EXPLORING THE PATHWAY OF RURAL STUDENTS INTO THE ENGINEERING FIELD

by

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A Dissertation

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Doctor of Philosophy

School of Engineering Education

West Lafayette, Indiana

May 2019

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To my incredibly supportive family:

Fernando, you are the most amazing husband! Your patience and encouragement over these past years have been crucial to my success in this endeavor! You have put up with too many weekends of me being busy and too many months of a messy house! As I wrote you over four years ago, 'You're my inspiration…' I love you forever.

Nando, Karen, and Paolo – Your belief in my ability to complete this still amazes me. You believed in me when I didn't believe in myself. Thank you for your love and support through all of this. I love you all more than you can ever imagine!

ACKNOWLEDGMENTS

I owe a huge debt of gratitude to my tireless advisor, Matthew W. Ohland. Matt, you never let me give up, and allowed this very non-traditional student to achieve a dream. Thank you for all the Skype sessions, your advice and input, and listening to all the 'life' that happened during these past 4 ½ years. I'm sure no other advisor would have been as patient as you, and with a constant smile on your face!

I also want to thank the rest of my amazing committee for their invaluable input and constant support for me throughout this journey. Thank you so much, Ruth Streveler, Allison Godwin, and Kerry Meyers!! I was so blessed to have you all serve on my committee! You are all great role models for me as I move forward!

Special thanks goes to Loretta McKinniss. Loretta, without you, I would never have begun this journey. Thank you for your words of encouragement, support, and helping to make sure I got my Thanksgiving dinner!

This journey would never have begun if my wonderful boss and chair, Dr. O. Hayden Griffin, had not encouraged me to look into the engineering education field and see what it had to offer. There is no better chair than the one who is concerned for the growth of their faculty! Hayden, you supported me throughout this process and guided me along the way. Without your encouragement, this would never have become my dream!

To the rest of my cohort of 2014, thank you for all the times you Skyped me into class or encouraged me to not give up! I couldn't have done it without you all!

And finally, thank you to my Heavenly Father, who guided each step and opened doors that I never thought would open! I still marvel at how this road twisted and turned and led me to this point. He can make a way where there is no way.

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ABSTRACT

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Degree Received: May 2019
Title: Exploring the Pathway of Rural Students into the Engineering Field.
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As diversity continues to be promoted in engineering, one category of students has largely been forgotten. That is the rural student. While rural students make up 20% of all public-school students, college enrollment rates for these students are lower than those of other locales. Reasons for the lower enrollment rates are explored in this research by examining the pathway of rural students into the engineering field. As previous studies on rural students have used differing definitions of rural, this work uses a definition of rural set forth by the National Center of Education Statistics along with the U.S. Census Bureau, to provide more consistency for future research on the rural student. This work includes multiple related studies. The first study examines the characteristics of the rural student to identify differences between students from rural areas and other locales. A case study then illustrates the distribution among locales of students applying to, being admitted to, and attending an engineering program at a large mid-Atlantic public university. This research shows that students from rural distant and rural remote locales come from communities that contain fewer racial/ethnic minorities than all other locales. There is less availability of Advanced Placement courses in these locales, specifically for courses related to STEM fields, and the percentage of students from these locales who apply to university is lower than for all other locales.

CHAPTER 1 - INTRODUCTION

Background

In 1992, the National Council on Education Standards and Testing issued a report voicing the concern that educational performance expectations in the nation were too low. In this report, the Council presented national educational goals that they believed were imperative to "promote educational equity, to preserve democracy and enhance the civic culture, and to improve economic competitiveness." The Council believed that these standards must be voluntarily implemented by each state, not mandated by the federal government. They also felt that each state needed to work on reducing the gap in student educational opportunities that are associated with race, income, gender, and geographical location (National Council on Education Standards and Testing (U.S.) & United States. Department of Education, 1992, p. 10). This call includes the rural student in particular. In 1994, in response to this report, Congress charged the Office of Educational Research and Improvement to report on the condition of education in small, rural schools (Stern, 1994).

Increasing college degree completion continues to be a priority in the United States. In 2001 the National Commission on the High School Senior Year released a report which stated that while 70% of high school seniors go on to college, only half of those graduate with a degree (Ndura, Robinson, & Ochs, 2003). The reason given for the lack of completion was that the students were not adequately prepared for the rigor of college courses. Offering more Advanced Placement (AP) courses has been proposed as one answer to this problem of some high school students being underprepared for college. The Commission suggested that AP courses be available for all students, not just the privileged few (Ndura et al., 2003). As of 2000, the percentage of minority students, including rural students, entering STEM fields was very small (Ndura et al., 2003). Ensuring that these students are prepared for the rigors of college work by giving them the opportunity and encouragement to take AP courses removes one potential barrier to academic and economic success, since taking advanced high school courses in math and science has been shown to increase interest in STEM careers (Sadler, Sonnert, Hazari, & Tai, 2014).

The country's natural resources and much of the food supply come from rural areas; and, in the future, alternative energy forms and food production will take place in these areas. Future opportunities are determined by the access to the education and skills necessary for the new, technologically advanced jobs (Carr & Kefalas, 2009). Thus, rural access to educational opportunities is vital to both these areas and to the nation.

Universities nationwide are seeing a rise in the number of rural students attending college. These students generally do not have the educational opportunities that others may take for granted. With rural counties containing 80% of land area and 20% of U.S. population, the underperformance of these rural areas is a waste of the nation's resources and can have a large effect on the country's economy (Porter, Ketels, Miller, & Bryden, 2004). The talents of these rural students are not being fully developed (Hill, 2014). With the economic decline in rural areas, education is a way to renew these areas. Increasing education levels has been one strategy to improve economic well-being in rural areas (Demi, Coleman-Jensen, & Snyder, 2010; Schafft, 2016). Educating the rural students will lead to a more educated workforce which in turn increases the productivity of regional businesses (Porter et al., 2004). A growing regional economy then helps increase the standard of living of the region.

Unfortunately, as more students from rural communities attend college, most of the educated young adults leave rural areas in search of better job opportunities. Like all other locales, rural areas are dependent on an educated workforce for economic health. This outmigration leaves rural areas with an aging population and trouble finding educated professionals, such as doctors, teachers, and business owners to replace the retiring population. The decisions these young adults make about whether to stay, leave, or return to rural areas has a significant impact on the future of rural areas (Carr & Kefalas, 2009).

To bring more equity in educational availability, to increase the education level of the population, and to bring more diversity into the engineering discipline, the rural student population as an underrepresented minority needs to be examined at a greater length than it currently is. Location should not be a barrier to educational opportunity (Stern, 1994). Below, I describe the varying definitions of "rural" and note general trends among this group.

Defining Rural

Compounding the paucity of research done on rural students in higher education is the inconsistency of how rural has been defined in past studies. There has not been a common definition of “rural”. Rather, previous studies have defined “rural” with one of several overlapping definitions. These differing definitions are in some ways the result of different scopes of research, yet these differing definitions have caused seemingly contradictory results among studies. Table 1 summarizes the differing definitions used by agencies doing research on rural populations.

Table 1: Definition of "Rural" by Various Agencies

AGENCY	HOW RURAL IS DEFINED	SOURCE
Census Bureau	Based on size and population density of area; 97% of U.S. land is rural by this definition	2010 Census Urban Area FAQs (U.S. Census Bureau, 2010)
Office of Management and Budget (OMB)	Based on county population, allowing some metro counties to contain undefined rural areas; 84% of U.S. land defined as rural	Defining Rural Population (HRSA, 2017)
U.S. Department of Agriculture’s Economic Research Service	Defined on a continuum from rural to urban based on population size and degree of urbanization	Rural-Urban Continuum Codes (USDA, 2013)
National Center for Education Statistics	Urban areas defined based upon population densities, while rural areas are defined based upon distances from urban areas	Status of Education in Rural America (“Status of education in rural America,” 2007)

To avoid the confusion of the different definitions and improve rural education reporting overall, in 2006 the NCES worked with the Census Bureau to improve upon the OMB definition, relying less on population size and county boundaries, and using improved geocoding to specify locations and incorporate the distance to an urbanized area in the definition. This new definition will afford more consistency to school data among research done on rural areas (“Status of education in rural America,” 2007). In this paper, the 2006 definition of urban and rural will be incorporated. Specific classifications with their definitions are listed in Table 2. Within these definitions, the Census Bureau’s use of the terms “urbanized area” and “urban cluster” are defined as follows:

- Urbanized Areas (UAs) have populations of 50,000 or more people;
- Urban Clusters (UCs) have populations of at least 2,500 and less than 50,000 people.

"Rural area" in these definitions refers to all population, housing, and territory not included within an urbanized area or urban cluster.

Table 2: Locale Definitions

LOCALE	DEFINITION
City- Large	Territory inside an urbanized area and inside a principal city with population of 250,000 or more
City- Midsize	Territory inside an urbanized area and inside a principal city with population less than 250,000 and greater than or equal to 100,000
City- Small	Territory inside an urbanized area and inside a principal city with population less than 100,000
Suburb- Large	Territory outside a principal city and inside an urbanized area with population of 250,000 or more
Suburb- Midsize	Territory outside a principal city and inside an urbanized area with population less than 250,000 and greater than or equal to 100,000
Suburb- Small	Territory outside a principal city and inside an urbanized area with population less than 100,000
Town- Fringe	Territory inside an urban cluster that is less than or equal to 10 miles from an urbanized area
Town- Distant	Territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area
Town- Remote	Territory inside an urban cluster that is more than 35 miles from an urbanized area
Rural- Fringe	Census-defined rural territory that is less than or equal to 5 miles from an urbanized area, as well as rural territory that is less than or equal to 2.5 miles from an urban cluster
Rural- Distant	Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster
Rural- Remote	Census-defined rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster

Due to differing definitions of "rural", previous research appears to show differing conclusions. Rural areas are very diverse from area to area, even within the same state (Schafft, 2016). Yet they are generally homogeneous within each particular area, and the large distance from an urbanized area keeps the identity of the rural area strong (Porter et al., 2004; Schafft, 2016; Stern, 1994). Rural schools tend to be smaller, multi-grade schools (Khattri, Riley, & Kane, 1997; Provasnik et al., 2007; Strange, 2011). Rural areas tend to have strong bonds within the community, strengthening the sense of belonging of the students (Bauch, 2001; Howley, 2006; Johnson, Elder, & Stern, 2005; Khattri et al., 1997; Schafft, 2016). The rural population typically values relationships over wealth, and believe hard work is enough to achieve what is necessary for a good life (Bauch, 2001; Burnell, 2003; Hill, 2014). Although some studies show that rural students have lower aspirations than students in other locales (Cobb, McIntire, & Pratt, 1989; Hektner, 1994; Mccracken & Barcinas, 1991; Schonert, Elliott, & Bills, 1991), more recent studies do not support this conclusion (Bajema, Miller, & Williams, 2002; Chenoweth & Galliher, 2004; Howley, 2006). Rural students have aspirations to attend college but have a specific goal in mind for the degree as a way to a job which fits their allegiance to their community (Howley, 2006).

The demographics of rural areas tend to be locally homogeneous and overall largely White (Bauch, 2001; Khattri et al., 1997; Provasnik et al., 2007). However racial/ethnic minorities are still found in pockets, such as the Black population in the Southern rural areas, or the Hispanic/Latino populations in the Midwestern rural areas (Khattri et al., 1997).

Although rural communities suffered longer than other areas after the recession in the 1980s, the level of poverty in rural areas currently does not exceed that of urban areas (Provasnik et al., 2007). In fact, some rural areas have less unemployment than urban areas (Provasnik et al., 2007). Fewer adults have bachelor's degrees in rural areas, since many jobs in the past did not require a college degree. Hence, a college degree is not seen as a necessity (Provasnik et al., 2007).

Because fewer rural students have typically attended college, the availability of upper level courses (honors and Advanced Placement) is lower in rural areas than in other locales. Yet research has shown that students who took AP courses in math or science were more likely to enroll in four-year colleges (Kelley-Kemple, Proger, & Roderick, 2010). Therefore, increasing the availability of AP courses in rural areas may help increase the number of rural students heading to college. Although both urban and rural areas have similar issues, such as higher poverty rates, lower school budgets, and parents with lower levels of education than suburban areas, there is a large difference between the needs of each locale. Local policies need to reflect these differences. Policies that may work in urban areas are not necessarily adequate for rural areas (Williams & Grooms, 2015)

Purpose of Research

As a rural Eastern North Carolina resident for the past twenty years, I have experienced the education system in the state as both a parent of public-school children and as a teacher of these students. I have witnessed the limited availability of upper level high school courses, the variability of teaching quality among and within schools, and the cultural differences in how the role of education is viewed from my upbringing in a large suburban area. I have also experienced the great impact a teacher here can have on how students view themselves and their future. With these experiences, I hope to explore the rural education system in an effort to help these students view engineering as a possible career.

This research will examine the educational opportunities available to rural students, especially related to STEM and engineering. Diversity in engineering is a growing concern and bringing more rural students into engineering careers will both help diversify the field and give students the educational opportunity which could achieve a level of economic security not currently available to them. By naming and removing the institutional barriers to educational opportunities for rural students, this population will have the equality in opportunity afforded to students of other locales.

Given the inconsistencies of previous research and the change in the rural economy over time, this research will use a common definition of 'rural' to evaluate the current state of rural secondary education and rural students in post-secondary engineering education. It will examine the educational opportunities and support currently afforded to rural students as well as research the success of rural students when applying to an engineering program. What will be shown is that rural students have less access to STEM related educational opportunities, such as breadth of AP courses. Although there is no bias in acceptance rates into engineering programs for rural students, the percentage of rural students who apply is lower than for other locales.

CHAPTER 2- LITERATURE REVIEW

Research has shown that education, in the form of a college degree, can help bring families out of poverty (Hout, 2012). Yet many children of rural families do not attend college (Peterson, Bornemann, Lydon, & West, 2015). College attendance for rural students has trailed behind their urban and suburban counterparts (Provasnik et al., 2007). By examining the characteristics of rural areas and the previous research done on rural populations, this work will inform future research into how to increase the number of rural students entering the engineering field.

Cultural Characteristics of Rural Areas

Although there are some common features to all rural areas, the main commonality is that they are all different (Khattri et al., 1997; Price Azano, Callahan, Brodersen, & Caughey, 2017; Stambaugh & Wood, 2015; Stern, 1994). Each area has its own personality and its cultural identity is strengthened by its isolation. The homogeneity of each area contributes to the strong sense of community pride and identity found in these areas (Bauch, 2001; Stambaugh & Wood, 2015). One key feature of rural areas is the low population density of the areas and the large distances separating them from other rural communities and from urban centers (Porter et al., 2004; Price Azano et al., 2017; Stambaugh & Wood, 2015; Stern, 1994). This isolation helps strengthen the identity of the region, as there is less interaction with other areas due to distance.

Characteristics of rural areas differ from state to state and even within a single state (Khattri et al., 1997; Porter et al., 2004; Price Azano et al., 2017; Stambaugh & Wood, 2015; Stern, 1994). Racial/ethnic makeup and socioeconomic status are just two of the characteristics that vary among rural areas and can confound results of studies on the education of the rural student. This variation is one reason why a cursory examination of previous research on rural areas may appear to show differing conclusions.

Numbers in Rural Schools

Rural areas enroll a large portion of public-school students. In the 1992-93 school year, over 26% of U.S. schools were in rural areas. These schools enrolled 16% of the public-school population

(Khattri et al., 1997). By the 2003-04 school year, one third of all public schools were located in rural areas, enrolling 20% of all public school students (Ayers, 2011; Provasnik et al., 2007; Stambaugh & Wood, 2015; Strange, 2011). Enrollment in rural schools grew at a higher rate than the national average during 2002-2005 (15% compared to the 1% national growth; (Ayers, 2011).

Rural schools are generally smaller than schools in other areas (Khattri et al., 1997; Provasnik et al., 2007; Strange, 2011). Smaller schools have resulted in higher participation in extracurricular activities (Schafft, 2016), safer environments for students and teachers, a greater sense of belonging, more individualized attention, mixed-ability classes, multiage classes (Jimerson, 2005), less bureaucracy leading to easier implementation of new methods and programs, and broader grade spans in schools limiting the student transitions to new schools. Nevertheless, public policy has led to consolidation of some schools in rural areas, which removes some of the advantages that rural schools once had (Bard, Gardener, & Wieland, 2006; Stern, 1994). While rural students generally attend smaller community-based schools, and are not offered the same breadth of courses as urban students (Khattri et al., 1997), these schools report fewer behavioral problems and higher teacher satisfaction with school conditions than other locales (Provasnik et al., 2007).

Community Involvement

One strength of rural areas is the strong social bonds which exist in the community (Schafft, 2016). Rural students have more community social support than non-rural students (S.-Y. Byun, Meece, & Irvin, 2012; Johnson et al., 2005). Rural schools have close ties to the community and the social capital given by the community is a support to the education of the students (Bauch, 2001; Howley, 2006; Johnson et al., 2005; Khattri et al., 1997). These social ties are demonstrated through higher levels of parental involvement in school events, both as volunteers and attendees of events (Provasnik et al., 2007). This social support has been shown to facilitate college attendance (S.-Y. Byun et al., 2012; Johnson et al., 2005). The strong intergenerational makeup of rural areas is an advantage to students as there is a strong sense of belonging built into the community (Bauch, 2001; Stambaugh & Wood, 2015).

Aspirations of Rural Students

Parents of rural students tend to value relationships over high-paying jobs (Stambaugh & Wood, 2015). They encourage their children to work hard, and they believe a steady income is adequate for a good life. Many do not believe a college degree is necessary to be financially stable. They encourage their children to pursue a trade or to enlist in the military. As most of these parents have never attended college themselves, they view a college setting as a place that changes a person, and not necessarily for the better. These parents believe that hard work and determination are enough to get through anything, and they have passed this belief system down to their children (Carr & Kefalas, 2009). The percentage of rural students whose parents expected their highest educational attainment to be less than a bachelor's degree (42 percent) was larger than the percentages of students in cities and suburban areas (30 and 25 percent, respectively) (Provasnik et al., 2007). These values are passed down to the students from the parents. Of course, not all students adopt these same values and research has shown varying conclusions on the aspirations of rural students.

Aspirations of rural students change with the economic standing of the areas. The farming crisis of the 1980s caused many farms to go bankrupt and forced the population to move into urban areas to find jobs. Studies using data from the 1980s claim that, in general, rural students tend to have lower educational and career aspirations than students from urban areas (Cobb et al., 1989; Hektner, 1994; Mccracken & Barcinas, 1991; Schonert et al., 1991). Poor secondary preparation, a lack of curriculum diversity, and poor resources have been given as factors contributing to this difference. Yet, the downturn of the economy could also explain these lower aspirations. A 1994 study showed that rural students had lower motivation to continue education after high school (Hektner, 1994). As this study took place shortly after the end of the farming crisis of the 1980s, the uncertainty related to their futures was more evident in rural students than urban students (Hektner, 1994) and this may have affected the motivation to continue to postsecondary education.

As the economy of rural area slowly recovered from this crisis, later studies show different results. A 2002 study of rural youth in Iowa did not find low educational aspirations from the students in the study (Bajema et al., 2002). Ninety-six percent of the rural students in the study stated their desire to continue their education past high school. The majority of these students planned to go to a four-year university.

A 2004 study conducted with students in West Virginia showed that 69% of students surveyed planned to go to college (Chenoweth & Galliher, 2004). This study showed that these rural students did not differ greatly from other high school students from any locale. Locale was not the critical factor, but students who had higher GPAs, took college prep courses, and had higher standardized test scores were more likely to apply to college. As economic conditions have improved, the aspirations of the rural students have also appeared to increase (Bajema et al., 2002).

The motivation of rural students is largely based on their perceptions of their own abilities and their view of how the education will further their future career goals (Hardre, Crowson, Debacker, & White, 2007). There are strong ties to community for rural youth as many generations of family have remained in the communities. Rural youth look for postsecondary education that will fit with their allegiance to community (Howley, 2006; Stambaugh & Wood, 2015).

Rural students view education as a means to a better job and the acquisition of knowledge for the goal of becoming self-sufficient (Burnell, 2003). The goals and values of rural high schools differ from those of urban and suburban schools (Bauch, 2001; Burnell, 2003). The focus on preparing students for university admission does not necessarily align with goals of rural students (Hill, 2014). The focus of high school faculty on university preparation tends to neglect the students who plan to stay in the area, resulting in a less educated rural population. Rural educators have competing priorities then, whether to focus more on helping the community or helping the national economy (Hill, 2014). There are some rural students who embrace both priorities and are attending college with the desire to come back and help the community (Petrin, Schafft, & Meece, 2014; Wright, 2012).

While currently rural students aspire to a college education at the same rate as their peers in other locales, there is a concern for the academic and financial preparation necessary to achieve that goal (Ley, Nelson, & Beltyukova, 1996). The main difference in aspirations among the different locales comes at the postgraduate level (Howley, 2006). Fewer rural students aspire to attend more than four years of college.

Economic Characteristics of Rural Areas

There is a misconception that agriculture is the main economy for rural areas. While this statement may have been true in the past, currently, less than 7% of employment in rural areas is in farming (Porter et al., 2004). The rural economy has been a mixture of agriculture, manufacturing, and service industries such as recreation, tourism, and retirement living (Carr & Kefalas, 2009). There were jobs available that did not require a college education, and families could live a stable life on those salaries.

In 1965, the Higher Education Act allowed for federally funded financial aid and made education more readily available to students from all walks of life. The consequence of this Act, however, has been an outmigration of the educated population from rural to urban areas. Between 1970 and 2000, the difference in percentage of population with a bachelor’s degree from most educated to least educated locales more than doubled. The gap increased from 5% in 1970 to 13% in 2000 (Carr & Kefalas, 2009).

As technology advanced, both farms and manufacturing plants have become more mechanized and require fewer workers to run them. The advance of agricultural science has allowed for the creation of mega-farms which successfully competed against the family farms. The recession and the farming crisis in the 1980s had a larger and longer-lasting effect on rural areas than on other locales, with higher unemployment being seen as one of the symptoms (Stern, 1994). Research studies from those years show a lower socioeconomic status in rural areas and rural students compared to other locales. A 1993-93 study showed that 64% of rural students attended mid to high poverty schools (Khattri et al., 1997). This was defined as schools with over 21% of students receiving free or reduced lunch.

While the 1970s saw a shift of manufacturing jobs from urban to rural areas, the implementation of NAFTA in 1995 harmed rural areas as many manufacturing jobs were lost to companies moving business outside of the United States for cheaper labor (Carr & Kefalas, 2009; Porter et al., 2004).

Current research is showing lessening poverty in rural areas. Between 1989 and 2000, the poverty rate in rural regions has been falling (Porter et al., 2004). When compared with urban students, a smaller proportion of rural students are poor and attend school with other poor students (Khattri et al., 1997; Porter et al., 2004). In a 2004 study, the percent of students living in poverty was lower in rural areas than in urban areas, but still higher than suburban areas (Provasnik et al., 2007). In 2004, the unemployment rate for adults was lower in rural areas than in other locales and the median earnings was higher in rural areas than in cities and towns (when adjusted for regional cost differences), regardless of educational attainment (Provasnik et al., 2007).

However, when only examining remote rural areas, the percent of public school students attending a moderate-to-high poverty school was higher than in all locales except large and midsize cities and those remote rural schools contained higher percentages of Black and American Indian/Alaska Native students than in large cities (Provasnik et al., 2007). In addition, studies from the early 1990s show that rural students more often live with two parents than urban students (Demi et al., 2010; Khattri et al., 1997). The studies also show a lower percentage of single-parent households in poor rural families when compared to poor urban households (Khattri et al., 1997). Poverty is, therefore, different in rural areas than in urban areas.

Demographic Characteristics of Rural Areas

Rural Race/Ethnicities

The percentage of White students is larger in rural areas than any other locale. Concomitantly, the percentage of Black, Hispanic/Latino, and Asian/Pacific Islander students is lower in rural areas than all other locales (Provasnik et al., 2007). In 2003, 78% of rural children were White, compared to 62% in suburban areas (Provasnik et al., 2007). However each rural area is homogeneous when it comes to race, religion, and socioeconomic status (Bauch, 2001; Carr & Kefalas, 2009). While many rural areas contain large percentages of minority students, those areas are usually located in the low socioeconomic rural areas (Provasnik et al., 2007). The rural areas with a large percentage of Hispanic/Latino students can be found in the West and the areas with large percentages of Black students can be found in the South (Khattri et al., 1997; Provasnik et al., 2007; Stambaugh & Wood, 2015).

