. Perhaps a change in the level of analysis would provide greater insight. Because this study uses a district average, it might be helpful to examine school-level data to determine whether this positive relationship exists at that level.

The fourth grade student-to-teacher ratio while controlling for percent minority students model is not substantially different from the original model, though there are slightly more statistically significant relationships scattered across the state. As with the original model, the statistically significant relationships are both positive and negative. This research is helpful in that it identifies where the positive relationships occur, creating opportunity for future study.

When SES was controlled for in the model of average teacher salary at the fourth grade level, the outcomes are dramatically different. Average teacher salary, which had no statistically significant coefficients at the fourth grade level in the original model, was statistically significant across much of the state when controlling for SES. The relationships were positive and significant across both metropolitan areas, along much of the eastern and western borders, and throughout the middle of the state. This means that a higher average teacher salary is statistically significantly related to higher achievement when controlling for SES.

This aligns well with the NCLB legislation indicating that poor and minority students should have equal access to high quality teachers (NCLB, 2002), if salary is a
function of teacher quality. However, the measures of teacher quality collected by the state of Missouri may not be the best measures of teacher effectiveness.

Improved model fit was also found for average teacher salary at the fourth grade level when percent minority students was controlled for. In this case, the results were less dramatic, with a relatively small number of statistically significant relationships scattered across the state. However, these statistically significant relationships were also all negative, meaning that when percent minority students was controlled for, higher average teacher salary was associated with lower fourth grade MAP performance.

These two models for average teacher salary show just how complex the effects of these school district composition variables are. While this research is limited in its interpretation, it does raise important questions about how SES and race/ethnicity interact with the other variables.

The next model that showed improved fit for fourth grade was that of percent of teachers holding master’s degrees while controlling for SES. This model produced slightly more statistically significant relationships. As with the original model the statistically significant relationships were positive. In other words, when SES was controlled for, percent of teacher’s holding a master’s degree had a positive relationship with fourth grade MAP outcomes.

Findings for the model of average teacher salary while controlling for percent minority students were similar, with slightly more statistically significant districts than the original model. However, unlike the original model, some of these statistically significant relationships had negative $t$-values. Further study is needed to understand why some districts had negative relationships with this model.
The last model for fourth grade that was found to be a better fit and statistically significant was that of per student expenditure while controlling for percent minority students. For this model, the statistically significant clusters found in the bootheel and Kansas City for the original model were eliminated, and significant relationships were instead found in north-central Missouri, the St. Louis metropolitan area, and scattered across the central part of the state. Like in the original model the relationships in the north-central part of the state were positive, while the other relationships were negative. It is not clear why higher spending, while controlling for percent minority students, would have a negative relationship with MAP outcome measures.

Next I turn to the models at the eighth grade level controlling for SES and race. The first model that demonstrated both a better fit and statistically significant findings was that of dropout rate while controlling for percent minority students. When percent minority students was controlled for, the cluster of statistically significant districts in the Kansas City area extending through northwest Missouri was eliminated. As with the original model, the statistically significant relationships were negative. This finding points to the role that race plays in the St. Louis area, as noted in Chapter Two (Robertson, 2004; Gordon, 2008).

Next, for the model of teacher-to-student ratio while controlling for percent minority students, the size of the clusters of statistically significant districts were reduced substantially from the original model. While there were still clusters of statistically significant coefficients in the St. Louis and Kansas City regions, the clusters were much smaller than those for the original model. Additionally, while the statistically significant relationships in the original model were all negative, for this model, there were both
negative and positive \(t\)-values for the statistically significant relationships in the model that controlled for race. This means that in some cases, controlling for percent minority students changed the direction of the model, where a higher student-to-teacher ratio was associated with higher eighth grade MAP scores. This stands in contrast, then, to findings by Nye, Hedges, and Konstantopoulos (2000) that smaller class sizes benefit all students. Yet, no conclusions about class size can be drawn from my study. It is very likely that one of the important implications of this study is that a district level analysis is not optimal for determining the relationship between class size and literacy outcomes.

For percent highly qualified teachers at the eighth grade level, controlling for SES provided a slightly better model fit. Overall, the statistically significant districts were clustered in the same geographic locations, and the direction of the relationships remained the same. The same was true for the highly qualified teachers model at the eighth grade level. The statistically significant clusters and direction of the relationships remained unchanged.

When SES was controlled for in the average teacher salary model at the eighth grade level, the statistically significant clusters were much larger, but in essentially the same location. In other words, more districts in those areas were found to have statistically significant relationships, the statistically significant findings weren’t extended into different parts of the state where there had been no statistically significant relationships in the original model. The direction of the relationships for the model remained the same, with higher teacher salary having a positive relationship with eighth grade communication arts MAP scale scores. As with the original model, this may be because the variable has so little variance, with nearly all districts reporting all or almost
all of their teachers meeting highly qualified status. Again, this points to the need for a better measure of effective teachers at the state level.

Controlling for percent minority students in the percent of teachers holding a master’s degree model at the eighth grade level produced many more statistically significant relationships. These relationships extend across much of the eastern and western parts of the state, through central Missouri, and along much of the southern border of the state. As with the original model, these relationships are positive. This indicates that districts with a large percentage of minority students benefit from having a higher percentage of teachers holding a master’s degree, particularly in the two urban areas and southern aspect of the state.

The last model showing both a better fit and significant findings at the eighth grade level was that of per student expenditure while controlling for percent minority students. When controlling for percent minority students, statistically significant relationships were found in the Kansas City and St. Louis areas, as well as in the furthest southern districts of the boot heel. As with the original model, these relationships were negative, where higher per student expenditure was correlated with lower eighth grade MAP scores. Controlling for race slightly reduced the number of significant relationships, but otherwise did not substantially change the model. My findings are not consistent with the meta-analytic review conducted by Greenwald, Hedges, and Laine (1996), which found that studies of school resources using aggregated data at the level of school districts and smaller unit or in longitudinal design were positively related to student outcomes. This inconsistency may be a function of my method and data analysis approach. Clearly, there is a need to move beyond a one year snapshot as offered in my
study. Longitudinal design is more appropriate in estimates of the effect of school resources on academic achievement.

Finally, for the English II EOC, a number of relationships demonstrating a better fit based on AICc and adjusted $R^2$ values were identified. When the beta coefficients for these relationships were examined, however, none were found to be statistically significant. That is, using the Benjamin-Hochberg comparison, none of the $t$-values for the models were found to be statistically significant. Further research is needed to determine why this would be the case only for the English II EOC.

While it is difficult to draw conclusions from these models, they do demonstrate the complexity of the relationships between school district composition variables. When each of these variables interacts with one another, as in Hogrebe and Tate (2010), the effects on academic achievement become even more difficult to understand. By mapping these relationships across the state, it is possible to see where patterns emerge, how relationships may be changed by controlling for certain factors, and finally how these relationships vary across geospatial location.

**Place as a Contextual Factor**

Place and the geography of opportunity are well established in the literature, and mapping of those spaces has been used to study the geography of opportunity (Tate, 2008; Gordon, 2008). The actual effects of geographic location are far less studied, and that is the most significant finding of this study. For each significant relationship, at all grade levels, the variables were nonstationary. While some of the patterns were predictable, with significant relationships found primarily in urban areas, many others were not. The maps provided by this analysis offer easily accessible visual
representations of these nonstationary relationships. Because these maps are easy to read and understand, they are useful both to practitioners and researchers, broadening the potential impacts of this research.