Parental Education

Parents of students in rural schools tend to be less educated than parents in other locales. The percent of school age children who had parents with only a high school degree was higher in rural areas than in cities or suburbs, even when controlling for school poverty (Felder, Mohr, Dietz, & Baker-Ward, 1994; Khattri et al., 1997; Provasnik et al., 2007). The loss of jobs in rural areas has caused the more educated to migrate to urban areas where jobs may be found. The jobs remaining in rural areas are low-paying/ low benefit jobs (Carr & Kefalas, 2009).

Educational Characteristics of Rural Areas

Rural Secondary Education

In rural schools, teachers and school counselors play a larger role in the educational path of the students than in other locales. A 1994 study showed that the community plays a large role in rural students' decisions to enter higher education (Hektner, 1994). While most parents do not have a degree beyond high school, the school environment is where the aspirations for a university degree are encouraged. Unfortunately, rural culture categorizes some students as college bound and other students as "stayers" from the time a student begins formal schooling in kindergarten (Carr & Kefalas, 2009). These categorizations are basically determined along socioeconomic lines, with students from elite families being singled out for more attention than students from the "wrong side of the tracks." More attention is paid to these "college bound" students, who are considered worthy of the time investment (Carr & Kefalas, 2009). This trend occurs even when adults realize that this investment will lead to a loss for the community because the student will most likely leave the town after graduation and not return. Attachment to rural community and the desire to remain in the area is devalued by educators, especially for the students with the academic ability to succeed in higher education (Petrin et al., 2014).

Teachers in rural schools tend to be younger and less well-educated than their peers in other locations (Khattri et al., 1997; Stern, 1994). No Child Left Behind had an unfortunate negative effect on rural areas (Jimerson, 2005). The highly qualified teacher requirements were well-intentioned but left rural areas with inadequate numbers of teachers. It also devalued the "homegrown" teachers who have the local knowledge that has been one strength of rural teachers

(Williams & Grooms, 2015). While there are the disadvantages of less qualified teachers and fewer upper level courses, a 2004 report shows that high school completion rates of rural students matches that of metropolitan regions (Porter et al., 2004). Yet a gap still exists in the rates of college attendance between rural areas and others.

Performance of rural students in national assessments met the national mean in the early 1990s, and rural students outperformed urban students in those assessments (Schafft, 2016; Stern, 1994). The academic achievement of students in poor rural schools is higher than those in poor urban schools (Khattri et al., 1997). The dropout rate is lower (11% vs. 13%) and the graduation rate is higher than for urban schools (75% vs. 65% for urban schools) (Strange, 2011). The strong community support of rural areas helps to keep students in school through high school graduation.

Advanced Placement Program and the Rural Student:

The College Board, which founded the Advanced Placement (AP) Program, was formed in 1900 with a mission to expand access to higher education (The College Board, 2018). This increase in access was done by offering college level courses to students in high school. At first these AP courses were only offered in elite schools (Stoel, 1988). As the benefits from taking AP courses was proven, access to these courses has increased. In 1990, approximately 42% of U.S. high schools were participating in the AP program (Herr, 1992). By 2009, that number had risen to over 60% of public high schools in the United States (Jeong, 2009).

AP classes have been shown to prepare students for college level work (Curry, MacDonald, & Morgan, 1999; Sadler & Tai, 2007; Santoli & Curricu, 2002). Taking an AP science course in high school has been shown to be a predictor for students entering a STEM major in college (Ndura et al., 2003). A study of Chicago area public schools reported that students who took AP courses in math or science were more likely to enroll in four-year colleges (Kelley-Kemple et al., 2010). Also, receiving credit from AP Calculus exam is shown to be the best predictor of success in STEM fields (Ackerman, Kanfer, & Calderwood, 2013).

Taking AP courses is also a benefit when applying to college. Universities have used AP as a measure of predicting academic success (Ackerman et al., 2013; Curry et al., 1999; Sadler & Tai, 2007; Santoli & Curricu, 2002). High schools are ranked by the number of AP courses offered (DiMaria, 2013; Santoli & Curricu, 2002). Taking AP courses in high school has been correlated with greater success in college, both in overall GPA and college graduation rates (Ackerman et al., 2013; Curry et al., 1999; Hargrove, Godin, & Dodd, 2008; Mattern & Xiong, 2009; Morgan & Klaric, 2007; Murphy & Dodd, 2009; Santoli & Curricu, 2002; Scott, Tolson, & Lee, 2010). Students who take and pass an AP test have an assurance that they are capable of handling college level coursework (Curry et al., 1999; Santoli & Curricu, 2002; Stoel, 1988).

Yet there is disproportionate access to AP courses for students attending schools with higher percentages of minority students and lower socioeconomic status. The level of success in the AP courses does not differ based on the school characteristics of minority and socioeconomic status, only the access to the AP courses (Barnard-Brak, McGaha-Garnett, & Burley, 2011).

Rural students have less access to AP courses than their peers in other locales. In a 1997 study of schools in New York, rural high schools were seen to offer fewer honors and AP courses (Spade, Columba, & Vanfossen, 1997). Where these honors and AP courses are offered, access to these courses is higher in rural areas than in urban areas because rural schools tend to have fewer restrictions on who can take the upper level courses (Spade et al., 1997). In successful rural schools, targeted recruiting encourages students to take the upper level courses, showing the students how the subject is relevant to their lives. Parents are given a greater role in choosing the classes than in the affluent schools where teachers are the ones placing students into upper level courses (Spade et al., 1997), but without parental support for higher education, the qualified students may not end up in upper level courses.

In the 2002-03 school year, the percentage of public high school students attending schools offering AP courses was lowest in rural areas (69% compared with 93 and 96% for cities and suburbs; (Provasnik et al., 2007). Over 47% of rural schools had no AP enrollment according to a 2015 study (Gagnon & Mattingly, 2015), compared to a maximum of 20% for other locales. Locations further from urbanized areas have the least amount of access to AP. This lack of access makes rural students much less likely to take AP courses than their peers in other locales. Given the proven benefits of AP preparation for college, rural students are being disadvantaged in their schooling.

Rural Students in Higher Education

College enrollment rates for both 18- to 24-year-olds and 25- to 29-year-olds were generally lower in rural areas than in all other locales in 2004 (Provasnik et al., 2007). A study of rural students in Pennsylvania showed that that although rural students were less likely to enter postsecondary education, their likelihood of entering college increased with the number of science courses taken in high school (i.e. physics, chemistry, and biology) and if they were enrolled in an academic, as opposed to vocational, high school program (Yan, 2001). Yet rural student enrollment in college increased by nearly 7% between 2003 and 2007 (S.-Y. Byun et al., 2012).

Influence of the school (school context) in the decision to pursue postsecondary education is greater for rural students than others, perhaps because of the larger role the school has in the community (Demi et al., 2010; Khattri et al., 1997). Those students who have been in the ‘college bound’ group since kindergarten generally feel obligated to go on to college, while those not in that category often feel they should stay close to family instead of leaving for college, regardless of ability levels. With stronger bond to parents, rural students experience more conflict in their decision to leave the community and go to college (Demi et al., 2010).

Those rural students not from elite families may need to work and save money for college after high school, rather than going straight on to college (Burnell, 2003). Since they typically view college as a means to the goal of a job, they do not go to college unless they know what they want to do with the degree. They view college as a waste of time and a delay to “real” life if their degree is not going to be used for a specific job purpose (Burnell, 2003).

Studies from the 1980s and early 1990s show that rural students are less likely than urban students to complete college (Felder et al., 1994). Reasons for this trend are attributed to a weaker secondary preparation, less-educated parents, and less social pressure to attend postsecondary institutions. Byun and colleagues (2012) examined differences in degree completion for rural versus non-rural students. They found that the strong community support helped increase the level of degree attainment, despite the socioeconomic status and academic preparation difficulties. The rigor of the high school program, along with the encouragement from family and community, have been found to be good predictors of college completion for rural students (S. Byun, Irvin, & Meece, 2012). Rural persistence rates also differed by U.S. region. Midwestern rural areas tend to have higher college persistence rates than other rural areas (Schonert et al., 1991). A 1994 study of North Carolina students in chemical engineering classes found that rural students underperformed in comparison to their urban peers (Felder et al., 1994). In this case, the urban/rural status was self-reported.

Theoretical Framework

Critical Education Theory will be used to frame this research. Critical Education Theory evolved from Critical Social Theory which views the current education system as a means of maintaining social control for the current privileged population. The aim of critical social theory is to liberate human beings from societal constructs which may dominate them or limit their freedom (Bohman, 2016; Giarelli, 1992). The purpose of critical education theory is to achieve social, cultural, and economic equity by transforming society barriers with the use of education. Educational institutions and their policies exert social control by determining who receives knowledge in the form of education and who is kept out. Those with knowledge retain power and are the elite in society.

Based on this theory, educational opportunities available to rural students will be compared to opportunities available to students in other locales. Educational opportunity in the form of AP courses in high school will be examined to determine whether the educational system is designed to prevent rural students from participating in higher education by keeping rural students from receiving equitable access to these AP courses. If there are inequities in course availability across locales, factors which may contribute to or be concomitant with this inequity will be explored. This theory will be used to explore whether educational opportunity for the rural student is being restricted, preventing them from achieving social and economic equity.

Research Questions

Based on the review of the literature, no specific research has been done to examine the educational equity of rural students in their preparation to enter the engineering field. While research has identified factors that encourage students in general to enter a STEM field, the extent to which these same factors are relevant for rural students has not been examined. Also, the underrepresentation of rural students in engineering has not been addressed. This research aims to begin the study of rural students and their pathways into engineering.

The research questions for this work focus on the academic preparation received in high school, and the prevalence and success of rural students in applying and being accepted to an engineering program. Focusing on academic preparation for entering a STEM major in college, this work answers two research questions:

1. In comparison to other geographic locales, how available are AP courses to rural students? Are there differences in availability based on socioeconomic status, percentage of minority students, size of the school, or just based on distance to larger population centers? Are there differences in availability among rural locales nationally?
2. Are the AP courses available to rural students pertinent to a career in STEM?

Considering an engineering program at a university in a rural North Carolina town, two further questions have been added:

3. How are students from rural areas represented in this engineering program, compared with engineering programs nationally?
4. Compared to the overall acceptance rate, what is the acceptance rate into the engineering program for rural students? Does being from a rural high school make a student less likely to be admitted into the engineering program?
5. How do high school size, high school socioeconomic status, and racial/ethnic background of students ***in engineering*** differ from high school students nationally?

CHAPTER 3 – HIGH SCHOOL CHARACTERISTICS STUDY

Introduction

To begin the research on rural students in engineering, the academic preparation of rural students was examined. Availability of AP courses in rural locales compared to all other locales will be studied specifically to see how much, if any, disparity comes through the lack of availability. School size, racial/ethnic makeup, and the socioeconomic condition of the schools was included as variables to control for their influence as confounding factors in the number AP courses offered, regardless of geographic locale. Here the socioeconomic status of schools is defined by the percentage of students receiving free or reduced lunch at the school. The type of AP courses being offered to rural students was also examined to determine whether the courses offered are pertinent to a degree in engineering. After examining the characteristics of rural areas nationwide, this same examination was conducted on schools in North Carolina specifically.

This study seeks to answer the first two research questions:

1. In comparison to other geographic locales, how available are AP courses to rural students? Are there differences in availability based on socioeconomic status, percentage of minority students, size of the school, or just based on distance to larger population centers? Are there differences in availability among rural locales nationally?
2. Are the AP courses available to rural students pertinent to a career in STEM?

Methods

Data

Data were obtained from the National Center for Education Statistics (NCES) ("Public Elementary/Secondary School Universe Survey," 2014) and from The College Board ("AP Report to the Nation," 2016). From NCES for the 2014-15 school year, a listing of each public high school with its geographic locale (one of the twelve classifications detailed previously) was obtained. With each school listing, data was also obtained on the number of students in the school, number of students receiving free/reduced lunch, and the percentages of different race/ethnicities in the school (i.e., American Indian, Asian, Hispanic/Latino, Black, Hawaiian or Pacific Islander, White, or Two or more races). In NCES records, these schools are identified by name and by an ID number. Separately, The College Board offered a listing of all schools in the world that offer Advanced Placement courses by school year and by subject offered. The number and type of AP courses offered by each school of interest from 2007-2016 was tallied. This study examines only U.S. public schools, since many private schools do not submit free or reduced lunch or racial/ethnic data to NCES. College Board uses a different ID number from those of NCES to identify their schools. Using a crosswalk that was obtained and updated (Long, 2011), the information from College Board was matched with the information from NCES for each school.

Once the data sets were combined, the sample contained data for 17,835 public U.S. high schools. This sample is meant to represent the available public schools for secondary education in the United States, drawn from a total population of over 24,000 public high schools during that timeframe. Variables for this study include school name, identifying code, address, city, state, zip code, county, locale, area, school level, total number of students in the school, percent of students receiving free/reduced lunch, racial/ethnic distribution, and number and type of AP courses offered.

Some schools (n= 2,834) were eliminated from the final sample because of missing or incorrect reporting making it impossible to find the school in one or the other of the original data sets. Alternative schools, schools for special populations, juvenile detention centers, middle schools, and early college high schools were excluded from the sample. Schools with less than 30 students were also omitted due to statistical significance reasons (n= 1,230). The final count of schools used for this analysis was 15,448.

Analysis

AP Availability per Locale

To explore the equity of educational opportunity among locales, educational opportunity will be operationalized as availability of Advanced Placement courses in the high school. The hypothesis for this study is that rural areas do not have the same access to AP courses as other locales, and the courses available may not contribute to success in a STEM field. Figure 1 shows the average number of AP courses offered per school in each of the twelve locales. As evidenced by the lower median and interquartile range in the figure, the lowest number of AP courses offered per school nationally occurs in rural distant and rural remote schools. Although also labeled as rural, rural fringe schools are less different from other locales compared with the other two rural classifications. Rural school consolidation in those fringe areas may account for much of that difference.

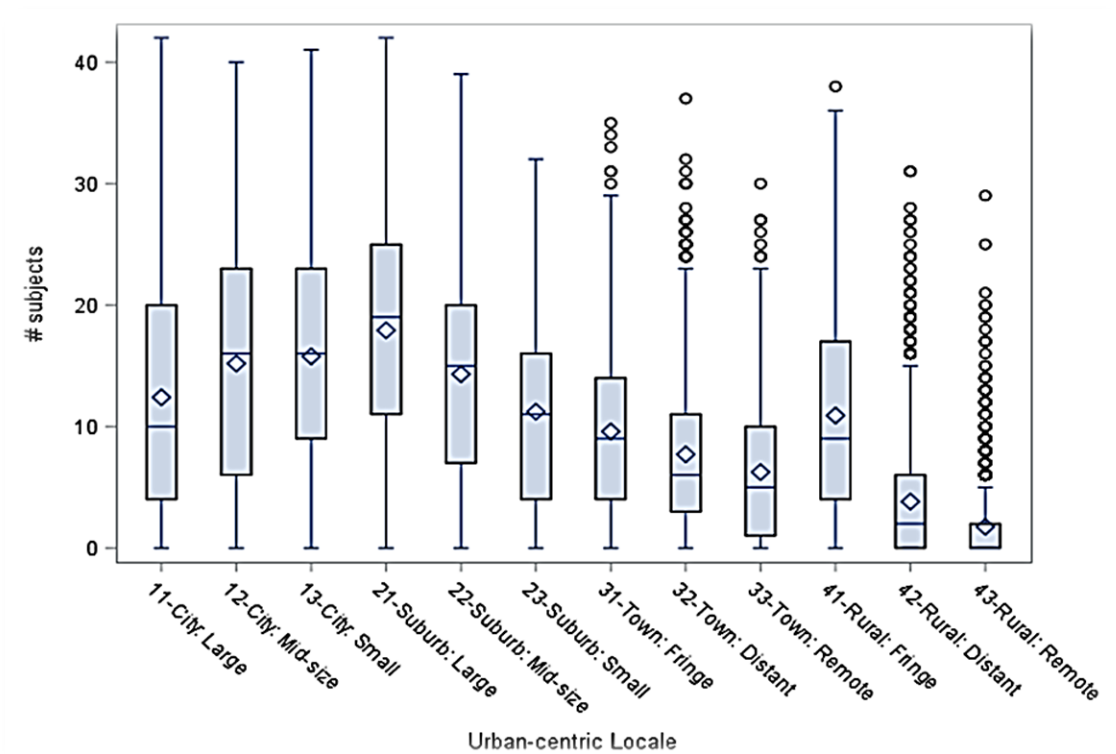


Figure 1: Number of AP Subjects Offered per Locale (2014-15)

As described previously, successful completion of STEM AP exams has been linked to STEM major persistence in college (Ackerman et al., 2013). STEM AP course availability is an important factor to bring more rural students into engineering. Therefore, current access to AP courses for rural students was examined to see how it compares with access in other locales. Examining STEM course availability in rural schools, Table 3 shows the likelihood of finding a specific STEM AP course in each locale. Fractions of schools offering the AP course is listed as the numerical value in each box. Rural distant and remote areas have up to 14 AP courses (both STEM and non-STEM) that are not offered in any school in that locale. These include four STEM AP courses. Looking at STEM courses specifically, these two locales have the lowest availability of all locales for STEM related AP courses, as evidenced by the red colored boxes in Table 3. Large suburban areas consistently have the highest availability among locales as evidenced by the green boxes. The results show that AP course availability decreases as the distance from populated areas increases. The full table of AP course availability, both STEM and non-STEM courses may be found in Appendix A.

Table 3: Fraction of Schools offering STEM courses

LOCALE:	**11**	**12**	**13**	**21**	**22**	**23**	**31**	**32**	**33**	**41**	**42**	**43**
Statistics	0.49	0.61	0.65	0.72	0.63	0.49	0.46	0.34	0.26	0.45	0.15	0.07
Physics C: Mechanics	0.17	0.23	0.26	0.37	0.2	0.15	0.1	0.06	0.04	0.15	0.02	0
Physics C: Electricity	0.09	0.13	0.16	0.23	0.1	0.07	0.04	0.03	0.01	0.07	0	0
Physics B	0.35	0.46	0.48	0.54	0.47	0.35	0.27	0.21	0.19	0.33	0.09	0.04
Physics 2	0.1	0.15	0.19	0.2	0.14	0.14	0.06	0.03	0.03	0.09	0.01	0
Physics 1	0.28	0.44	0.43	0.5	0.4	0.33	0.23	0.16	0.14	0.28	0.06	0.02
Environmental Science	0.43	0.48	0.44	0.52	0.46	0.25	0.26	0.2	0.15	0.33	0.1	0.05
Computer Science AB	0.06	0.09	0.09	0.11	0.04	0.02	0.01	0.02	0.01	0.03	0	0
Computer Science A	0.21	0.3	0.35	0.41	0.32	0.2	0.16	0.11	0.07	0.2	0.05	0.02
Chemistry	0.48	0.65	0.7	0.77	0.68	0.56	0.49	0.42	0.37	0.55	0.2	0.08
Calculus BC	0.33	0.45	0.51	0.58	0.45	0.36	0.24	0.15	0.12	0.3	0.07	0.03
Calculus AB	0.66	0.77	0.83	0.88	0.83	0.78	0.76	0.71	0.61	0.78	0.44	0.23
Biology	0.61	0.7	0.78	0.82	0.75	0.65	0.64	0.53	0.46	0.66	0.31	0.15

Legend:

11-City: Large	12-City: Mid-size	13-City: Small
23-Suburb: Small	22-Suburb: Mid-size	21-Suburb: Large
31-Town: Fringe	32-Town: Distant	33-Town: Remote
41-Rural: Fringe	42-Rural: Distant	43-Rural: Remote

While it is evident there are descriptively different AP course availability among locales, if these differences are significant and the magnitude of those differences cannot be determined without inferential statistics. Due to the non-normal distributions of data, nonparametric methods were used in the analysis to compare AP availability among locales. The Dwass, Steel, Critchlow-Fligner (DSCF) multiple comparison analysis was used to analyze pairwise samples of locales and compute effect sizes. This analysis uses two-sample Wilcoxon comparisons and is relevant when the number of class levels is greater than two. The analysis returns a two-sided DSCF *p*-value, as well as the Wilcoxon Z score (Coolican, 2014). After calculating *p*-values, all locale pairs that were considered significantly different at the α less than .05 level had the effect size calculated from the Wilcoxon Signed-rank test. The effect size is calculated as the Wilcoxon Z divided by the sum of the total number of samples in each locale. Effect sizes (r) are labeled as small effects less than .3; medium effects from .3 to .5; and large effects .5 or larger (Coolican, 2014). Table 4 shows the effect sizes for all significant comparisons among locales when looking at the number of AP courses offered. Comparisons with large effect sizes are boxed in red at the top of the table. Since rural distant and remote areas are contained in all comparisons with large effect sizes, and half of the medium effect sizes, these rural distant and remote areas are distinctly different than other locales in this measure.

Table 4: DSCF Multiple Comparison Analysis Results for Number of Courses

Urban-centric Locale	Wilcoxon Z	DSCF Value	Pr > DSCF	r
43-**Rural: Remote** vs. 21-Suburb: Large	-49.52	70.03	<.0001	-0.70
43-**Rural: Remote** vs. 13-City: Small	-33.00	46.68	<.0001	-0.67
42-**Rural: Distant** vs. 21-Suburb: Large	-49.35	69.79	<.0001	-0.66
41-**Rural: Fringe** vs. 43-**Rural: Remote**	38.16	53.96	<.0001	0.64
43-**Rural: Remote** vs. 12-City: Mid-size	-29.28	41.40	<.0001	-0.61
43-**Rural: Remote** vs. 22-Suburb: Mid-size	-27.46	38.84	<.0001	-0.60
43-**Rural: Remote** vs. 11-City: Large	33.73	47.71	<.0001	0.59
43-**Rural: Remote** vs. 31-Town: Fringe	-26.12	36.94	<.0001	-0.56
43-**Rural: Remote** vs. 32-Town: Distant	-28.48	40.28	<.0001	-0.55
42-**Rural: Distant** vs. 13-City: Small	29.25	41.36	<.0001	0.53
33-Town: Remote vs. 13-City: Small	-19.51	27.59	<.0001	-0.49
43-**Rural: Remote** vs. 23-Suburb: Small	-21.23	30.02	<.0001	-0.48
41-**Rural: Fringe** vs. 42-**Rural: Distant**	30.57	43.23	<.0001	0.47
42-**Rural: Distant** vs. 12-City: Mid-size	-24.81	35.09	<.0001	-0.46
33-Town: Remote vs. 21-Suburb: Large	-29.31	41.45	<.0001	-0.46
32-Town: Distant vs. 21-Suburb: Large	-29.41	41.59	<.0001	-0.44
33-Town: Remote vs. 22-Suburb: Mid-size	-15.48	21.89	<.0001	-0.44
43-**Rural: Remote** vs. 33-Town: Remote	21.69	30.67	<.0001	0.44
42-**Rural: Distant** vs. 22-Suburb: Mid-size	-22.91	32.40	<.0001	-0.44
42-**Rural: Distant** vs. 11-City: Large	27.11	38.34	<.0001	0.43
33-Town: Remote vs. 12-City: Mid-size	-16.26	23.00	<.0001	-0.43

Table 4 continued

13-City: Small vs. 32-Town: Distant	17.97	25.41	<.0001	0.42
31-Town: Fringe vs. 42-**Rural: Distant**	18.80	26.58	<.0001	0.35
32-Town: Distant vs. 12-City: Mid-size	-14.52	20.53	<.0001	-0.35
41-**Rural: Fringe** vs. 21-Suburb: Large	-25.30	35.78	<.0001	-0.35
32-Town: Distant vs. 22-Suburb: Mid-size	-13.41	18.96	<.0001	-0.34
31-Town: Fringe vs. 13-City: Small	-11.80	16.69	<.0001	-0.33
42-**Rural: Distant** vs. 32-Town: Distant	18.30	25.88	<.0001	0.31
42-**Rural: Distant** vs. 23-Suburb: Small	15.65	22.13	<.0001	0.31
31-Town: Fringe vs. 21-Suburb: Large	-18.78	26.56	<.0001	-0.30
33-Town: Remote vs. 23-Suburb: Small	-9.15	12.94	<.0001	-0.28
31-Town: Fringe vs. 22-Suburb: Mid-size	-8.58	12.13	<.0001	-0.27
31-Town: Fringe vs. 12-City: Mid-size	-9.34	13.20	<.0001	-0.27
11-City: Large vs. 33-Town: Remote	13.19	18.66	<.0001	0.27
41-**Rural: Fringe** vs. 33-Town: Remote	13.72	19.40	<.0001	0.26
11-City: Large vs. 21-Suburb: Large	-18.42	26.04	<.0001	-0.26
43-**Rural: Remote** vs. 42-**Rural: Distant**	-16.25	22.99	<.0001	-0.26
33-Town: Remote vs. 31-Town: Fringe	-8.92	12.61	<.0001	-0.24
41-**Rural: Fringe** vs. 13-City: Small	-12.07	17.07	<.0001	-0.23
23-Suburb: Small vs. 13-City: Small	-6.80	9.62	<.0001	-0.21
42-**Rural: Distant** vs. 33-Town: Remote	10.99	15.54	<.0001	0.20
11-City: Large vs. 32-Town: Distant	10.26	14.50	<.0001	0.20
23-Suburb: Small vs. 21-Suburb: Large	-11.16	15.79	<.0001	-0.19
41-**Rural: Fringe** vs. 32-Town: Distant	9.93	14.04	<.0001	0.18
23-Suburb: Small vs. 32-Town: Distant	6.56	9.28	<.0001	0.18
41-**Rural: Fringe** vs. 12-City: Mid-size	-9.03	12.76	<.0001	-0.18
23-Suburb: Small vs. 12-City: Mid-size	-5.27	7.45	<.0001	-0.17
23-Suburb: Small vs. 22-Suburb: Mid-size	-4.62	6.53	0.00	-0.17
11-City: Large vs. 13-City: Small	-8.26	11.68	<.0001	-0.17
41-**Rural: Fringe** vs. 22-Suburb: Mid-size	-7.39	10.45	<.0001	-0.15
31-Town: Fringe vs. 32-Town: Distant	5.37	7.59	<.0001	0.13
21-Suburb: Large vs. 22-Suburb: Mid-size	7.85	11.11	<.0001	0.13
11-City: Large vs. 12-City: Mid-size	-6.03	8.53	<.0001	-0.13
33-Town: Remote vs. 32-Town: Distant	-4.94	6.99	<.0001	-0.11
21-Suburb: Large vs. 12-City: Mid-size	6.34	8.97	<.0001	0.10
11-City: Large vs. 22-Suburb: Mid-size	-4.58	6.48	0.00	-0.10
23-Suburb: Small vs. 31-Town: Fringe	2.58	3.65	0.29	0.09
13-City: Small vs. 21-Suburb: Large	-5.76	8.14	<.0001	-0.09
11-City: Large vs. 31-Town: Fringe	3.92	5.54	0.01	0.08
13-City: Small vs. 22-Suburb: Mid-size	2.63	3.72	0.26	0.08
41-**Rural: Fringe** vs. 31-Town: Fringe	2.50	3.54	0.34	0.05
12-City: Mid-size vs. 22-Suburb: Mid-size	1.42	2.01	0.96	0.04
41-**Rural: Fringe** vs. 11-City: Large	-2.42	3.43	0.39	-0.04
13-City: Small vs. 12-City: Mid-size	1.08	1.53	1.00	0.03
41-**Rural: Fringe** vs. 23-Suburb: Small	-0.88	1.25	1.00	-0.02
11-City: Large vs. 23-Suburb: Small	0.60	0.84	1.00	0.01

AP course availability is therefore an issue for rural schools, but is this due solely to being farther away from larger population areas, or might the effects also be influenced by other characteristics of rural areas? To determine which factors may be explanatory for the difference of AP availability among locales, several factors were investigated. The average school size, number of AP courses offered, and racial/ethnic breakdown of the schools in each of the twelve main locales for school location were explored using descriptive statistics. In the following sections, comparisons among the locales are described from the graphical representations. Results are shown per each of the twelve geographic locales in Figures 2-5.

To examine whether Advanced Placement course availability is related to more than just geographic locale, descriptive statistics examined for average school size, the average percentage of students on free or reduced lunch in a school, and the racial/ethnic makeup of schools per geographic locale. Appendices B and C show the tabular results for these statistics.

High School Size by Locale

To get a general understanding of the distribution of high schools geographically in the United States, as well as the makeup of the student body in the high schools, descriptive statistics were run on the final database of schools. Within the final database of schools, Table 5 shows the distribution of schools among the locales.

This breakdown shows thirty-eight percent (n = 5,884) of these schools were in rural areas, with two-thirds of those rural schools being at least five miles from a census-defined urbanized area (i.e. distant or remote rural areas; Table 5). Thus 25% of all U.S. schools in this representation are situated in rural distant or rural remote areas. Figure 2 shows the distribution of schools in the U.S. by geographic locale. The largest subset of schools is in large suburban areas with 21% of the total schools. Smaller suburban schools are much fewer in number compared with the rest of the locales, due to lower population in that subgroup. When looking at the rural subgroups, rural schools make up 38% of all high schools in the United States. Rural distant and remote areas have 25% of the total U.S. schools.

Table 5: Number of U.S. Schools per Locale

Locale	Size	Number
City	Total	3,100
	Large	1,665
	Mid-size	656
	Small	779
Suburb	Total	4,057
	Large	3,338
	Mid-size	444
	Small	275
Town	Total	2,407
	Fringe	534
	Distant	1,070
	Remote	803
Rural	Total	5,884
	Fringe	1,927
	Distant	2,304
	Remote	1,653

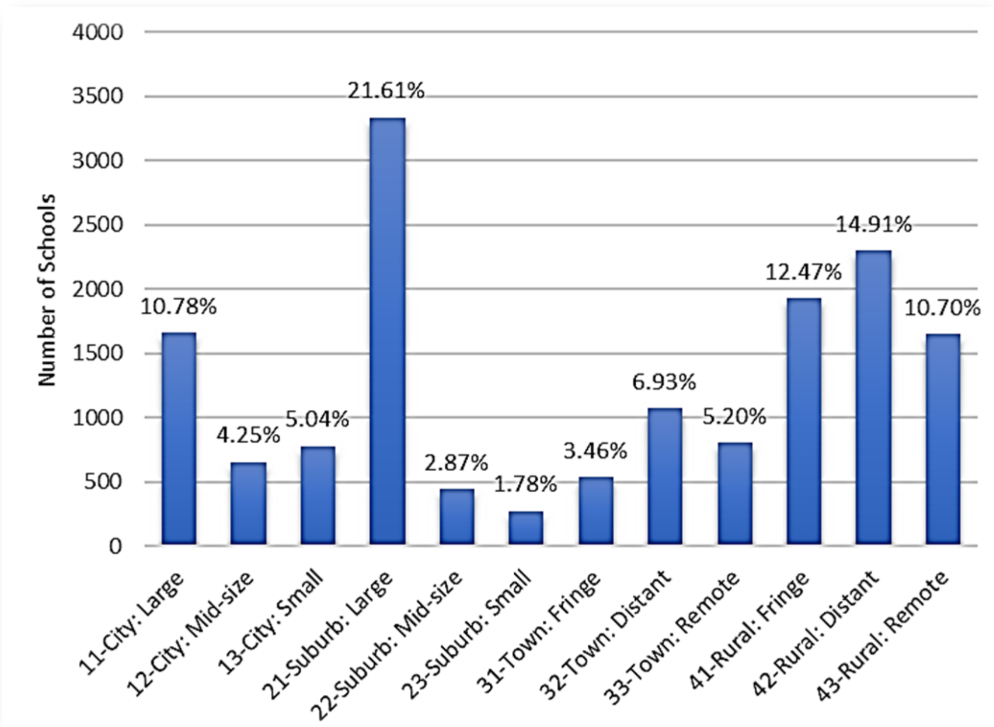


Figure 2: Number of U.S. Schools by Locale (2014-15)

Figure 3, however, tells another part of the story. This graph shows that although 25% of schools are in rural distant or remote areas, only about 8% of students in the United States are being educated in those schools. The proportion goes up to 20% when all rural areas are included. This leads to the conclusion that rural schools must be smaller than schools in other locales.

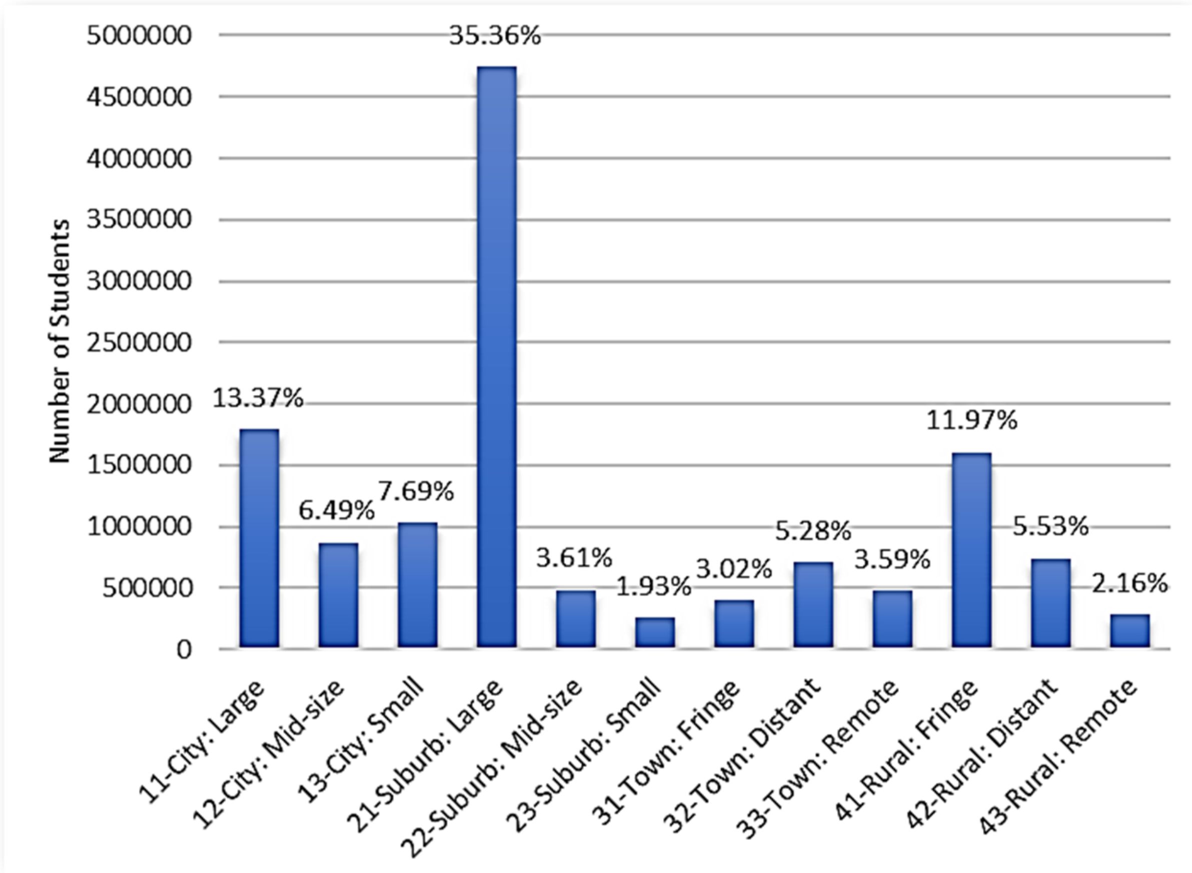
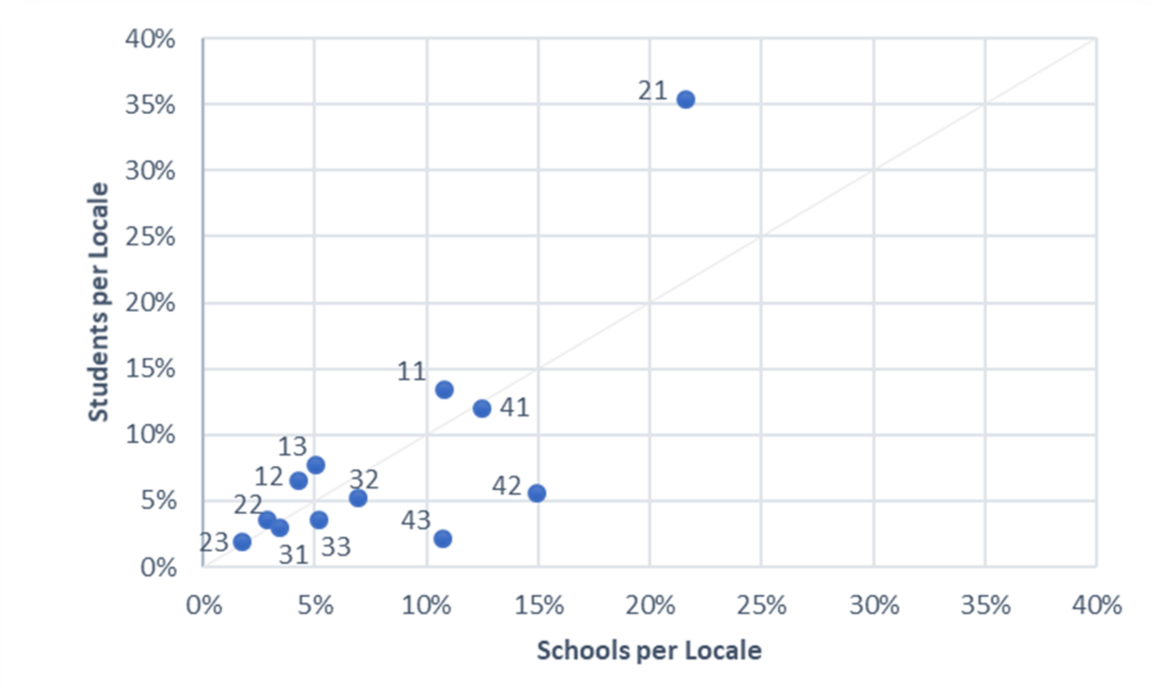


Figure 3: Total Students per Locale in the U.S. (2014-15)

The parity plot in Figure 4 illustrates the difference in rural school size in comparison to other locales. The line in the plot is the line where the percentage of schools and the percentage of students in the locales are equal. Locales are represented as points on the graph. If a point falls below the line, that locale will have more schools than students by percentage. If it falls above the line, the locale has more students than schools. While most locales fall close to the line, Rural distant and remote schools (42 and 43) are well below the line, while large suburban schools (21) are far above the line. This trend shows that nationwide, rural distant and remote schools have the fewest number of students.



Legend:

11-City: Large	12-City: Mid-size	13-City: Small
23-Suburb: Small	22-Suburb: Mid-size	21-Suburb: Large
31-Town: Fringe	32-Town: Distant	33-Town: Remote
41-Rural: Fringe	42-Rural: Distant	43-Rural: Remote

Figure 4: Parity Plot of School Size per Locale

For the average school size per locale, Figure 5 shows city and suburban schools have a higher average number of students than town and rural schools, as seen with the higher median lines in the interquartile range. Numbers drop when schools are in distant or remote rural areas, having only 200-300 students per school on average. Rural fringe areas are less different from other locales in school size. This result may be due to school consolidation efforts in these areas (Bard et al., 2006). This figure also shows that the range of school sizes is smaller in rural distant and remote areas. This difference is seen as smaller interquartile boxes and outliers that are not as far from the mean as in other locales.

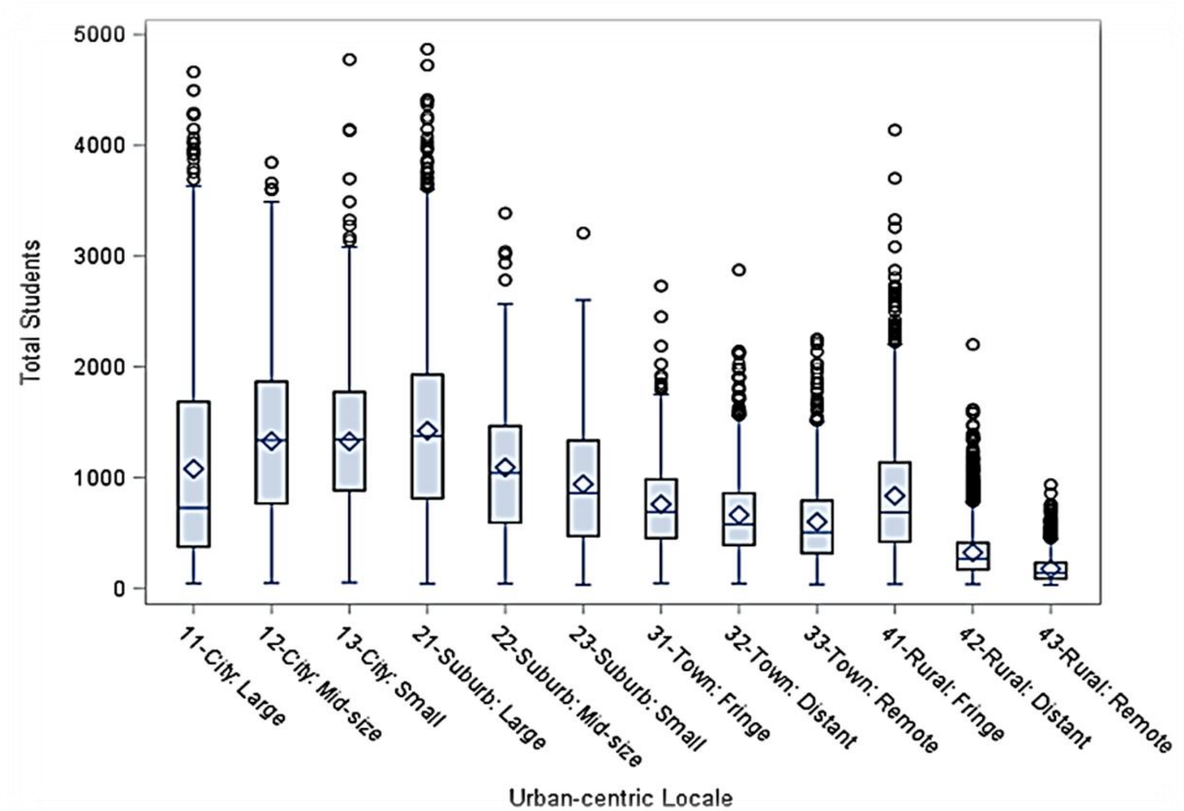


Figure 5: Average School Size per Locale (2014-15)

As with the analysis of number of AP courses per school, comparisons were analyzed using a multiple comparison analysis with the DSCF method. Effect sizes (r) were again calculated, and the results are shown in Table 6. Again, the table is sorted by effect size with large effect sizes boxed in red at the top of the table. Large effect sizes occur when comparing rural distant and remote schools with all other locales. Schools in fringe rural areas have only small or medium effect sizes, similar to remote town schools. In fact, no significant difference was found when comparing rural fringe school sizes with remote town schools. This result again is most likely due to the school consolidation in those areas.

Table 6: DSCF Comparison Results for Average School Size per Locale

Urban-centric Locale	Wilcoxon Z	DSCF Value	Pr > DSCF	r
41-Rural**: Fringe** vs. **43-Rural: Remote**	45.55	64.41	<.0001	0.76
43-Rural**: Remote** vs. 21-Suburb: Large	-53.61	75.82	<.0001	-0.76
43-Rural**: Remote** vs. 32-Town: Distant	-38.23	54.07	<.0001	-0.73
11-City: Large vs. **43-Rural: Remote**	41.74	59.03	<.0001	0.72
43-Rural**: Remote** vs. 13-City: Small	-35.39	50.05	<.0001	-0.72
42-Rural**: Distant** vs. 21-Suburb: Large	-53.90	76.23	<.0001	-0.72
43-Rural**: Remote** vs. 12-City: Mid-size	-32.99	46.65	<.0001	-0.69
43-Rural**: Remote** vs. 31-Town: Fringe	-31.00	43.84	<.0001	-0.66
33-Town: Remote vs. 43-Rural**: Remote**	32.11	45.41	<.0001	0.65
43-Rural**: Remote** vs. 22-Suburb: Mid-size	-29.08	41.13	<.0001	-0.64
13-City: Small vs. 42-Rural**: Distant**	32.91	46.54	<.0001	0.59
41-Rural**: Fringe** vs. 42-Rural**: Distant**	37.73	53.36	<.0001	0.58
42-Rural**: Distant** vs. 12-City: Mid-size	-29.78	42.12	<.0001	-0.55
11-City: Large vs. 42-Rural**: Distant**	33.30	47.09	<.0001	0.53
43-Rural**: Remote** vs. 23-Suburb: Small	-23.17	32.77	<.0001	-0.53
33-Town: Remote vs. 13-City: Small	-20.82	29.44	<.0001	-0.52
32-Town: Distant vs. 42-Rural**: Distant**	28.92	40.90	<.0001	0.50
42-Rural**: Distant** vs. 22-Suburb: Mid-size	-25.56	36.15	<.0001	-0.49
13-City: Small vs. 32-Town: Distant	20.96	29.65	<.0001	0.49
33-Town: Remote vs. 12-City: Mid-size	-18.39	26.01	<.0001	-0.48
31-Town: Fringe vs. 42-Rural**: Distant**	24.94	35.27	<.0001	0.47
32-Town: Distant vs. 21-Suburb: Large	-29.57	41.82	<.0001	-0.45
33-Town: Remote vs. 21-Suburb: Large	-28.32	40.05	<.0001	-0.44
32-Town: Distant vs. 12-City: Mid-size	-18.06	25.54	<.0001	-0.43
31-Town: Fringe vs. 13-City: Small	-15.40	21.78	<.0001	-0.43
43-Rural**: Remote** vs. 42-Rural**: Distant**	-25.46	36.00	<.0001	-0.40
33-Town: Remote vs. 22-Suburb: Mid-size	-14.19	20.07	<.0001	-0.40
31-Town: Fringe vs. 12-City: Mid-size	-13.34	18.86	<.0001	-0.39
41-Rural**: Fringe** vs. 21-Suburb: Large	-27.73	39.22	<.0001	-0.38
33-Town: Remote vs. 42-Rural**: Distant**	20.98	29.67	<.0001	0.38
23-Suburb: Small vs. 42-Rural**: Distant**	18.90	26.73	<.0001	0.37
32-Town: Distant vs. 22-Suburb: Mid-size	-12.93	18.29	<.0001	-0.33
41-Rural**: Fringe** vs. 13-City: Small	-17.20	24.32	<.0001	-0.33
31-Town: Fringe vs. 21-Suburb: Large	-19.41	27.45	<.0001	-0.31
41-Rural**: Fringe** vs. 12-City: Mid-size	-14.66	20.74	<.0001	-0.29
31-Town: Fringe vs. 22-Suburb: Mid-size	-8.63	12.20	<.0001	-0.28
33-Town: Remote vs. 23-Suburb: Small	-8.91	12.60	<.0001	-0.27
23-Suburb: Small vs. 13-City: Small	-8.10	11.45	<.0001	-0.25
23-Suburb: Small vs. 12-City: Mid-size	-7.23	10.23	<.0001	-0.24
11-City: Large vs. 21-Suburb: Large	-16.17	22.87	<.0001	-0.23
11-City: Large vs. 33-Town: Remote	11.05	15.63	<.0001	0.22
33-Town: Remote vs. 31-Town: Fringe	-7.87	11.13	<.0001	-0.22
41-Rural: Fringe vs. 33-Town: Remote	10.73	15.18	<.0001	0.21
23-Suburb: Small vs. 32-Town: Distant	7.18	10.15	<.0001	0.20

11-City: Large vs. 13-City: Small	-8.92	12.61	<.0001	-0.18
41-Rural: Fringe vs. 22-Suburb: Mid-size	-8.37	11.84	<.0001	-0.17
13-City: Small vs. 22-Suburb: Mid-size	6.01	8.50	<.0001	0.17
23-Suburb: Small vs. 21-Suburb: Large	-10.09	14.27	<.0001	-0.17
11-City: Large vs. 12-City: Mid-size	-7.82	11.06	<.0001	-0.16
11-City: Large vs. 32-Town: Distant	8.31	11.75	<.0001	0.16
12-City: Mid-size vs. 22-Suburb: Mid-size	5.21	7.36	<.0001	0.16
23-Suburb: Small vs. 31-Town: Fringe	3.99	5.64	0.00	0.14
21-Suburb: Large vs. 22-Suburb: Mid-size	8.41	11.89	<.0001	0.14
41-Rural: Fringe vs. 32-Town: Distant	7.13	10.08	<.0001	0.13
31-Town: Fringe vs. 32-Town: Distant	4.69	6.64	0.00	0.12
23-Suburb: Small vs. 22-Suburb: Mid-size	-3.03	4.28	0.10	-0.11
33-Town: Remote vs. 32-Town: Distant	-4.73	6.69	0.00	-0.11
11-City: Large vs. 31-Town: Fringe	3.48	4.91	0.03	0.07
11-City: Large vs. 22-Suburb: Mid-size	-3.28	4.64	0.05	-0.07
41-Rural: Fringe vs. 23-Suburb: Small	-3.15	4.45	0.07	-0.07
41-Rural: Fringe vs. 11-City: Large	-3.99	5.64	0.00	-0.07
13-City: Small vs. 21-Suburb: Large	-2.41	3.41	0.40	-0.04
21-Suburb: Large vs. 12-City: Mid-size	2.26	3.19	0.51	0.04
41-Rural: Fringe vs. 31-Town: Fringe	1.12	1.58	0.99	0.02
11-City: Large vs. 23-Suburb: Small	0.14	0.20	1.00	0.00
13-City: Small vs. 12-City: Mid-size	-0.10	0.15	1.00	0.00

To examine the significance of differences of variables in rural areas from other geographic locales, effect sizes of the differences in average school size, percent of students on free or reduced lunch, and percent race/ethnicity for White students were calculated. (Although all race/ethnicities were included initially, results showed that only the percentage of White students at a school could be used to explain the racial/ethnic status of a school.) Data for each variable per locale was first tested for normality using the Kolmgorov-Smirnov test, as many of the sample sizes exceeded 2000. All distributions were not normally distributed, except for the one distribution of percentage of students on free or reduced lunch in small cities. Because of the non-normal distributions, nonparametric methods were used to calculate effect sizes. Wilcoxon scores for each locale were calculated, and the Kruskal-Wallis test was used to test for any significant differences among locales. Here significant differences were found among locales ($\chi^2(11, N = 15{,}448) = 5{,}271$, $p <$ .001). Pairs were then compared using the Wilcoxon Z scores and the DSCF value.