**Implications and Future Research**

The findings presented here demonstrate that relationships are not the same in every district at every grade. Rather, the relationships vary substantially: by location, by grade, and while controlling for SES and race. This research has identified where those statistically significant relationships occur, the strength of the correlation, and the direction of the relationship. By demonstrating where the statistically significant relationships occur, this research offers insight to policy stakeholders at the state and district levels. Because this allows stakeholders to understand what school district composition factors are statistically significant in their district, this offers the opportunity to create policies that address these specific issues.

This research also offers new opportunities for education research. First, much more research is needed to understand the statistically significant relationships identified in this analysis. By identifying the districts, the analysis offered here creates the need for additional research to better understand the nuance of those relationships. But beyond just identifying where the statistically significant relationships occur, this research also identifies where the correlations are strongest, and where statistically significant relationships occur despite a weak correlation. Finally, this research demonstrates that within a single grade level, relationships may be both positive and negative. Further investigation of these relationships offers potential insight into how and why the demonstrated effects occur.
The importance of literacy is well established, both by research and policy. By discerning which district composition variables have significant effects on literacy achievement, and identifying where those relationships occur, the research presented here has offered an innovative way to think about education policy and access to literacy development.
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Appendix A: Validity and Reliability

The Missouri Department of Elementary and Secondary Education (2007) provides information about the validity and reliability of the Missouri Assessment Program. The information contained in this appendix reviews the information on validity and reliability provided by MODESE in the MAP Technical Report (2007).

Construct Validity

Construct validity involves the meaning of test scores and what they measure. For the MAP test, MODESE uses construct validity measures provided by testing company CTB. One factor of construct validity is the content-development phase. Content-development steps are utilized to minimize construct-irrelevant variance and construct under-representation include specification, item writing, review, field testing, and test construction (MODESE, 2007). At each phase, CTB gathers empirical evidence to assess construct relevance as well as conducting additional studies to determine construct relevance (MODESE, 2007).

Reliability

A reliable test produces scores that are relatively stable if the test is administered repeatedly under similar conditions, that is, the same is similar results occur. Because it is impractical to administer multiple forms of an achievement test, reliability for the MAP is estimated by a single administration of the test (MODESE, 2007). The internal consistency provided from this administration of the test offers an estimate of how consistently examinees perform across items within a test. With guidance from the Standards for Educational and Psychological Testing (American Educational Research
Association, 1999), CTB calculates the reliability of each MAP test in a variety of ways, including reliability of raw scores, overall standard error of measurement, IRT-based conditional standard error of measurement, and decision consistency or achievement level classifications (MODESE 2007). For the study proposed here, achievement level classifications will not be utilized as the scale score is the measure included in the model. This is to avoid potential validity issues created with the use of cut scores.

As reported in Chapter 3 of this proposal, the Chronbach’s (1951) Alpha, which is a lower-bound estimate of test reliability, for each Communication Arts exam are above the rule of thumb 0.80.

**Decision Consistency and Accuracy**

Classification consistency or decision consistency is defined as the extent to which the classifications of students agree on the basis of multiple administrations of the test, either with the same form or with parallel forms. Because it is impractical to administer multiple versions of the test, a common practice is to estimate decision consistency from one administration of a test (MODESE, 2007).

Decision accuracy is defined as the extent to which the actual classifications of test takers agree with classifications that would be made on the basis of their true scores. This is different from decision consistency in that it refers to the agreement between the observed score and the true score. CTB uses the Livingston-Lewis (1995) methodology to calculate decision accuracy (MODESE 2007).