Racial/Ethnic Diversity of Schools

When examining racial/ethnic data, as shown in Figure 6, higher populations of Black and Hispanic/Latino students are attending city schools, with numbers decreasing as the locales get further away from the city. Overall, the percent of Hispanic/Latino students is higher than the percentage of Black students for all locales except for mid-size cities. Populations of White students show the opposite trend. For this study, percent of White students will be the racial/ethnic factor in the model.

Although pockets of racial/ethnic minority populations occur in different geographic regions of the United States (Black populations in the South, Hispanic/Latino populations in the West), the difference between rural locales and other locales still follows the trend in Figure 6. Rural communities tend to have fewer minority students in general. The states with higher populations of minority students in rural areas also have high populations of the same minorities in other locales in the state. It is not a characteristic of the rural area, but of the state in which the rural area is contained.

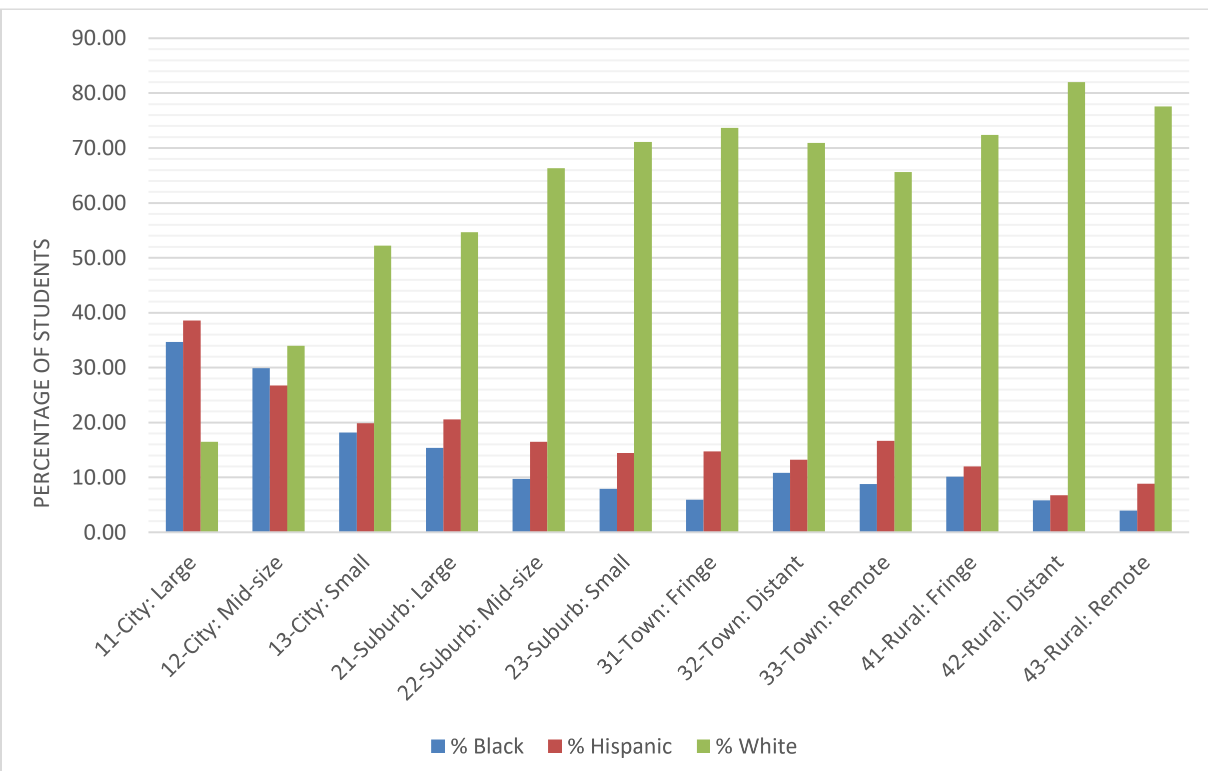


Figure 6: Percent Race/Ethnicity per Locale (2014-15)

Table 7 shows the results of significance and effect size testing for minority populations. As with the socioeconomic status testing, the large effect sizes are occurring for large and mid-size cities. Rural areas have effect sizes across the board from large to none, with the large effects occurring when comparing with city schools.

Table 7: DSCF Results for Percentage of White Students Per School

Urban-centric Locale	Wilcoxon Z	DSCF Value	Pr > DSCF	r
11-City: Large vs. 42-**Rural: Distant**	-49.69	70.27	<.0001	-0.79
11-City: Large vs. 43-**Rural: Remote**	-43.47	61.48	<.0001	-0.75
41-**Rural: Fringe** vs. 11-City: Large	44.19	62.49	<.0001	0.74
11-City: Large vs. 32-Town: Distant	-37.64	53.23	<.0001	-0.72
11-City: Large vs. 33-Town: Remote	-32.39	45.81	<.0001	-0.65
11-City: Large vs. 31-Town: Fringe	-30.51	43.15	<.0001	-0.65
31-Town: Fringe vs. 12-City: Mid-size	21.50	30.41	<.0001	0.62
42-**Rural: Distant** vs. 12-City: Mid-size	32.49	45.95	<.0001	0.60
11-City: Large vs. 22-Suburb: Mid-size	-27.25	38.54	<.0001	-0.59
43-**Rural: Remote** vs. 12-City: Mid-size	28.40	40.16	<.0001	0.59
32-Town: Distant vs. 12-City: Mid-size	23.58	33.34	<.0001	0.57
11-City: Large vs. 13-City: Small	-28.02	39.62	<.0001	-0.57
11-City: Large vs. 21-Suburb: Large	-39.08	55.27	<.0001	-0.55
23-Suburb: Small vs. 12-City: Mid-size	16.64	23.54	<.0001	0.55
12-City: Mid-size vs. 22-Suburb: Mid-size	-17.60	24.89	<.0001	-0.53
11-City: Large vs. 23-Suburb: Small	-23.25	32.88	<.0001	-0.53
41-**Rural: Fringe** vs. 12-City: Mid-size	26.70	37.75	<.0001	0.53
13-City: Small vs. 42-**Rural: Distant**	-28.76	40.67	<.0001	-0.52
42-**Rural: Distant** vs. 21-Suburb: Large	38.77	54.83	<.0001	0.52
33-Town: Remote vs. 12-City: Mid-size	19.36	27.38	<.0001	0.51
43-**Rural: Remote** vs. 13-City: Small	23.66	33.45	<.0001	0.48
31-Town: Fringe vs. 13-City: Small	15.82	22.37	<.0001	0.44
43-**Rural: Remote** vs. 21-Suburb: Large	29.20	41.29	<.0001	0.41
13-City: Small vs. 32-Town: Distant	-16.20	22.91	<.0001	-0.38
41-**Rural: Fringe** vs. 13-City: Small	19.50	27.57	<.0001	0.37
11-City: Large vs. 12-City: Mid-size	-16.67	23.57	<.0001	-0.35
23-Suburb: Small vs. 13-City: Small	10.81	15.28	<.0001	0.33
13-City: Small vs. 12-City: Mid-size	12.43	17.58	<.0001	0.33
33-Town: Remote vs. 42-**Rural: Distant**	-17.57	24.84	<.0001	-0.32
41-**Rural: Fringe** vs. 21-Suburb: Large	22.75	32.17	<.0001	0.31
42-**Rural: Distant** vs 22-Suburb: Mid-size	15.76	22.28	<.0001	0.30
33-Town: Remote vs. 13-City: Small	11.03	15.60	<.0001	0.28
13-City: Small vs. 22-Suburb: Mid-size	-9.66	13.66	<.0001	-0.28
32-Town: Distant vs. 42-**Rural: Distant**	-15.01	21.23	<.0001	-0.26
32-Town: Distant vs. 21-Suburb: Large	17.00	24.05	<.0001	0.26
43-**Rural: Remote** vs 22-Suburb: Mid-size	11.61	16.42	<.0001	0.25

Table 7 continued

21-Suburb: Large vs. 12-City: Mid-size	15.99	22.62	<.0001	0.25
41-**Rural: Fringe** vs. 42-**Rural: Distant**	-16.39	23.18	<.0001	-0.25
33-Town: Remote vs. 43-**Rural: Remote**	-12.37	17.50	<.0001	-0.25
31-Town: Fringe vs. 21-Suburb: Large	15.24	21.56	<.0001	0.24
31-Town: Fringe vs. 22-Suburb: Mid-size	6.13	8.66	<.0001	0.20
31-Town: Fringe vs. 42-**Rural: Distant**	-10.06	14.23	<.0001	-0.19
23-Suburb: Small vs. 42-**Rural: Distant**	-9.39	13.28	<.0001	-0.18
43-**Rural: Remote** vs. 32-Town: Distant	9.18	12.99	<.0001	0.18
33-Town: Remote vs. 21-Suburb: Large	10.13	14.32	<.0001	0.16
23-Suburb: Small vs. 21-Suburb: Large	9.38	13.27	<.0001	0.16
41-**Rural: Fringe** vs. 43-**Rural: Remote**	-9.28	13.12	<.0001	-0.16
33-Town: Remote vs. 31-Town: Fringe	-5.43	7.68	<.0001	-0.15
43-**Rural: Remote** vs. 23-Suburb: Small	6.16	8.71	<.0001	0.14
41-**Rural: Fringe** vs. 22-Suburb: Mid-size	6.35	8.97	<.0001	0.13
21-Suburb: Large vs. 22-Suburb: Mid-size	-7.56	10.69	<.0001	-0.12
32-Town: Distant vs. 22-Suburb: Mid-size	4.76	6.73	0.00	0.12
43-**Rural: Remote** vs. 31-Town: Fringe	5.64	7.98	<.0001	0.12
41-**Rural: Fringe** vs. 33-Town: Remote	6.12	8.65	<.0001	0.12
23-Suburb: Small vs. 22-Suburb: Mid-size	3.13	4.43	0.07	0.12
33-Town: Remote vs. 32-Town: Distant	-4.24	6.00	0.00	-0.10
43-**Rural: Remote** vs. 42-**Rural: Distant**	-5.56	7.87	<.0001	-0.09
33-Town: Remote vs. 23-Suburb: Small	-2.45	3.47	0.37	-0.07
23-Suburb: Small vs. 31-Town: Fringe	-1.86	2.63	0.79	-0.07
13-City: Small vs. 21-Suburb: Large	-3.71	5.25	0.01	-0.06
31-Town: Fringe vs. 32-Town: Distant	1.89	2.67	0.77	0.05
41-**Rural: Fringe** vs. 23-Suburb: Small	1.46	2.07	0.95	0.03
41-**Rural: Fringe** vs. 32-Town: Distant	1.52	2.14	0.94	0.03
33-Town: Remote vs. 22-Suburb: Mid-size	0.80	1.13	1.00	0.02
41-**Rural: Fringe** vs. 31-Town: Fringe	-0.91	1.29	1.00	-0.02
23-Suburb: Small vs. 32-Town: Distant	-0.51	0.73	1.00	-0.01

Socioeconomic Status of Schools

The box and whisker plot in Figure 7 gives a graphical representation of the differences among locales of the percent of students on free/reduced lunch in a school. As shown in the figure, the largest percentage of students on free or reduced lunch occurs in city schools. Rural schools do not appear to differ from suburban or town schools.

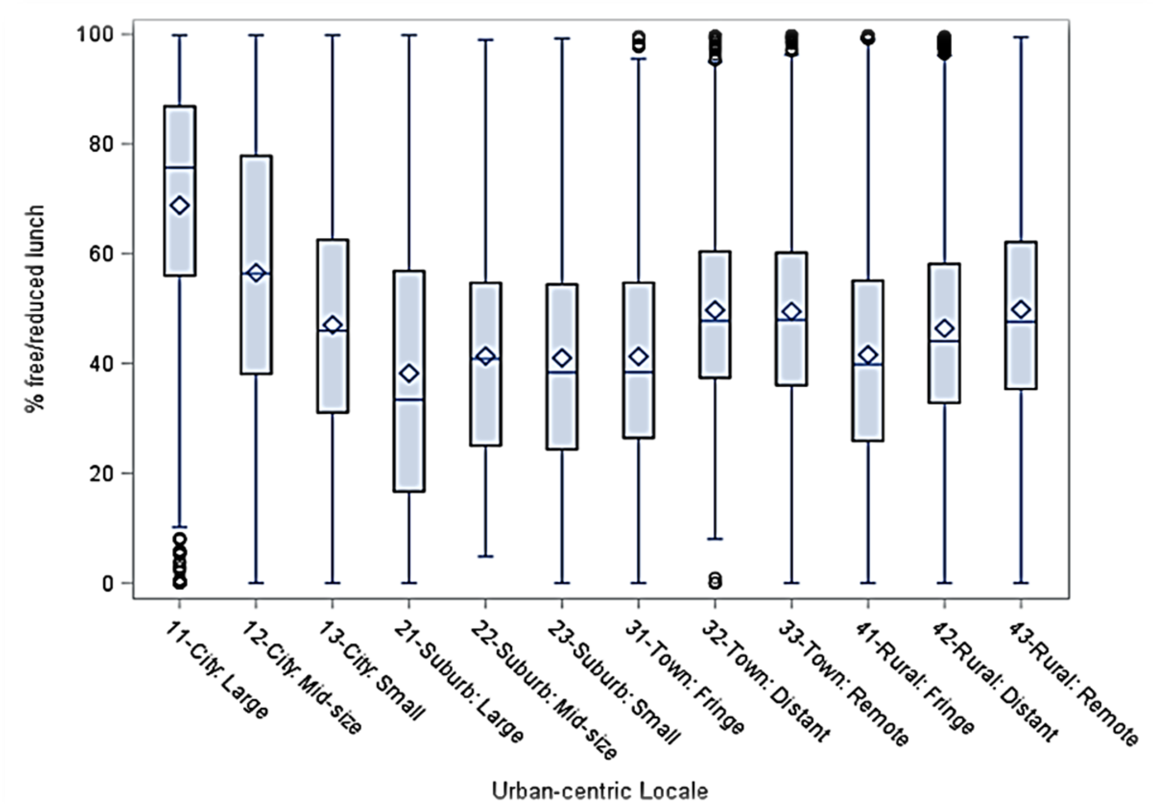


Figure 7: Percent Free/Reduced Lunch Students per Locale (2014-15)

Table 8 shows the results when comparing locales for significance and effect sizes. All large and medium effect sizes are found when comparing large and mid-size cities with other locales. In fact, no significant difference is found when comparing much of rural areas with other locales. Any effect sizes found for rural areas were small. This result indicates that having a large portion of students on free or reduced lunch is not a characteristic of rural schools, but it is for city schools.

Table 8: DSCF Results for Percent Free or Reduced Lunch

Urban-centric Locale	Wilcoxon Z	DSCF Value	Pr > DSCF	r
41-**Rural: Frin**ge vs. 11-City: Large	-31.01	43.86	<.0001	-0.52
11-City: Large vs. 21-Suburb: Large	34.92	49.39	<.0001	0.49
11-City: Large vs. 42-**Rural: Distant**	29.09	41.14	<.0001	0.46
11-City: Large vs. 31-Town: Fringe	21.54	30.46	<.0001	0.46
11-City: Large vs. 22-Suburb: Mid-size	19.90	28.15	<.0001	0.43
11-City: Large vs. 32-Town: Distant	22.21	31.41	<.0001	0.42
11-City: Large vs. 43-**Rural: Remote**	24.40	34.51	<.0001	0.42

Table 8 continued

11-City: Large vs. 13-City: Small	20.56	29.08	<.0001	0.42
11-City: Large vs. 33-Town: Remote	20.00	28.28	<.0001	0.40
11-City: Large vs. 23-Suburb: Small	16.46	23.27	<.0001	0.37
31-Town: Fringe vs. 12-City: Mid-size	-10.83	15.32	<.0001	-0.31
12-City: Mid-size vs. 22-Suburb: Mid-size	9.92	14.03	<.0001	0.30
23-Suburb: Small vs. 12-City: Mid-size	-8.76	12.39	<.0001	-0.29
41-**Rural: Fringe** vs. 12-City: Mid-size	-13.28	18.79	<.0001	-0.26
21-Suburb: Large vs. 12-City: Mid-size	-15.97	22.58	<.0001	-0.25
43-**Rural: Remote** vs. 21-Suburb: Large	17.68	25.01	<.0001	0.25
32-Town: Distant vs. 21-Suburb: Large	15.36	21.72	<.0001	0.23
11-City: Large vs. 12-City: Mid-size	11.05	15.63	<.0001	0.23
31-Town: Fringe vs. 32-Town: Distant	-8.75	12.37	<.0001	-0.22
33-Town: Remote vs. 31-Town: Fringe	7.81	11.05	<.0001	0.21
33-Town: Remote vs. 21-Suburb: Large	13.20	18.67	<.0001	0.21
41-**Rural: Fringe** vs. 32-Town: Distant	-10.83	15.31	<.0001	-0.20
41-**Rural: Fringe** vs. 43-**Rural: Remote**	-11.82	16.72	<.0001	-0.20
42-**Rural: Distant** vs. 21-Suburb: Large	14.81	20.95	<.0001	0.20
13-City: Small vs. 12-City: Mid-size	-7.37	10.42	<.0001	-0.19
43-**Rural: Remote** vs. 31-Town: Fringe	8.91	12.59	<.0001	0.19
32-Town: Distant vs. 22-Suburb: Mid-size	7.37	10.42	<.0001	0.19
33-Town: Remote vs. 22-Suburb: Mid-size	6.68	9.44	<.0001	0.19
33-Town: Remote vs. 23-Suburb: Small	6.12	8.65	<.0001	0.19
42-**Rural: Distant** vs. 12-City: Mid-size	-9.86	13.95	<.0001	-0.18
23-Suburb: Small vs. 32-Town: Distant	-6.64	9.39	<.0001	-0.18
41-**Rural: Fringe** vs. 33-Town: Remote	-9.27	13.11	<.0001	-0.18
43-**Rural: Remote** vs. 22-Suburb: Mid-size	7.59	10.73	<.0001	0.17
33-Town: Remote vs. 12-City: Mid-size	-6.04	8.54	<.0001	-0.16
13-City: Small vs. 21-Suburb: Large	9.98	14.11	<.0001	0.16
43-**Rural: Remote** vs. 23-Suburb: Small	6.73	9.51	<.0001	0.15
32-Town: Distant vs. 12-City: Mid-size	-6.29	8.90	<.0001	-0.15
31-Town: Fringe vs. 13-City: Small	-5.14	7.27	<.0001	-0.14
43-**Rural: Remote** vs. 12-City: Mid-size	-6.68	9.45	<.0001	-0.14
23-Suburb: Small vs. 13-City: Small	-4.11	5.81	0.00	-0.13
13-City: Small vs. 22-Suburb: Mid-size	4.40	6.23	0.00	0.13
41-**Rural: Fringe** vs. 42-**Rural: Distant**	-7.64	10.80	<.0001	-0.12
41-**Rural: Fringe** vs. 13-City: Small	-6.10	8.63	<.0001	-0.12
31-Town: Fringe vs. 42-**Rural: Distant**	-5.77	8.16	<.0001	-0.11
41-**Rural: Fringe** vs. 21-Suburb: Large	6.80	9.62	<.0001	0.09
42-**Rural: Distant** vs. 22-Suburb: Mid-size	4.69	6.64	0.00	0.09
32-Town: Distant vs. 42-**Rural: Distant**	5.12	7.24	<.0001	0.09
43-**Rural: Remote** vs. 42-**Rural: Distant**	5.32	7.52	<.0001	0.08
23-Suburb: Small vs. 42-**Rural: Distant**	-4.29	6.07	0.00	-0.08
33-Town: Remote vs. 42-**Rural: Distant**	4.09	5.78	0.00	0.07
31-Town: Fringe vs. 21-Suburb: Large	4.40	6.23	0.00	0.07
21-Suburb: Large vs. 22-Suburb: Mid-size	-3.80	5.38	0.01	-0.06

Table 8 continued

13-City: Small vs. 32-Town: Distant	-2.56	3.62	0.30	-0.06
43-**Rural: Remote** vs. 13-City: Small	2.57	3.64	0.29	0.05
33-Town: Remote vs. 13-City: Small	2.00	2.82	0.70	0.05
23-Suburb: Small vs. 21-Suburb: Large	2.93	4.14	0.13	0.05
13-City: Small vs. 42-**Rural: Distant**	1.08	1.53	1.00	0.02
33-Town: Remote vs. 32-Town: Distant	-0.38	0.54	1.00	-0.01
41-**Rural: Fringe** vs. 23-Suburb: Small	0.40	0.57	1.00	0.01
23-Suburb: Small vs. 22-Suburb: Mid-size	-0.20	0.29	1.00	-0.01
41-**Rural: Fringe** vs. 31-Town: Fringe	0.37	0.52	1.00	0.01
23-Suburb: Small vs. 31-Town: Fringe	-0.19	0.27	1.00	-0.01
43-**Rural: Remote** vs. 32-Town: Distant	-0.28	0.40	1.00	-0.01
33-Town: Remote vs. 43-**Rural: Remote**	-0.16	0.23	1.00	0.00
31-Town: Fringe vs. 22-Suburb: Mid-size	-0.09	0.13	1.00	0.00
41-**Rural: Fringe** vs. 22-Suburb: Mid-size	0.10	0.13	1.00	0.00

In summary, being a rural student is not characterized by being poor. It is partially characterized by going to a smaller school than those in other locales. It can also be characterized by having fewer ethnic minority students than other locales, yet those effect sizes are not large ones. A question still remains from the results of these analyses: How do these generalizations hold up when looking at different regions of the United States?

Regional Variation

Rural areas are confined to specific pockets of the United States and each pocket has its own demographic characteristics. The specific characteristics of each area affect the school environment and the needs of the students in that area. For each area, the rural characteristics need to be understood to understand their needs. As each state has differing levels of rural population, and precollege education decisions are made at the state level, the rural characteristics need to be understood. The following research looks at rural characteristics of each of four regions of the United States. The U.S. Census Bureau categorizes states into four main regions: West, Mid-west, Northeast, and South. This categorization is shown in Figure 8.

Figure 8: Geographical Regions of the United States (United States Census Bureau, 2018)

Regional comparisons of the average number of AP courses offered per locale is shown in Figure 9. Each square in the matrix compares two regions labeled on two of the sides. Opposite the region label, the numbers represent the average number of AP courses offered in that region. Locale points are then placed in the box showing how the number of AP courses in that locale differs between the two regions. Points that fall along the diagonal indicate that there are no regional differences for the locale represented by the point. In this matrix scatterplot it is notable that in every comparison, rural distant and rural remote areas can be seen to offer the lowest number of AP courses, regardless of region of the U.S., as evidenced by the location of these areas in the lower left corner of every square. This figure also shows that there is no regional effect for the number of AP courses offered among locales. Across the board, rural areas offer the fewest number of AP courses.

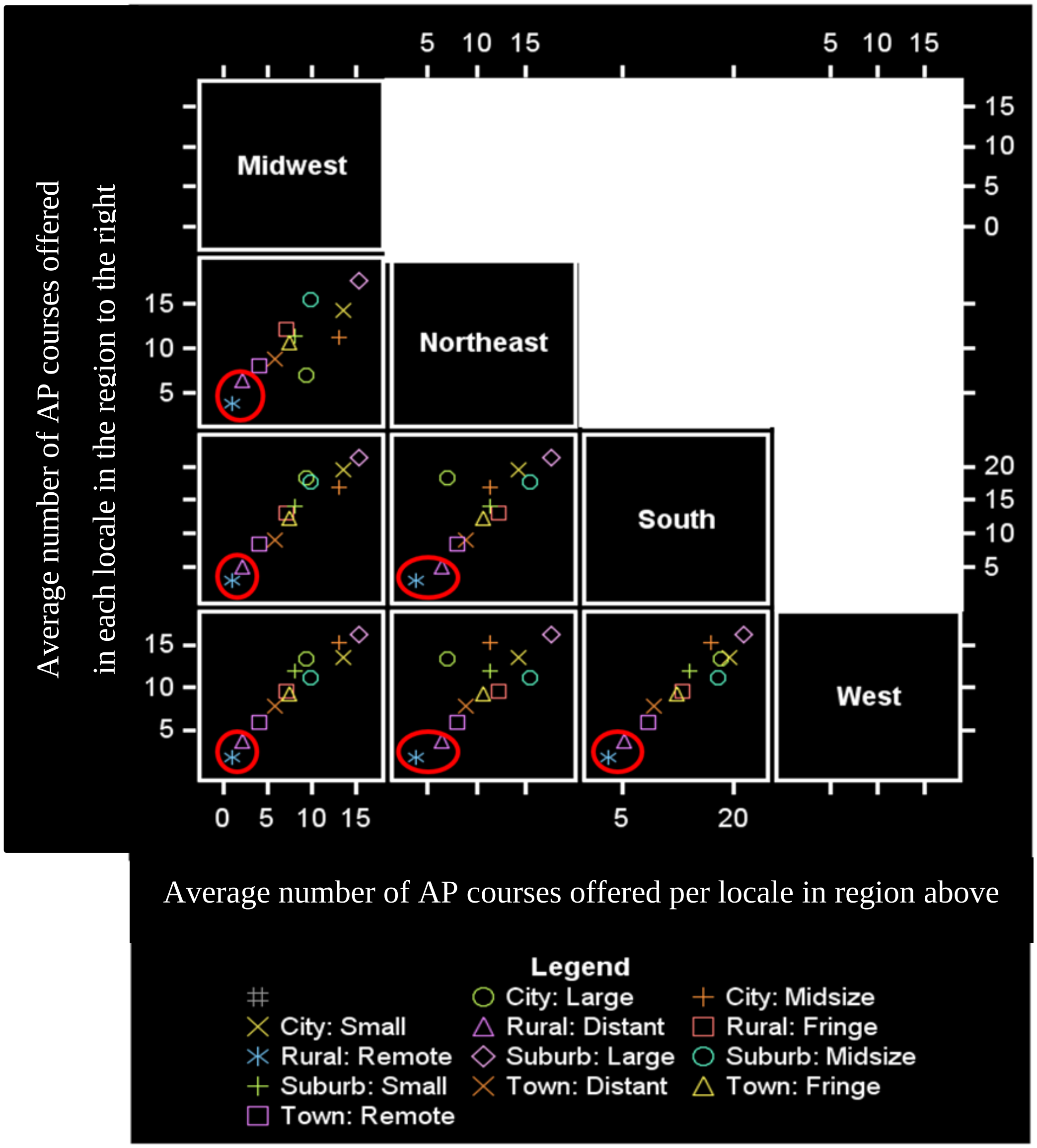


Figure 9: Average Number of AP Courses Offered

School size comparisons are shown in Figure 10. Each square now compares the average school size in the two regions represented. Numbers show the school size in thousands of students. Again, the rural distant and rural remote locales always have the lowest school enrollment regardless of region of the United States. These two figures show that rural areas are characterized by small school sizes and few AP course offerings when compared to all other geographic locales.

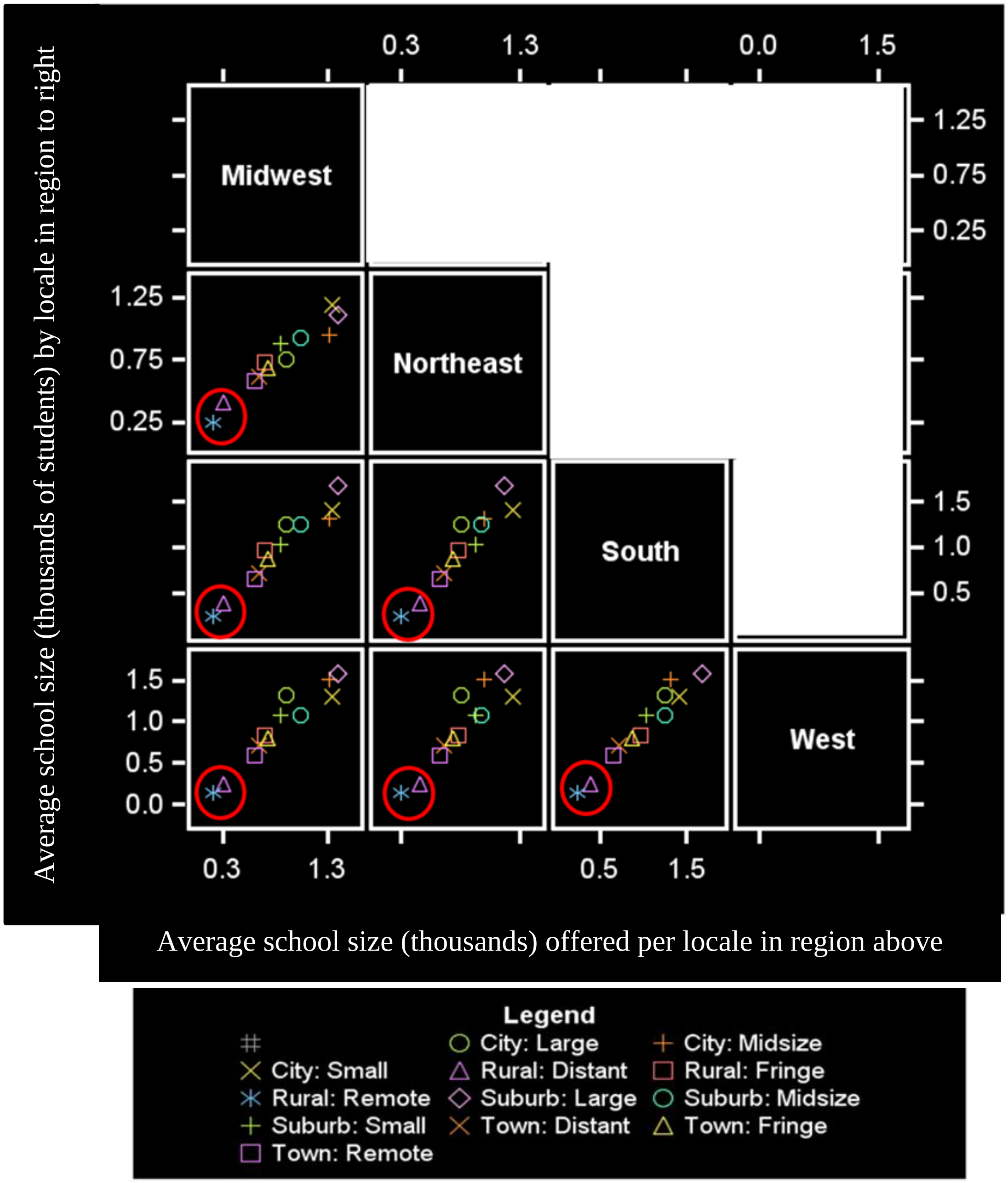


Figure 10: Average School Size (thousands) per Locale by Region

A matrix scatterplot of socioeconomic status, as defined by the percent of students **not** on free or reduced lunch plans, is shown in Figure 11. Regional differences are shown by the deviation of locales from the diagonal. For socioeconomic status, the rural distant and rural remote locales can be seen in the center of all the other locales, for all regions of the United States. Yet, when comparing these two locales among the regions of the United States, the South has lower socioeconomic status in rural areas than any of the other three locales. In the South, 35-45% of students are not on a free or reduced lunch program, but in all other locales rural areas have 40-60% of students not on a free or reduced lunch program. Therefore, being in a rural area in the South is characterized by having lower socioeconomic status than those rural locales in other areas, but not lower than other locales in the South. In all regions, rural distant and remote schools have a socioeconomic makeup that falls in the middle of all locales in the region.

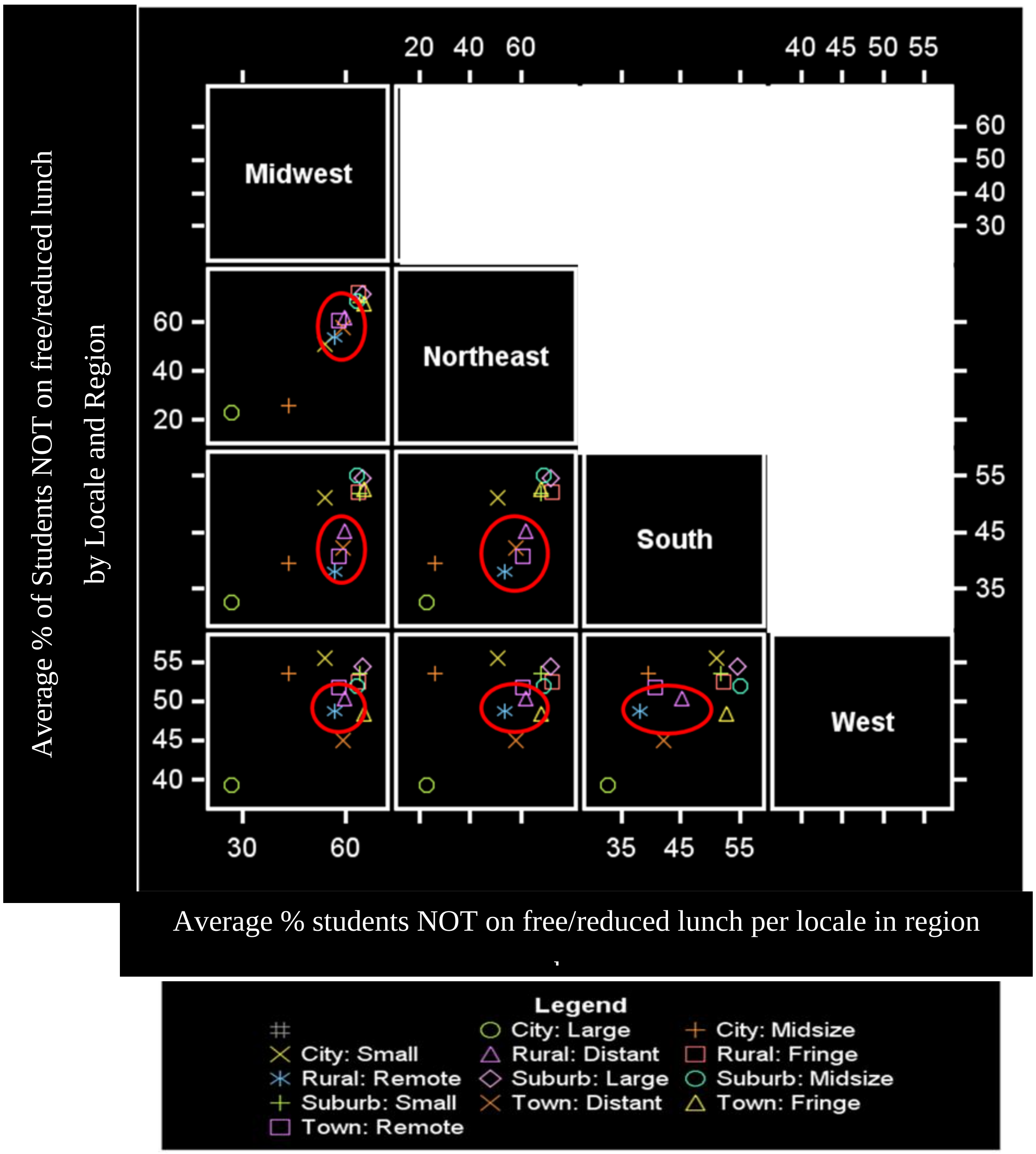


Figure 11: Average Percent Students not on Free/Reduced Lunch

Other regional differences can be seen when examining the matrix scatterplots of race/ethnicities that are shown in Figures 12-15. For the percent of White students per school, rural distant and remote locales are the locales with the highest percent among all locales with their marks being in the right upper corner of each box. However, when examining regional effects, the South has lower percentages than the other three regions. The Midwest and Northeast have the highest percentages of White students with 80-99%. The South has the highest percentage of Black students with 10-20%, compared to all other regions. So even though rural areas are largely White, Southern rural students have higher percentages of Black students. Hispanic/Latino students are found in higher percentages in the West. Asian students are found in very low percentages, but the highest percentages are found in the West, consistent with prior studies (Khattri et al., 1997; Provasnik et al., 2007; Stambaugh & Wood, 2015). Overall, rural distant and remote areas have the least diverse student populations.

Regression Model

Generalized Linear Modeling was used to select the factors that significantly affect the number of AP courses offered at a school. While all factors and combinations of factors were originally included in the model, any factors that accounted for less than one percent of the variation were removed from the model. This process caused all ethnicity factors and interactions to drop out of the model. A regression model was then created both nationally and by region. Nationwide, 68% of the variation in number of AP courses offered could be explained by four factors: school size, urban-centric locale, percent of free or reduced lunch, and region. Variance inflation factors were calculated to check for collinearity and all were found to be less than 5.0, within normal limits (de Jongh et al., 2015). Therefore, the variance of each remaining factor were not inflated due to collinearity. Portions of the variation accounted for by each significant factor are shown in Table 9.

Table 9: Variance Accounted for in Generalized Linear Model of U.S.

Source	Eta-Square
Urban-centric Locale	0.3285
Total Students (thousands)	0.2937
% free/reduced lunch	0.0268
Region	0.03