Important to the study proposed here is that scale scores are used, rather than achievement levels. Because of this, decision consistency and accuracy as applied to cut scores do not impact the model.
# Appendix B

## Table AB.1: Research and Findings on SES and Race

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<thead>
<tr>
<th>Variable</th>
<th>Studies</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>SES</td>
<td>Bornstein &amp; Bradley, 2003</td>
<td>• SES is operationalized in a wide variety of ways</td>
</tr>
<tr>
<td></td>
<td>Sirin, 2005</td>
<td>• SES of a child's parents is a predictor of literacy achievement</td>
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<td></td>
<td>Reardon, 2011</td>
<td>• Poverty affects cognitive function</td>
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<td></td>
<td>Reardon &amp; Bischoff, 2011</td>
<td>• Income disparities appear to be growing</td>
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<td></td>
<td>Coleman, et al., 1966</td>
<td>• Poverty has a strong geospatial component</td>
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<td></td>
<td>Farah et al., 2006</td>
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<tr>
<td></td>
<td>Manai, Mallainanathan, Shafir &amp; Zhao, 2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kahlenberg, 2012</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>Orfield, 2002</td>
<td>• Poverty and race are linked</td>
</tr>
<tr>
<td></td>
<td>Matel, Perkins &amp; Aberger, 2002</td>
<td>• Race also has a strong geospatial component</td>
</tr>
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<td></td>
<td>Hallinah, 2001</td>
<td>• There are racial disparities in literacy achievement, but the underlying</td>
</tr>
<tr>
<td></td>
<td>Jencks &amp; Philips, 1998</td>
<td>mechanisms are not well understood</td>
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<td></td>
<td>Rumberger &amp; Palardy, 2005</td>
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<td></td>
<td>Logan &amp; Oakley, 2012</td>
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<td></td>
<td>Wells et al., 2012</td>
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<td></td>
<td>Wilson, 1987</td>
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<td></td>
<td>Massey &amp; Denton, 1993</td>
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<td></td>
<td>Briggs, 2003</td>
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<td></td>
<td>Morris &amp; Monroe, 2009</td>
<td></td>
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<td></td>
<td>Gordon, 2008</td>
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### Table AB.2: Research and Findings School Composition Factors

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<th>Variables</th>
<th>Studies</th>
<th>Key Findings</th>
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<td>Mobility</td>
<td>Leventhal and Brooks-Gunn, 2004</td>
<td>• Student mobility is a significant predictor of academic success</td>
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<td></td>
<td>Scherrer, 2013</td>
<td>• Student mobility has longitudinal effects for student reading achievement</td>
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<td></td>
<td>Voight, Shinn, and Nation, 2012</td>
<td>outcomes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Student mobility is a significant predictor of academic success</td>
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<td>• Student mobility has longitudinal effects for student reading achievement</td>
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<td>Dropout rates</td>
<td>Lee and Burkam, 2003</td>
<td>• Results are mixed; effectiveness at promoting learning may prevent</td>
</tr>
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<td></td>
<td>Rumberger and Palardy, 2005</td>
<td>dropouts</td>
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<tr>
<td>School discipline rates</td>
<td>Rumberger and Palardy, 2005</td>
<td>• Higher rates of school discipline are associated with lower achievement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>scores</td>
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<tr>
<td></td>
<td>Rausch and Skiba, 2004</td>
<td>• African American students are more likely to experience suspension or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>expulsion</td>
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<tr>
<td></td>
<td></td>
<td>• Location of school plays a role in the rate of suspension or expulsion,</td>
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<tr>
<td></td>
<td></td>
<td>but the effects aren’t clear</td>
</tr>
<tr>
<td>Class size</td>
<td>Shin and Raudenbush, 2011</td>
<td>• Smaller class size leads to improved test scores</td>
</tr>
<tr>
<td>Teacher Characteristics</td>
<td>Wayne and Young, 2003</td>
<td>• All students appear to benefit from effective teachers</td>
</tr>
<tr>
<td></td>
<td>Konstatopoulos and Chung, 2011</td>
<td>• All students appear to benefit from effective teachers</td>
</tr>
<tr>
<td>School Resources</td>
<td>Hanushek, 1997</td>
<td>• School resources do not appear to be significantly related to academic</td>
</tr>
<tr>
<td></td>
<td>Unnever, Kerckhoff, and Robinson, 2000</td>
<td>achievement</td>
</tr>
</tbody>
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