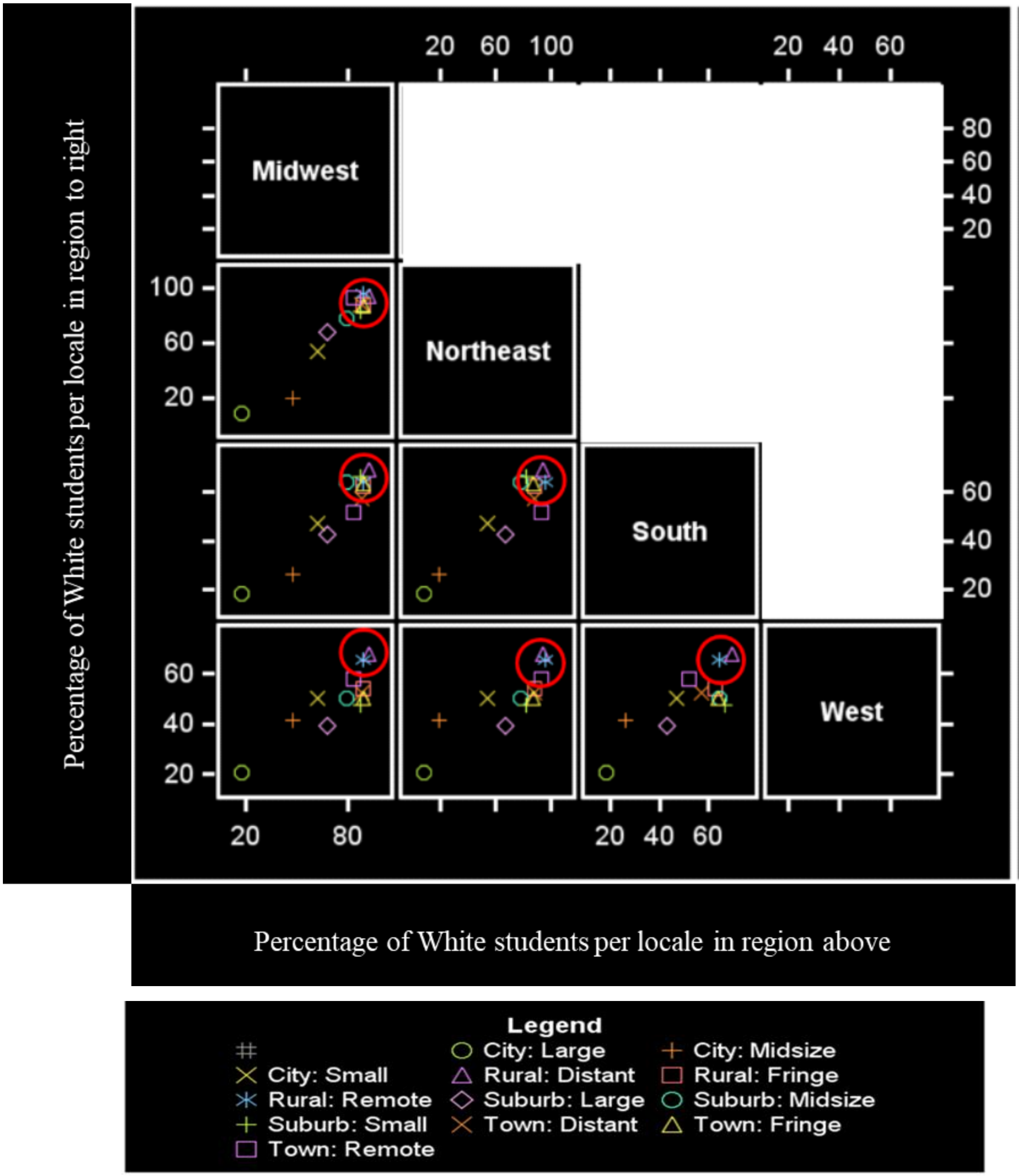


Figure 12: % White students per locale by region

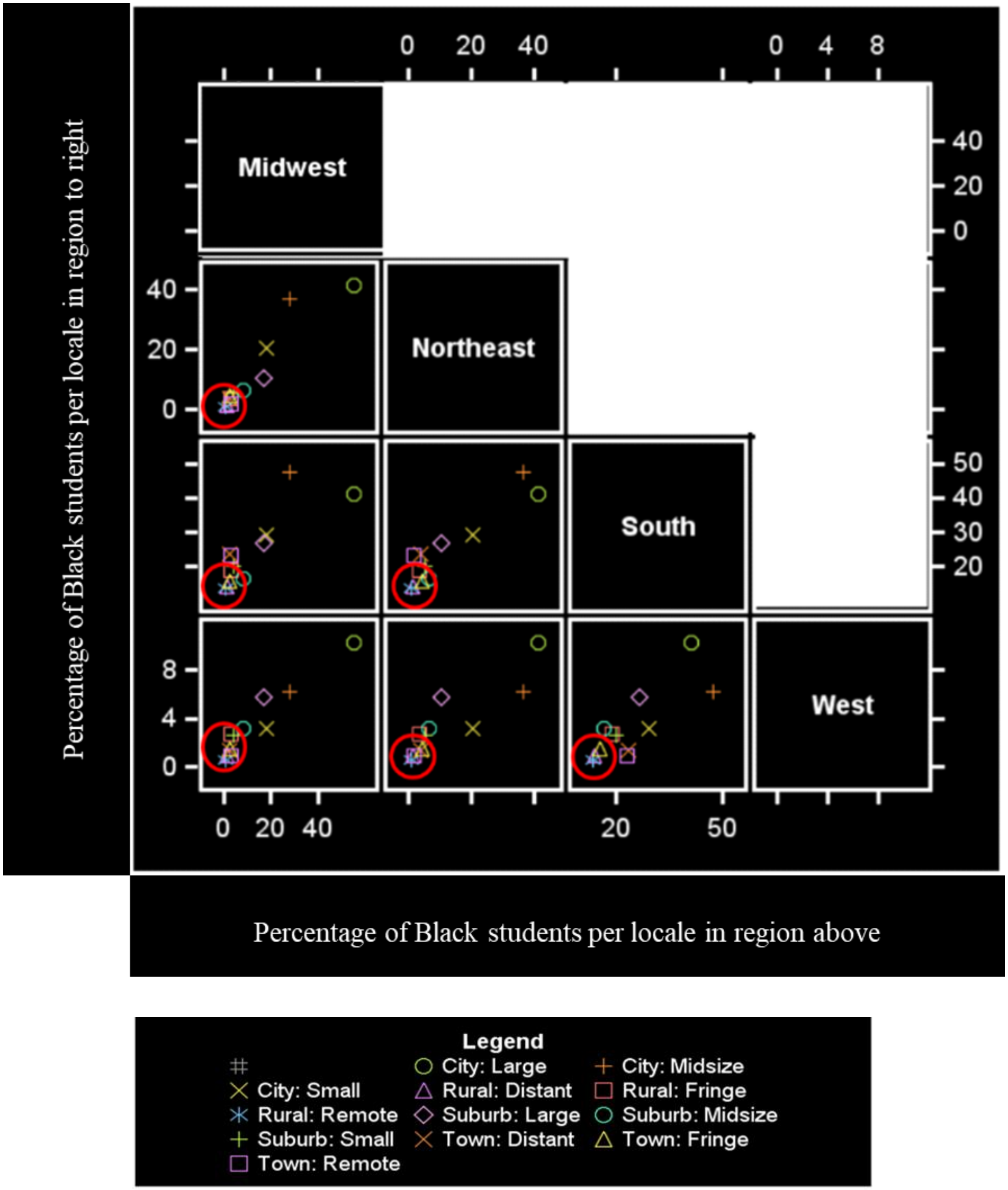


Figure 13: % Black students per locale by region

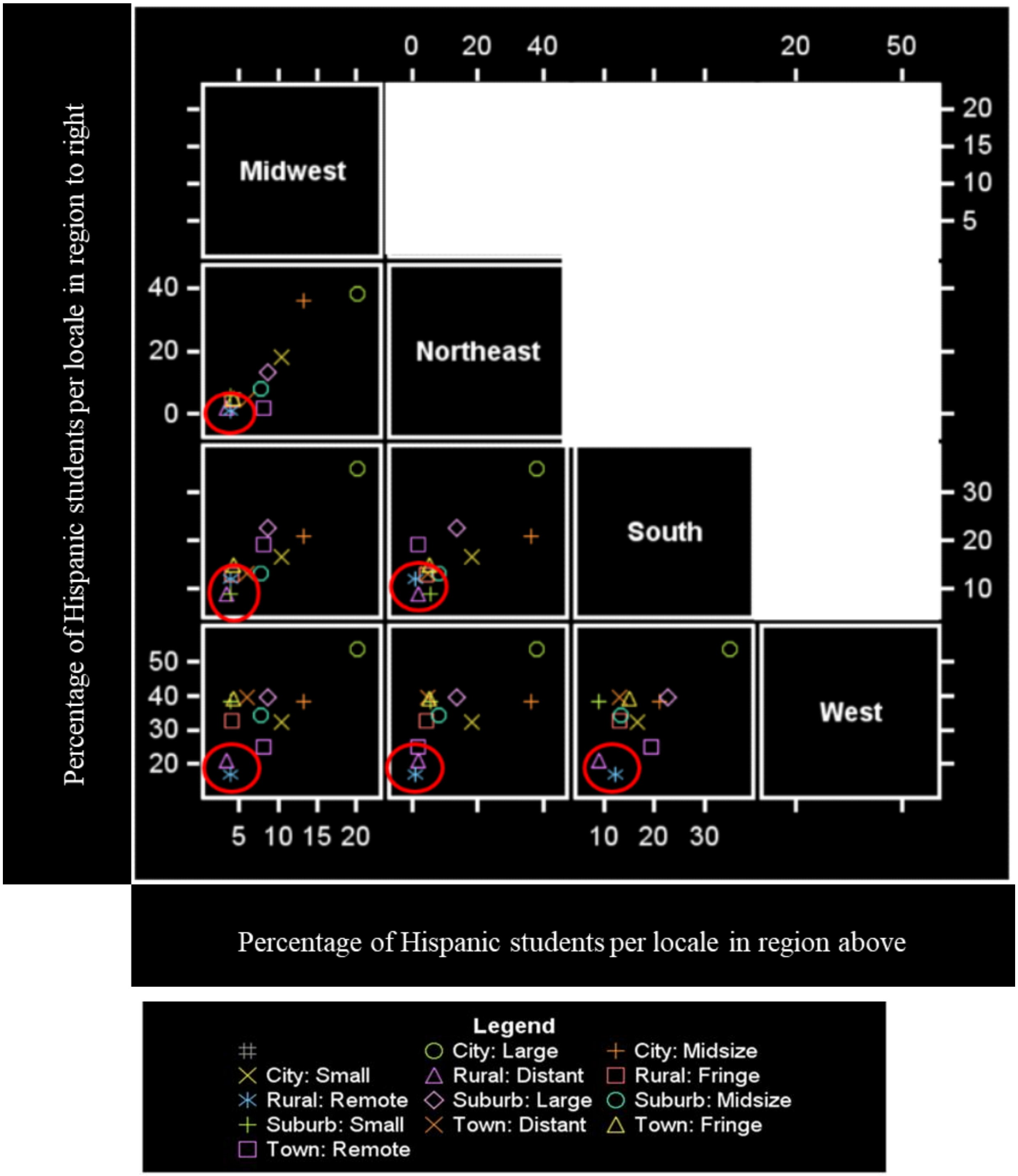


Figure 14: % Hispanic students per locale by region

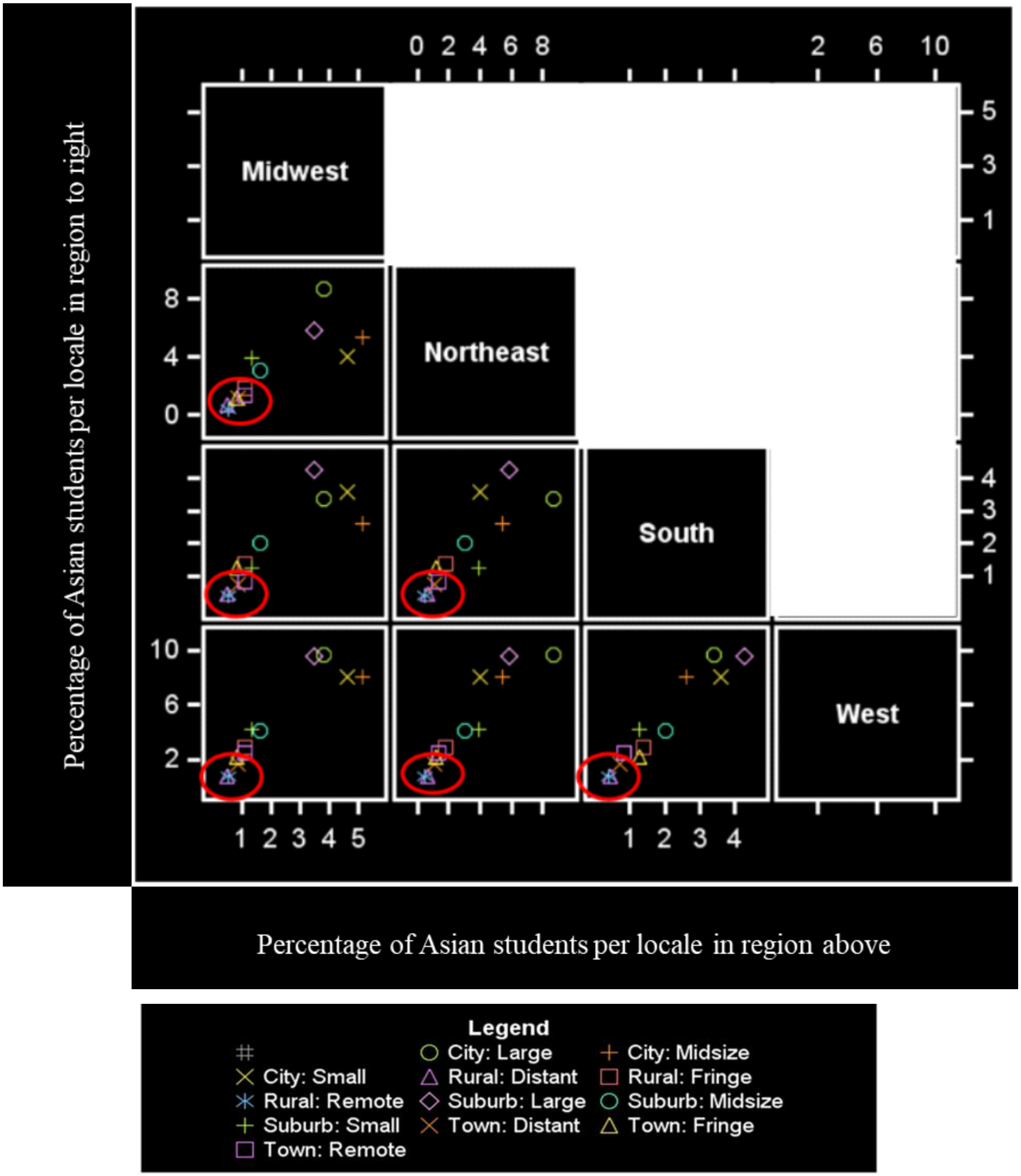


Figure 15: % Asian students per locale by region

These results indicate that the variation in number of AP courses offered can be accounted for in large part by both the locale and school size. Rural students receive fewer AP courses not just because they attend smaller schools, but because they are in rural areas. Larger schools offer more

AP courses while schools in rural areas offer fewer. Socioeconomic status of the school and region both explain up to 3% of the variation, after locale and school size are taken into account, with the number of AP courses decreasing as the percentage of students on free or reduced lunch increases.

The general linear model was run using the Midwest region and rural remote locale as references. Maximum likelihood estimation was used for the model. The normal distribution was used as the identity link function. The solution for parameter estimates in the model is given in Table 10.

Table 10: Generalized Linear Model for Number of AP Courses offered in U.S.

Parameter	**Estimate**
Intercept	3.349 ***
Locales	
11-City: Large	4.156 ***
12-City: Mid-size	3.586 ***
13-City: Small	3.570 ***
21-Suburb: Large	4.086 ***
22-Suburb: Mid-size	3.300 ***
23-Suburb: Small	1.958 ***
31-Town: Fringe	1.922 ***
32-Town: Distant	1.208 ***
33-Town: Remote	0.525 **
41-Rural: Fringe	1.919 ***
42-Rural: Distant	-0.029
Regions	
West	0.753 ***
South	4.115 ***
Northeast	2.671 ***
School Size (thousands)	8.221 ***
% Free/reduced lunch	-0.086 ***
Scale	5.541
** $p < .05$, *** $p < .0001$ N=15,448 Mean # of subjects = 10.6 Scale parameter estimated by maximum likelihood	Reference variables: 43-Rural: Remote Region – Midwest

All factors were significant at the α = .001 or .05 level, except for the rural distant locale. This result again shows that the rural distant and rural remote locales behave similarly and are significantly different than all other locales. As all coefficient estimates are positive, this model reveals that the rural remote and distant locales offer the fewest numbers of AP courses, consistent with the descriptive data presented earlier. With the highest estimate values, the South offers the highest number of AP courses among the regions. The school size coefficient shows that the average number of AP courses increases as the school size increases. However, the negative coefficient for % Free/Reduced lunch shows that as the percent of these students in a school increases, the average number of AP courses decreases, although minimally.

Comparisons by region are shown in Table 11. Regardless of the region of the United States, between 61 and 68% of variation in the number of AP courses offered can be accounted for with the combination of locale, school size, and socioeconomic status factor. Locale accounted for between 27 and 40% of the variation and explained the largest amount of variation in the Midwest. School size accounted for between 23 and 38% of the variation and was most significant in schools in the West. Socioeconomic status was found to be most significant in the Northeast, accounting for just over 10% of the variation in number of AP courses offered.

Table 11: Variation by Region

Region	Proportion of Variation Accounted For	Response Variables	Semi-Partial Variation	Mean # Subjects
Midwest	.67	Locale	0.399	6.56
		Total Students	0.257	
		% Free/Reduced Lunch	0.018	
Northeast	.61	Locale	0.275	12.67
		Total Students	0.233	
		% Free/Reduced Lunch	0.102	
South	.68	Locale	0.350	13.06
		Total Students	0.289	
		% Free/Reduced Lunch	0.040	
West	.68	Locale	0.284	10.74
		Total Students	0.384	
		% Free/Reduced Lunch	0.014	

Results show that rural distant locales are not significantly different from rural remote areas, as previously suggested. All other locales show significant differences. While all regions show significance as to the difference from the Midwest, the West is the least different and the South the most different than the Midwest. The South and Northeast regions offer more AP courses overall compared to the Midwest. As a region, the South offers the greatest number of AP courses, but when looking at locales, large suburbs offer the most and, as hypothesized, rural distant and remote areas offer the fewest.

North Carolina Results

This data for North Carolina schools was examined to understand how students in a Southeastern state with wide variation in locales function. This analysis was conducted separately from the regional and national data. As North Carolina is a Southern, highly rural state, the demographics for North Carolina will now be compared with the national data to see if significant differences can be seen.

Statistics

The distribution of AP courses in North Carolina is different than the distribution nationwide. In North Carolina, large cities offer the largest number of AP courses on average as shown in Figure 16, compared with large suburbs offering the largest number nationwide.

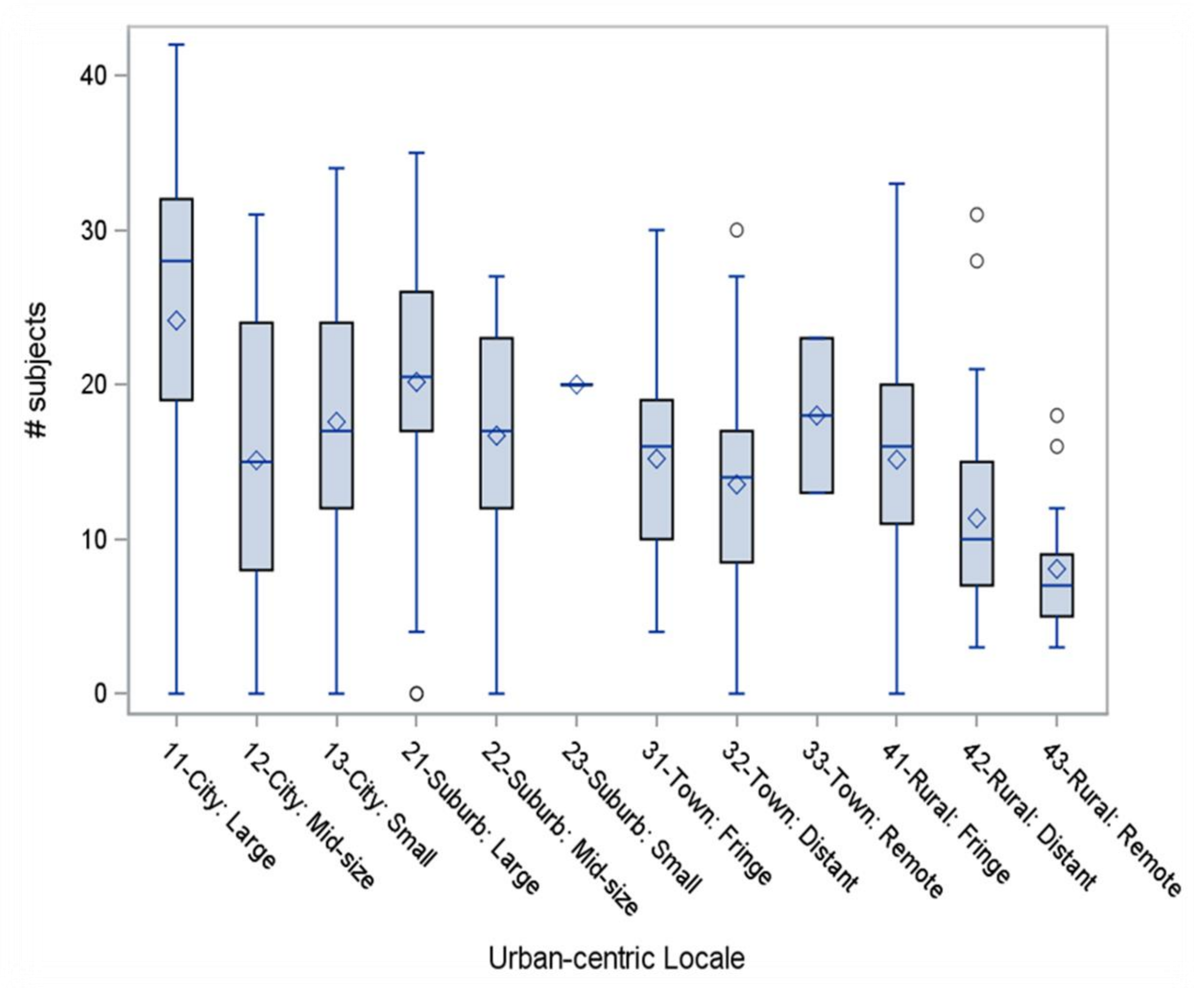


Figure 16: Average AP Subjects per Locale in North Carolina

Rural areas in North Carolina offer more AP courses than the national average for rural areas. Also, North Carolina has very few small suburban schools as can be seen by the lack of an interquartile range for small suburbs in the figure. These trends raise the question: Do these results occur as a result of school size and percent of White students as predicted by the correlational analysis nationally?

In North Carolina, the largest percentage of schools are in rural areas. Figure 17 shows the breakdown of NC schools among the twelve geographic locales. Over forty-seven percent of the total number of schools lie in one of the three rural locales, compared to 38% nationwide.

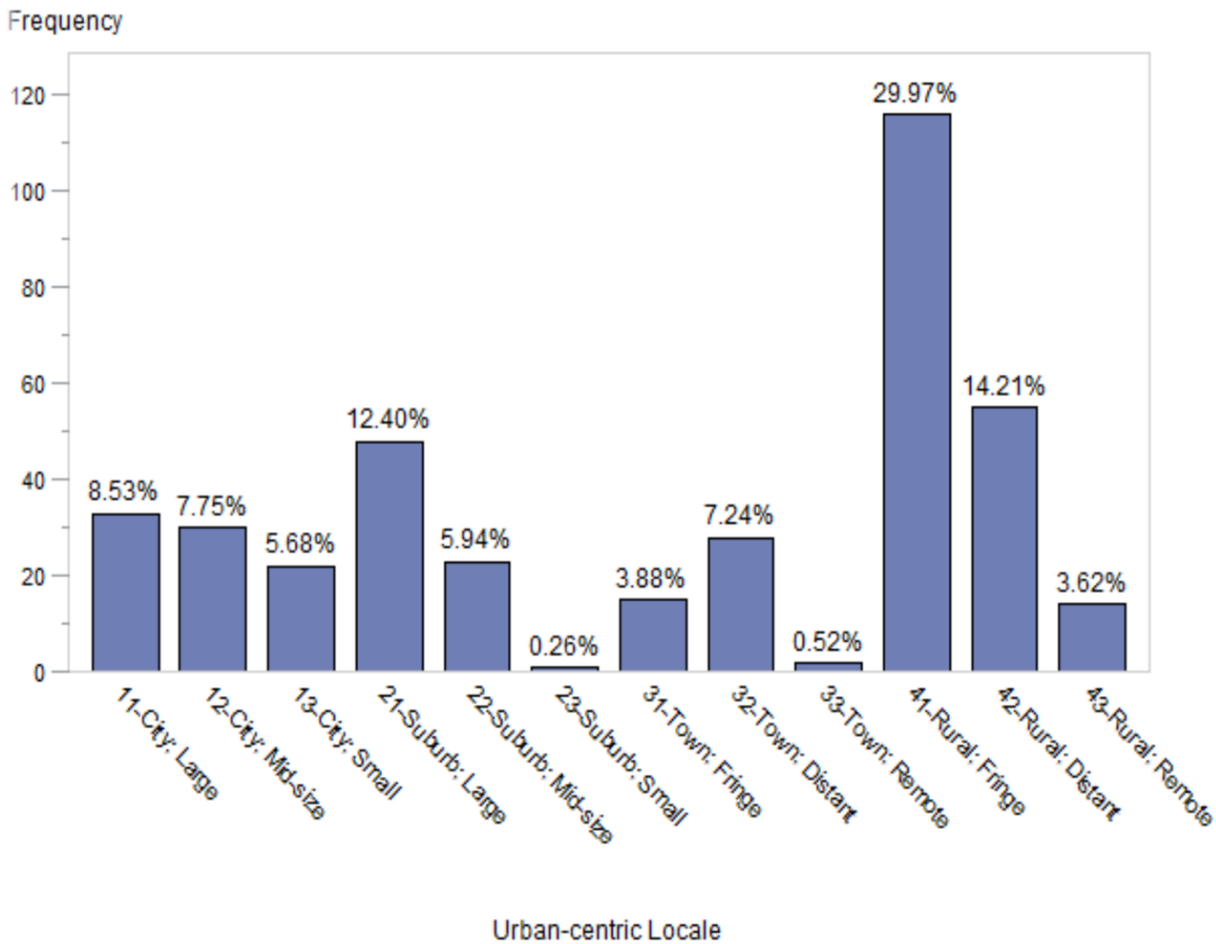


Figure 17: Number of NC Schools per Locale

Comparing this information with total student populations as was done with the national data, Figure 18 shows the total students in each locale for North Carolina. Over 55% of the total students in public high schools in NC are attending schools in rural areas. This percentage is different from the 20% national average. This trend reinforces the statement that North Carolina is a highly rural state.

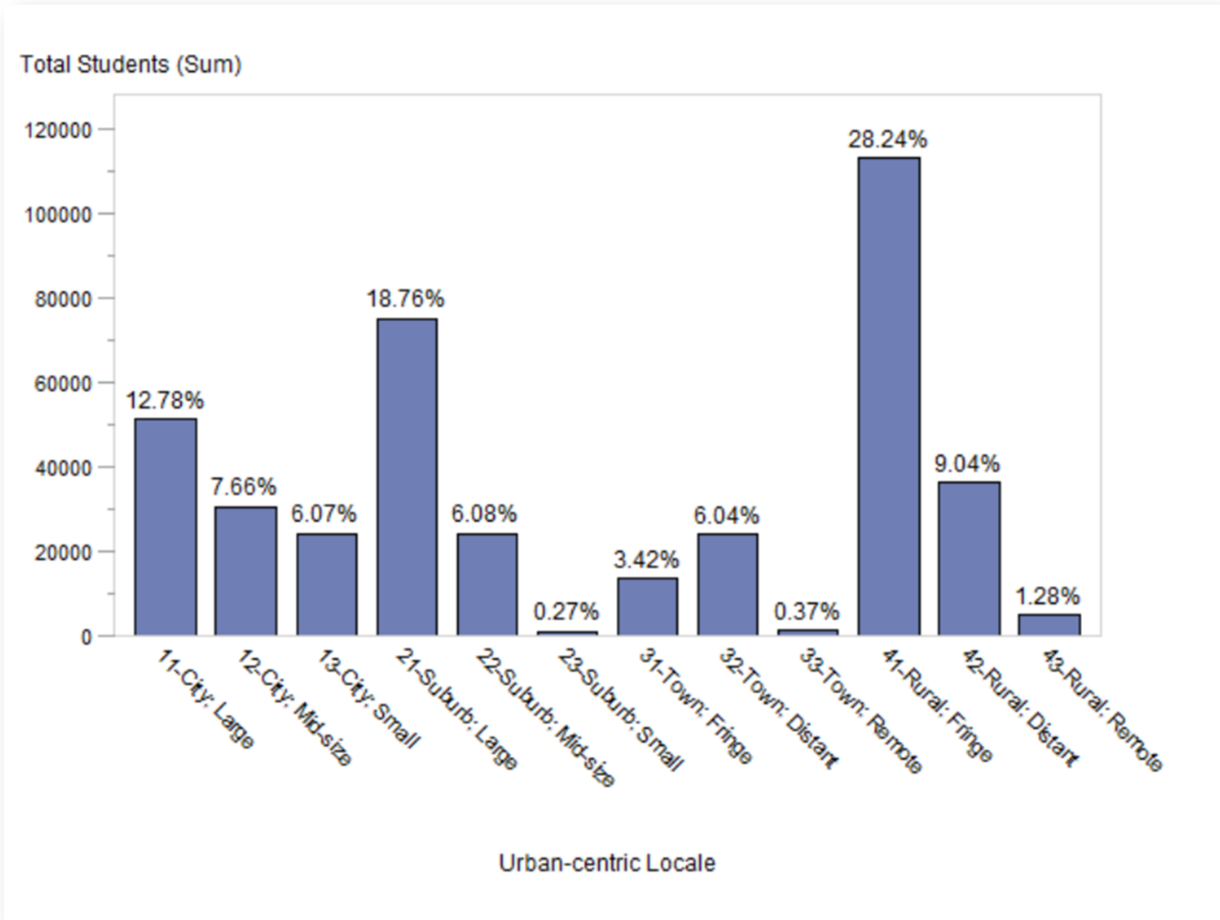
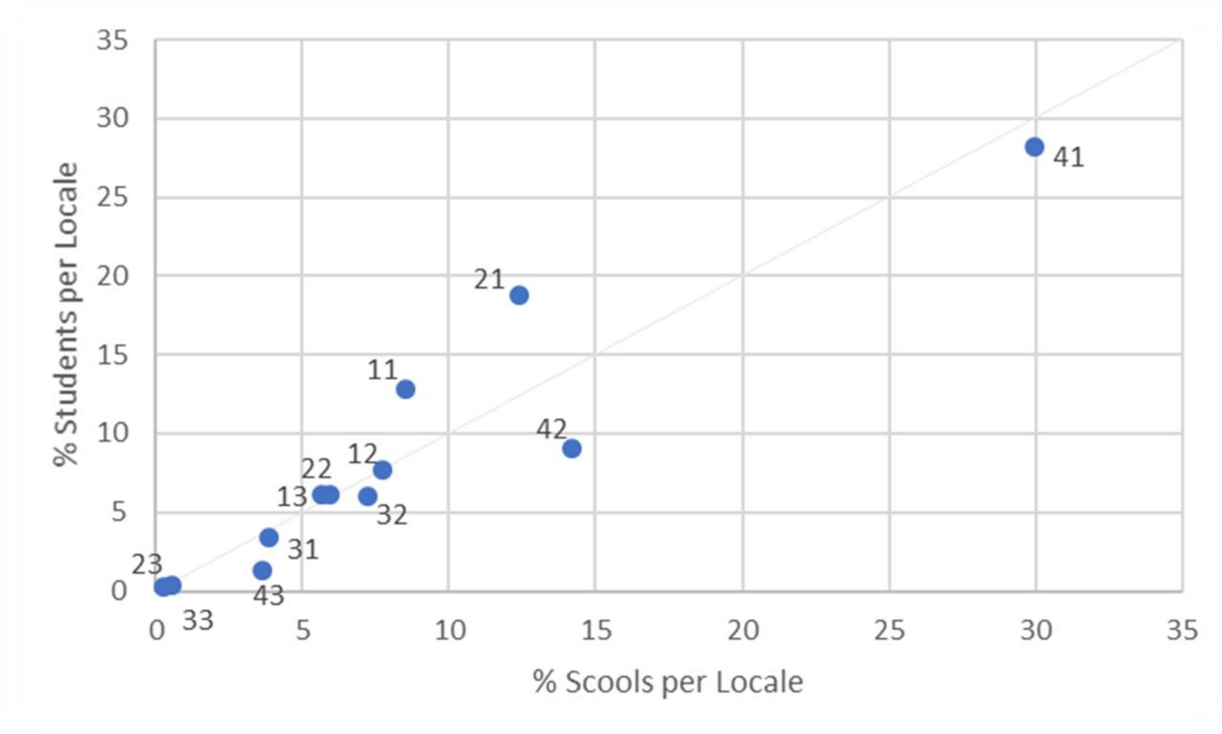


Figure 18: Total Students per Locale in North Carolina Schools

The parity plot of school size in Figure 19 shows, like the national plot, that rural distant and remote areas (42 and 43) fall below the parity line and are smaller than average, and large suburban schools (21) fall above the line and are larger than average. What stands out here is that the percentage of schools in rural fringe areas in North Carolina is the highest of all locales. This is not the case nationally as seen in Figure 4.



Legend:

11-City: Large	12-City: Mid-size	13-City: Small
23-Suburb: Small	22-Suburb: Mid-size	21-Suburb: Large
31-Town: Fringe	32-Town: Distant	33-Town: Remote
41-Rural: Fringe	42-Rural: Distant	43-Rural: Remote

Figure 19: Parity Plot of School Size in NC

Comparison of ranges of school sizes and percent free or reduced lunch values between North Carolina and the national ranges are shown in Figures 20 and 21. For school sizes, North Carolina meets the national averages in school sizes for city and suburban schools being larger than 1000 students on average. However, for rural distant and remote schools, North Carolina has average school sizes of 660 and 366, respectively, compared to the national average sizes of 200-300. With more students located in these rural areas, North Carolina has larger school sizes in these areas but the school sizes in the rural distant and remote areas still have the fewest number of students.

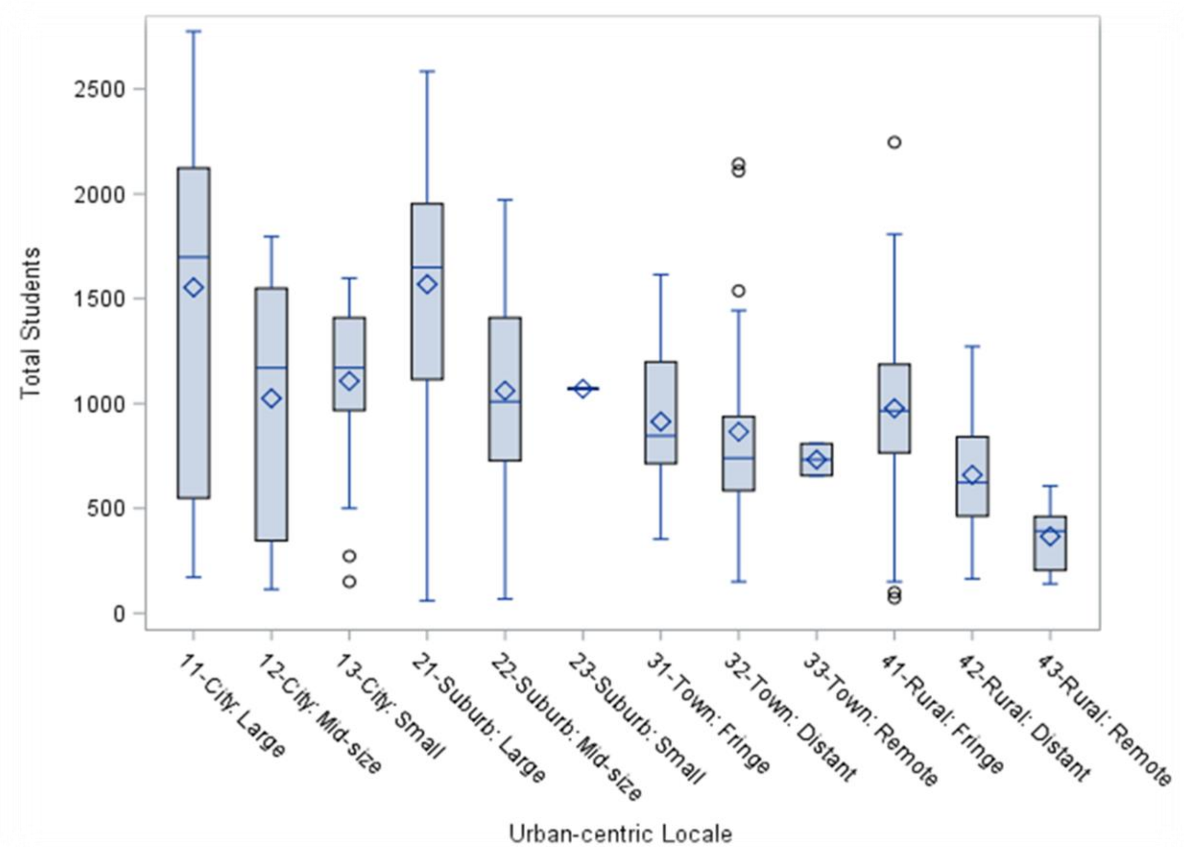


Figure 20: Average School Size per Locale for North Carolina

The plot of students on free or reduced lunch for North Carolina is shown in Figure 21. Rural areas in North Carolina do not appear to differ from other locales of NC in terms of socioeconomic status, as defined by percentage of students on free or reduced lunch. Large suburbs have the lowest percentage of students on free or reduced lunch, matching the national averages. The highest percentage on free or reduced lunch, however, is not found in large cities, but in fringe or distant towns, as seen by higher averages in these locales. Again, low socioeconomic status is not a characteristic of rural areas.

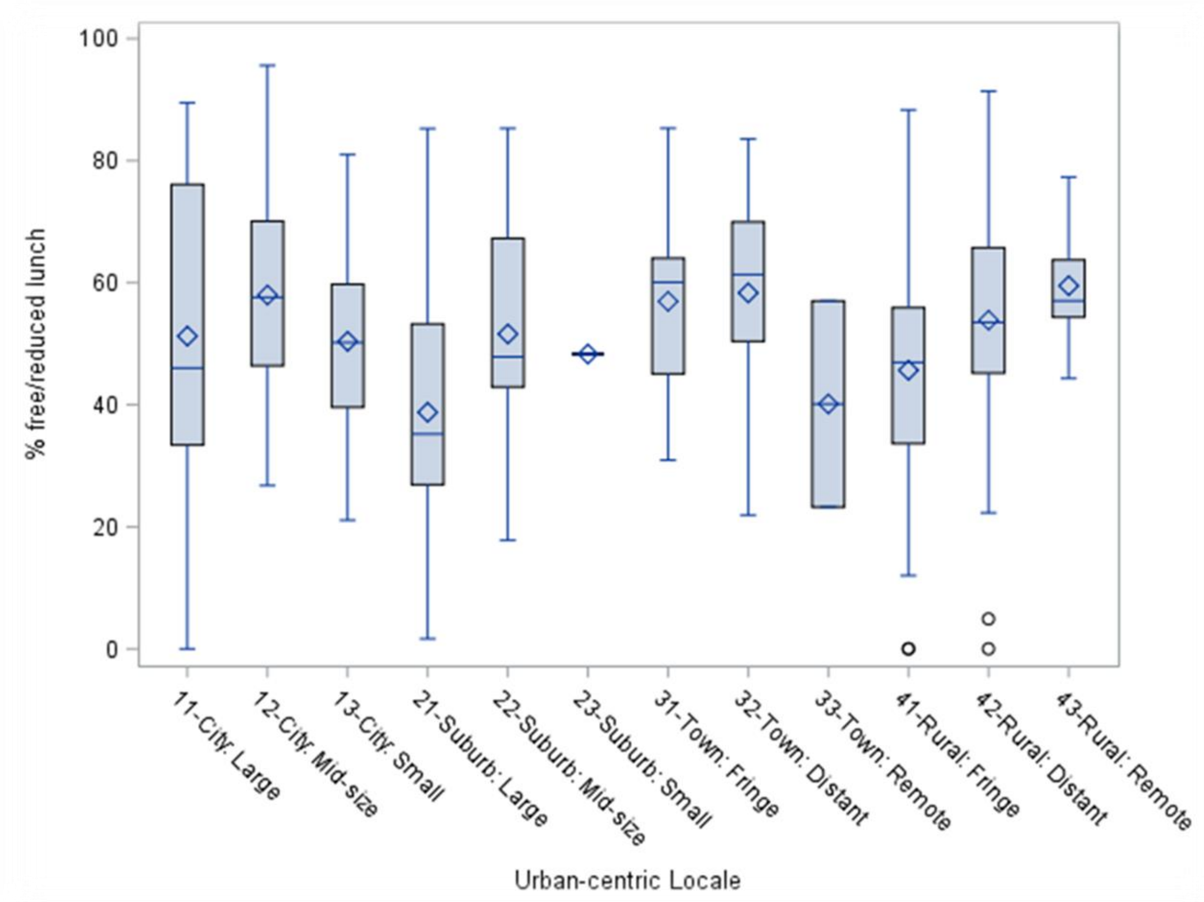


Figure 21: Percent of Free or Reduced Lunch Students per Locale in North Carolina Schools

As mentioned earlier, states in the South have larger percentages of students of Black race/ethnicity. When looking at students in North Carolina, rural areas contain 59-64% White students and 20-26% Black students, compared to the national averages of 72-82% White and less than 10% Black students. The percentage of Hispanic/Latino students in North Carolina schools is the same as the national average, around 10%. While ethnicity distributions may differ, the factor of race/ethnicity does not come out to be significant when accounting for the number of AP classes offered in a school in the United States.

As has been shown, North Carolina differs from other states in characteristics of school size, socioeconomic status, and racial/ethnic makeup of each locale. When running the generalized linear model for North Carolina schools only, other differences appear. Table 12 compares the percent of variation accounted for by the three main factors (locale, school size, socioeconomic status) for North Carolina. It shows that North Carolina is influenced less by locale and school size when accounting for the number of AP courses in a high school, but socioeconomic status plays a larger role than in the nation or Southern region. As much of North Carolina is rural, locale may play less of a role because of homogeneity. As was shown when comparing regions, the South has slightly more students on free and reduced lunch when compared with other locales. This may explain why in North Carolina, socioeconomic status accounts for 5.5% or the variation, as opposed to 2.7% nationally. This percentage is still not a large amount, but it is significant. Overall, the North Carolina model shows that even without the region factor, 56% of variance in the number of AP courses offered is still accounted for by the three main factors of locale, school size, and socioeconomic status of a school.

Table 12: Variance Accounted for in Generalized Linear Model for NC

Source	**Eta-Square**
Overall	0.56
Urban-centric Locale	0.2617
Total Students (thousands)	0.245
% free/reduced lunch	0.0553

Table 13 gives the parameter estimates for the three factors. It also shows which locales differ significantly from the rural remote area used as a reference. For North Carolina, only the large city locales are significantly different from rural remote areas when modeling the number of AP courses per school. Total students and socioeconomic status are still significant factors in the model, similar to the national model.

Table 13: North Carolina Generalized Linear Model for Number of AP Courses

Parameter	Estimate
Intercept	12.234 ***
11-City: Large	7.027 **
12-City: Mid-size	2.298
13-City: Small	3.033
21-Suburb: Large	0.757
22-Suburb: Mid-size	2.262
23-Suburb: Small	5.110
31-Town: Fringe	2.547
32-Town: Distant	1.427
33-Town: Remote	4.779
41-Rural: Fringe	1.103
42-Rural: Distant	0.316
School Size (thousands)	7.811 ***
% free/reduced lunch	-0.118 ***
Scale	5.469

** $p < .05$, *** $p < .0001$
$N = 374$
Mean # of subjects = 16.3

Scale parameter estimated by maximum likelihood
Reference variable: 43-Rural: Remote

Discussion

These results characterize rural distant and remote schools as having fewer students per school than other locales, a lower proportion of minority students per school, and a socioeconomic status rating similar to other locales. Availability of Advanced Placement courses in rural distant and remote areas is hypothesized to be less than other locales. The data supports this hypothesis, as shown in Figures 1 (nationally) and 12 (North Carolina).

With a total of 42 different AP subjects available, some city and suburban schools offer almost the entire selection of AP courses. The mean number of courses offered is highest nationally in large suburban schools. Town and rural schools offer, on average, about half of what is offered in city/suburban schools. However, distant and remote rural areas offer only two to four subjects on average. These distant and remote rural areas also have many more outliers in the data, compared to city and suburban schools whose range of course availability tends to cover most of the available courses. For North Carolina, large city schools offer the highest number of AP courses, as opposed to large suburban locales nationally.

Regardless of whether we look at the national data, regional data, or North Carolina data, a huge amount of variation in the number of AP courses offered can be explained by the locale of the school. Does the inequity in AP course availability influence whether these rural students apply and are admitted to engineering programs? The next chapter looks to answer this question.

CHAPTER 4 – COLLEGE ENTRANCE STUDY

Introduction

Fewer rural students attend university than students in other locales (Provasnik et al., 2007). Identifying the current breakdown of locales of students in engineering is the first focus of this study. No study could be identified that examines the percent of rural students in engineering programs. Knowing the current status of the rural student's presence in engineering will facilitate future work on rural students in engineering and STEM. The second part of this study will look at a case study of students applying to the engineering program at a large public mid-Atlantic university to see if any differences exist in acceptance rates among locales.

This section will be seeking answers to the following research questions:

1. How are students from rural areas represented in engineering programs nationally, and at a university located in a rural area?
2. Compared to the overall acceptance rate, what is the acceptance rate into the engineering program for rural students? Does being from a rural high school make a student less likely to be admitted into the engineering program?
3. How do high school size, high school socioeconomic status, and racial/ethnic background of students ***in engineering*** differ from high school students nationally?

Methods

Data

Data sources for this study are laid out in Figure 22. For this part of the research, data were taken from the MIDFIELD (Multiple Institution Database for Investigating Engineering) database (Ohland & Long, 2016). The MIDFIELD data used in this study includes data on entering engineering students during 2000-2016 from 12 different universities from the states of Colorado, Florida, Georgia, North Carolina, Oklahoma, Pennsylvania, South Carolina, and Virginia. Demographic data from MIDFIELD included: person identifier number, high school code, high school ZIP code, race/ethnicity, and sex. Combining these with the NCES data, the locale and socioeconomic status of the high school for each student attending a public school was used. Only first-time-in-college students for U.S. high schools was included in this study. This sample includes a total of 33,311 students. The proportions of students from each of the twelve geographic locales were compared. Potential covariates, such as sex and race/ethnicity, were included to see whether and how they influence the results, and the sample will be compared to the population to check for representativeness.

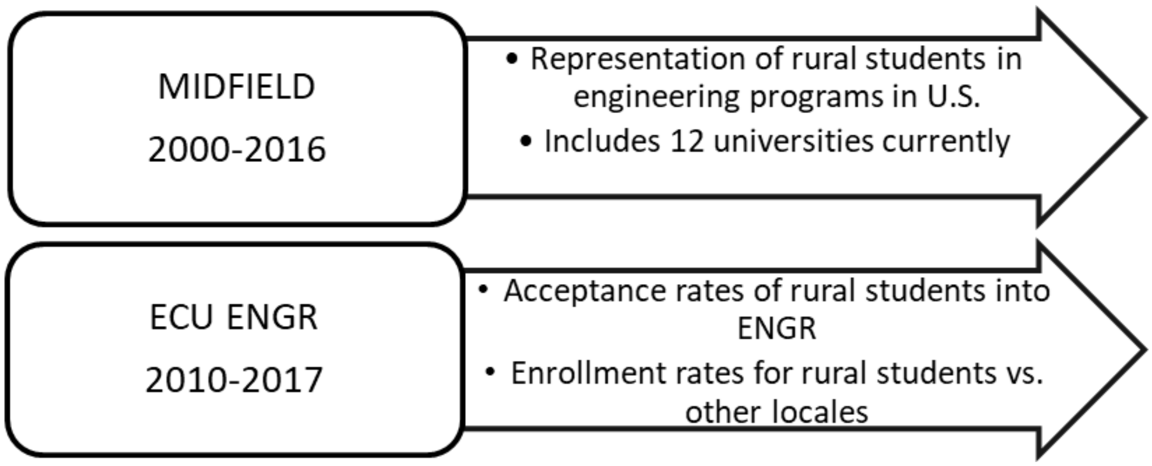


Figure 22: Data Sources for College Entrance Study

Notably, MIDFIELD lacks data on those applicants who were not admitted and those who were admitted yet did not matriculate. To investigate the acceptance rate of rural students into an engineering program compared to other locales, I used data from East Carolina University (ECU). Data from ECU contains demographic data for all applicants to the Department of Engineering from 2010 to 2017. The data include information from 2,352 students, both in state and out of state. Using the high school from which the student graduated, the acceptance rate of students in each locale can be compared for this one university. As this is a university which caters to rural students in Eastern North Carolina, the results will not be generalizable to most engineering programs yet can provide good status information to begin to study rural students in engineering programs. Future work may uncover ways to better prepare and encourage rural students to enter engineering.

Of the 33,311 students in MIDFIELD, 3,891 of them came from high schools in North Carolina. Table 14 compares enrollment rates for each locale nationally and for North Carolina, as estimated by the data from MIDFIELD. The first two columns, U.S. and N.C. student totals, were taken from the NCES totals of high school students both nationwide and in North Carolina and are used as reference points. The next two columns, MIDFIELD enrollments, represent the eight states nationally for which there was engineering data. The final two columns of ECU data represent enrollment in an engineering program, which caters to rural students and is located in a rural area.

Table 14: Locales of Students in Engineering Programs

LOCALE	US STUDENT TOTALS (%)	NC STUDENT TOTALS (%)	MIDFIELD ENROLLED ENGR (%)	MIDFIELD-NC ENROLLED ENGR (%)	ECU ENROLLED ENGR (%)	ECU NC ENROLLED ENGR (%)
City-Large	13.4	12.8	9.82	20.61	11.78	12.15
City-Midsize	6.50	7.67	7.04	12.08	5.58	5.90
City-Small	7.70	6.07	10.24	7.45	8.84	9.38
Suburb-Large	**35.4**	18.8	**41.63**	15.57	17.52	13.54
Suburb-Midsize	3.60	6.08	5.14	5.81	4.34	4.34
Suburb-Small	1.90	0.27	1.42	0.44	1.55	1.56
Town-Fringe	3.00	3.42	1.91	3.03	5.12	5.21
Town-Distant	5.30	6.04	3.66	5.96	4.50	4.69
Town-Remote	3.60	0.37	2.43	0.05	1.71	1.74
Rural-Fringe	12.0	28.2	12.45	**20.97**	30.08	**31.42**
Rural-Distant	**5.50**	9.04	**3.32**	6.78	**8.53**	9.55
Rural-Remote	**2.20**	1.28	**0.95**	1.23	**0.47**	0.52

In the national datasets (NCES and MIDFIELD), the largest percentage of students is found in Large Suburban locales with 35.4% of U.S. students and 41.63% of enrolled engineering students. For North Carolina, the largest percentage is found in Rural Fringe areas with MIDFIELD having

20.97% of NC engineering students from that locale and ECU containing 31.42% of students from that rural locale. Overall the distribution percentages appear different for each dataset. When looking at the number of students from rural distant and rural remote areas, nationally there are 7.7% overall in these areas, MIDFIELD only contains 4.27% in its database, but ECU 9.0% of students from these areas enrolled in the engineering program.

To examine whether locale has a negative effect on acceptance into the engineering program at ECU, acceptance rates for each locale were calculated. Table 15 shows the breakdown of applied, admitted, and enrolled students in engineering from the ECU data. These data include all students who applied to the ECU Engineering program between 2010 and 2016 for fall admission.

Table 15: ECU Student Application and Acceptance Numbers per Locale for 2010-2016

LOCALE		Acceptance Rate (%) (N)	*Enrollment Rate (%) (N)	NC Acceptance (N)	NC Enrollment (N)
11	City: Large	62.4 (306)	39.8 (191)	61.3 (287)	39.8 (176)
12	City: Midsize	56.9 (153)	41.4 (87)	57.0 (142)	42.0 (81)
13	City: Small	69.5 (174)	47.1 (121)	68.6 (156)	50.5 (107)
21	Suburb: Large	67.6 (583)	28.7 (394)	65.7 (408)	29.1 (268)
22	Suburb: Midsize	65.7 (105)	40.6 (69)	64.4 (90)	43.1 (58)
23	Suburb: Small	73.3 (30)	45.5 (22)	84.2 (19)	56.2 (16)
31	Town: Fringe	70.5 (95)	49.3 (67)	70.6 (85)	50.0 (60)
32	Town: Distant	57.5 (106)	47.5 (61)	55.1 (98)	50.0 (54)
33	Town: Remote	69.0 (29)	55.0 (20)	75.0 (24)	55.6 (18)
41	Rural: Fringe	72.5 (575)	46.5 (417)	72.2 (514)	48.8 (371)
42	Rural: Distant	64.6 (181)	47.0 (117)	64.9 (174)	48.7 (113)
43	Rural: Remote	60.0 (15)	33.3 (9)	60.0 (15)	33.3 (9)
Overall		**67.0**	**41.0**	**66.2**	**43.3**

*Although acceptance rates do not differ by locale, enrollment rates are influenced by locale ($p < .05$).

Analysis:

Chi square tests of independence were run on the ECU data of application and acceptance rates to see if locale had a negative effect on whether a student applied or was accepted into an engineering program. For eleven degrees of freedom and a 95% significance level, the critical value of chi squared is 19.68. The critical value for a 99% significance level is 24.72. If the calculated chi square value is above this level, the null hypothesis is rejected, and the distributions can be considered different. Table 16 shows the comparisons made and the corresponding chi squared values. Expected values represent the total applicants, admitted students, or enrolled students broken down into locale by the national or North Carolina percentage breakdown per locale (see Table 14).

Table 16: Distribution Comparisons Applicants/Accepted/Enrolled

Comparison	**Number**	**Chi Square (df = 11)**	***p*-value**
U.S. high school students vs. All applications	2,352	482	**
All applications vs. All admitted into ENGR	1,575	8.19	n/s
All admitted vs. All enrolled in ENGR	645	22.9	*
All NC students vs. All NC applications	2,012	113	**
All NC applicants vs. All NC admitted to ENGR	1,331	9.21	n/s
NC admitted students vs. NC enrolled in ENGR	567	20.2	*

* $p < .05$, ** $p < .01$, n/s = non-significant

The results in Table 16 show that large differences occur in the population of high school students and those who apply to a university engineering program, both nationally and for North Carolina. This is to be expected as only a small portion of the population attends college. Yet there is no significant difference at the 95% significance level for those who apply and those who are admitted, based upon their locale. For ECU, this shows there is no bias in acceptance rates based on locale. Smaller, yet significant, differences occur among distributions for students admitted into an engineering program and those who enroll in the program. For the engineering program at ECU, fewer students enroll from large suburbs. This finding is most likely due to the large number of universities in North Carolina, many of which are in larger populated areas. Rural remote areas also have low enrollment rates, but probably for very different reasons.

Chi square tests of independence were also run to compare the distributions of the MIDFIELD database and the data from ECU. Table 17 gives the outcome of those analyses. Results in Table 17 show that MIDFIELD data is representative of the locales of high school students both nationally and in North Carolina. ECU enrollment in the engineering program is representative of the high school population in North Carolina but not representative of the national high school locale breakdown. This is explained by the fact that ECU caters to students in North Carolina and only accepts a maximum of 15% of students from out of state into the university.

Table 17: Dataset Comparisons

Comparison	**Chi Square (df = 11)**	***p*-value**
MIDFIELD NC Enrolled vs. ECU NC Enrolled	22.5	*
MIDFIELD Enrolled vs. ECU Enrolled	54.2	**
ECU NC Enrolled vs. NC high school totals	17.5	n/s
MIDFIELD NC Enrolled vs. NC high school totals	11.03	n/s
ECU enrolled vs. national high school totals	42.6	**
MIDFIELD enrolled vs. national high school totals	6.59	n/s
* $p < .05$, ** $p < .01$, n/s = non-significant		

Student Demographics in Engineering

Figure 23 shows the racial/ethnic breakdown of students in engineering programs in MIDFIELD. When comparing this to the racial/ethnic breakdown of students in high school (Figure 7), it becomes evident that engineering programs overwhelmingly attract White students from each locale. Although the majority of students in high schools from large and mid-size cities are non-White, 60-70% of students in engineering programs from those same locales are White.

When looking more closely at rural locales (by zooming in on Figure 23), Figure 24 shows that race/ethnicities of students from rural distant and rural remote areas parallel the race/ethnicities of high schools in those locales. This simply reflects the previous research results that rural areas are largely White areas.

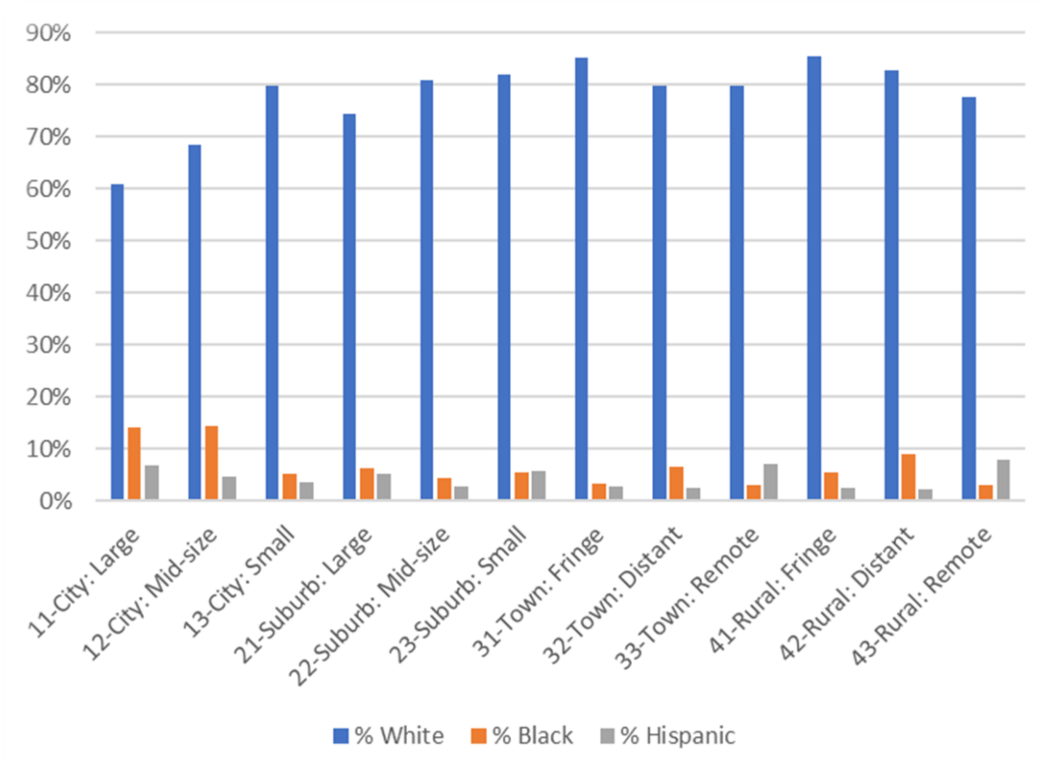


Figure 23: Race/Ethnicities per Locale for Students in Engineering

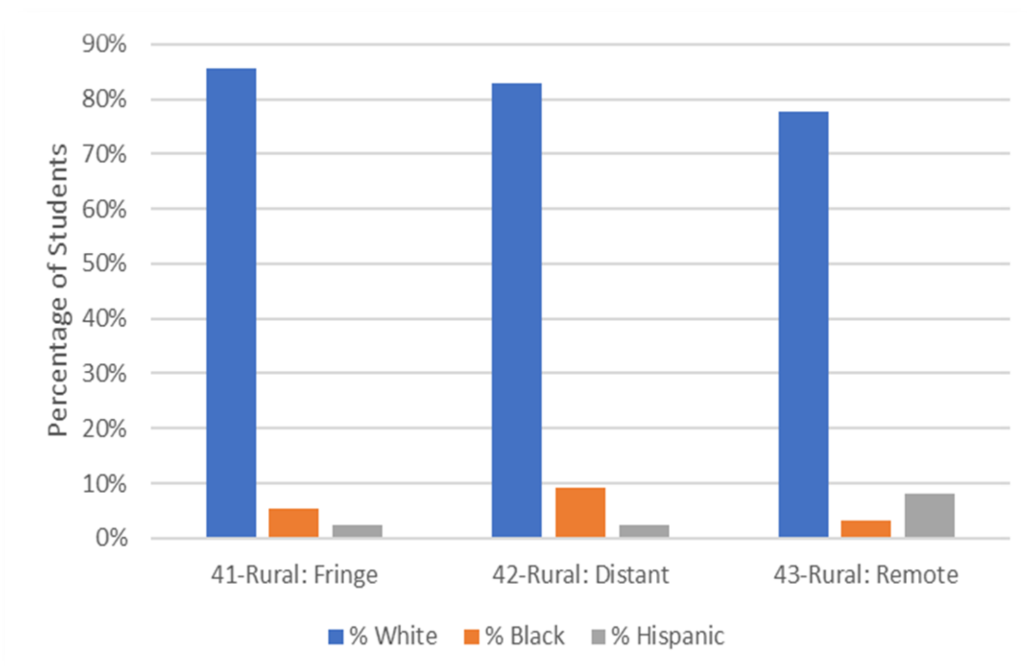
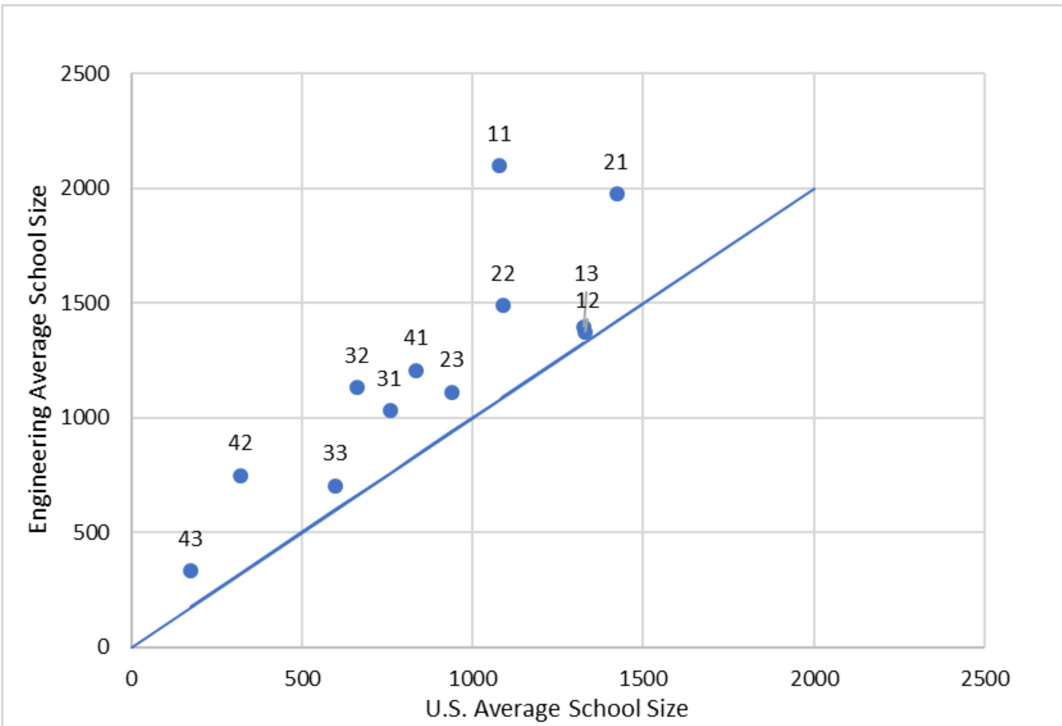


Figure 24: Race/Ethnicities of Rural Students in Engineering

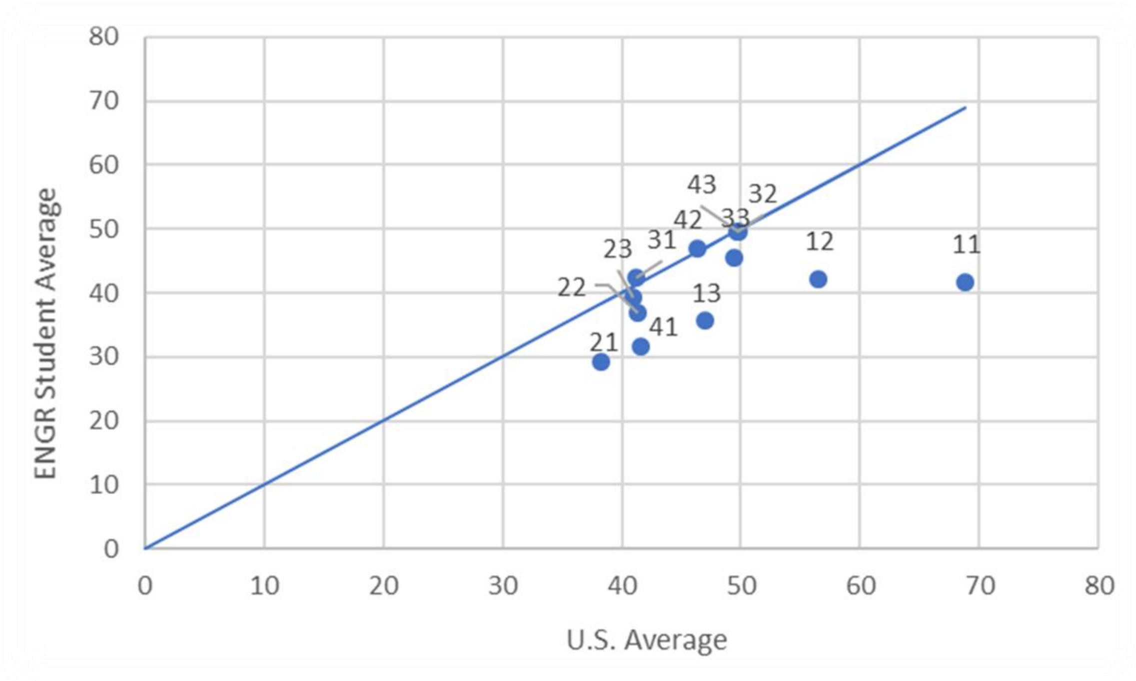
The parity plot of Figure 25 shows the comparison in high school sizes of students in engineering programs versus all high schools nationwide. If the engineering students' high school size is larger than the national average for that locale, the dot will be seen above the parity line. If the school is smaller than the national average, it will appear below the line. Overall, students in engineering programs come from larger high schools than the average for the locale. However, for students from large city (11), rural distant (42), or rural remote (43) schools, the school size is double that of the average for the locale.



11- City: Large	21- Suburb: Large	31- Town: Fringe	41- Rural: Fringe
12- City: Midsize	22- Suburb: Midsize	32- Town: Distant	42- Rural: Distant
13- City: Small	23- Suburb: Small	33- Town: Remote	43- Rural: Remote

Figure 25: Parity Plot of High School Size-Students in Engineering vs all High School

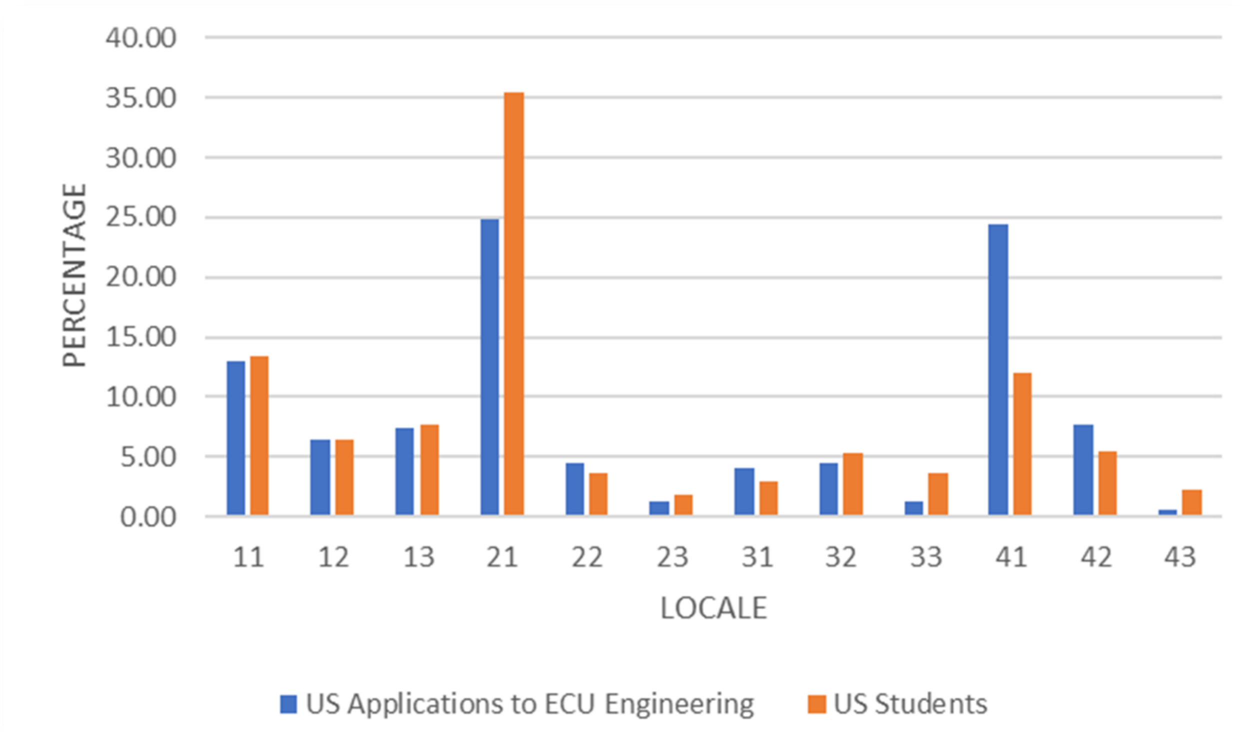
Examining the socioeconomic status background of students in engineering programs, as defined by the percentage of their high school on free or reduced lunch, Figure 26 shows the parity plot for engineering students and the average for national high school locales. Only the large and medium city schools (11 and 12) show large differences. Moderate differences are seen for rural fringe (41) and large suburban (21) areas. Overall, engineering students come from high schools with a smaller percentage of students on free or reduced lunch (thus a higher socioeconomic status.)



11- City: Large	21- Suburb: Large	31- Town: Fringe	41- Rural: Fringe
12- City: Midsize	22- Suburb: Midsize	32- Town: Distant	42- Rural: Distant
13- City: Small	23- Suburb: Small	33- Town: Remote	43- Rural: Remote

Figure 26: Parity Plot of Socioeconomic Status of Students in Engineering

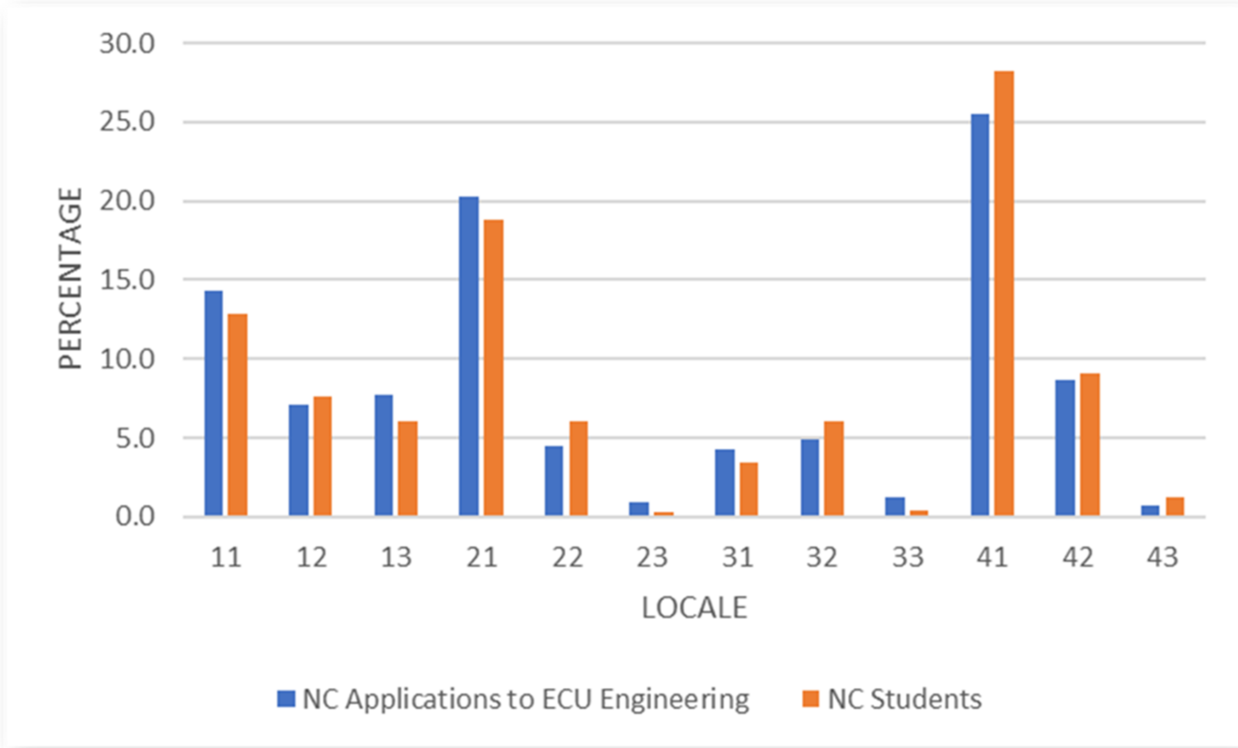
Figures 27 and 28 give the graphical representation of the student population in the ECU engineering program. The previous statistical analysis showed the locale distributions were significantly different from the high school student distribution. Figure 27 shows that for all students nationwide in ECU engineering, large cities (21), distant towns (33), and remote rural areas (43) are noticeably underrepresented in the program. Rural fringe (41) and rural distant areas (42) are notably overrepresented.



11- City: Large	21- Suburb: Large	31- Town: Fringe	41- Rural: Fringe
12- City: Midsize	22- Suburb: Midsize	32- Town: Distant	42- Rural: Distant
13- City: Small	23- Suburb: Small	33- Town: Remote	43- Rural: Remote

Figure 27: Applicants per Locale Nationwide for ECU Engineering

For the North Carolina population, although still a statistically different distribution, the high school population and student population in ECU Engineering are more closely aligned, as shown in Figure 28. While City, Suburban, and Town locales have some overrepresentation and some underrepresentation, all rural locales are underrepresented. This would show that the students from out of state are largely from rural areas.



11- City: Large	21- Suburb: Large	31- Town: Fringe	41- Rural: Fringe
12- City: Midsize	22- Suburb: Midsize	32- Town: Distant	42- Rural: Distant
13- City: Small	23- Suburb: Small	33- Town: Remote	43- Rural: Remote

Figure 28: NC Applicants per Locale for ECU Engineering

Discussion

Students from rural distant and rural remote locales make up 7.7% of high school students nationwide. In North Carolina, they represent 10.3% of all high school students. However, in engineering programs, these percentages drop. In the MIDFIELD database, which is being used to represent the national makeup of engineering programs, 4.27% of the students are from rural distant and remote locales. ECU Engineering more closely represents the North Carolina population, with 9% of its students from rural distant and remote areas, compared to the 10.3 % in N.C. state high schools. While ECU enrolls more students from rural areas, it enrolls fewer students from large suburbs than are seen nationally in engineering.

When looking at the high school characteristics of the students from rural distant and remote locales coming into engineering, the racial/ethnic makeup of the entering students matches the high schools, largely White students. School sizes are slightly larger in those students coming into ECU engineering. Also, the students entering engineering come from high schools with a higher socioeconomic status than the average rural distant or remote student. Yet the differences in school size or socioeconomic status are not large ones.

This underrepresentation of the rural distant and rural remote student is not due to bias in acceptance rates or enrollment rates, but largely due to the number of students applying to engineering programs from these locales. As ECU is a school in a rural area that caters to the rural student, numbers for this university are reasonably higher than for universities in non-rural areas. Research into the number of applicants for engineering programs nationwide should be done to determine the size of underrepresentation of rural applicants nationwide. More work also needs to be done to determine reasons why students from these rural locales do not apply to engineering programs in higher numbers.

CHAPTER 5 – CONCLUSION

The path into the engineering field is different for students from rural areas than for students from other locales. Rural students make up almost 20% of the national high school population, with 8% coming from rural distant and rural remote locales. Nevertheless, in university engineering programs, only 4% of students come from rural distant and remote locales, even though the percent from rural fringe areas remain consistent with high school percentages (13%). This study explored the reasons for the underrepresentation of this portion of the population in engineering.

While rural areas have been divided into three subgroups (i.e., fringe, distant, and remote), it is only the distant and remote subgroups that differ largely from all other locales. This is most likely due to school consolidation in the rural fringe areas, causing them to be more like town and suburban locales than other rural locales. The aggregation of all defined 'rural' areas actually masks the disparity that occurs for just the rural distant and remote locales, making it easier to continue to marginalize these populations. In the following paragraphs, 'rural students' refers only to the rural distant and rural remote students.

Rural communities tend to be more homogeneous in their racial/ethnic makeup and largely White, although pockets of Black minorities are found in the South and Hispanic/Latino minorities found in the West. The relative isolation of these rural distant and remote areas gives the community a strong identity and tight bonds within the community. Rural areas tend to be less diverse racially and ethnically with most of the population being White; race/ethnicity was not a significant factor in explaining the availability of AP courses. Based on participation in the National Free and Reduced Lunch Program, these rural areas are not of lower socioeconomic status when compared with other locales. Although there are poor areas, being poor is not a characteristic of the rural student in general. The number of Advanced Placement courses offered in rural distant and remote areas is significantly lower than all other locales. This lack of educational opportunity is seen across the United States, regardless of region. This finding reveals the systemic restriction of educational opportunity for rural students that is not explained by race/ethnicity or socioeconomic status.

Whereas smaller school sizes in rural areas may compound the issue of AP course availability, small school sizes offer advantages as well. The lower number of students per school in rural offers students more interaction with teachers and more opportunity in extracurricular school activities. Community involvement and support of students is very high in rural areas. This support has led to lower dropout rates and higher graduation rates for these students than for students from urban areas (Khattri et al., 1997; Provasnik et al., 2007). The strong intergenerational nature of rural areas gives the students a strong sense of belonging which helps in their success in school.

Rural students are underrepresented in both universities and engineering programs. Based on this work, the underrepresentation is not due to any bias in acceptance rates, but in fewer rural students applying to the programs. With fewer parents being college graduates, rural students tend to be raised with different expectations for life. This is compounded by the enforcement of societal expectations from others in rural communities. They may have been expected to remain in the community and not attend college. As expectations for rural students are higher for those with higher social standing, many rural students with the academic ability are never encouraged to pursue college. As rural students are raised in a way that determines their standing and whether they are college-bound from childhood, these students should be encouraged because of their ability and not dismissed because of their standing in the community. The restricted access rural students have to AP courses is one way in which these lower societal expectations are communicated to rural students.

Efforts need to be made to uproot the status quo and identify capable students, regardless of rurality, regardless of socioeconomic standing, to have access to and be enrolled in honors and AP courses. All these students should be mentored and encouraged as to how to navigate the college system. As can be seen in the case of ECU, with a mission to serve rural students, structural issues in education like the lack of AP courses and low college enrollments for rural students can be overcome.

While rural areas do not lack students or talent, they do suffer from lower educational opportunity. Bringing opportunity in the form of AP courses would help even the playing field for these students to enter university STEM programs. Students from these rural areas can bring new vision and innovation into the engineering field, if they are encouraged and mentored to enter post-secondary education. As equity in educational opportunity is improved, social and economic equity for rural areas will also improve. This will be good for the students who are able to achieve their potential, for the rural communities as their population becomes more educated, and ultimately the nation as future industries like food production move into these areas needing an educated workforce.

Future Research

More research is needed to uncover the societal constructs in place that keep rural students from moving towards post-secondary study and STEM fields, in particular. Ways to encourage these students who may not have role models or mentors must be fashioned and implemented. Increasing AP availability may be achieved by raising student numbers in the classes, but may also need technological advances, such as high-speed internet, in those rural areas. Although barriers currently exist, the benefit of overcoming these barriers, in the form of a more educated rural population and more diverse engineering field, is great.

As more schools are added into the MIDFIELD database, the data will more closely reflect the student population in engineering programs nationwide. Future work will include reanalyzing these numbers with the larger database to see if the conclusions still hold.

Future research will be done to examine the success of students upon entering an engineering program, using locale as a variable to reveal how rural students differ from other locales once they are admitted to an engineering program. This study will seek to identify any systemic institutional bias towards these students once they enter.

More research is also needed to reveal how rural students may be brought into the engineering field in greater numbers. While having a framework built by data is helpful, the heart of the rural student is still missing. Future work will include interviews with students from rural backgrounds to see how their experience of the pathway into engineering may differ from students from other locales. In this manner, we may uncover ways to encourage more students from rural areas to pursue a career in engineering.

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APPENDIX A. AP COURSE AVAILABILITY PER LOCALE

11-City: Large
12-City: Mid-size
13-City: Small
21-Suburb: Large
22-Suburb: Mid-size
23-Suburb: Small
31-Town: Fringe
32-Town: Distant
33-Town: Remote
41-Rural: Fringe
42-Rural: Distant
43-Rural: Remote

LOCALE:	**11**	**12**	**13**	**21**	**22**	**23**	**31**	**32**	**33**	**41**	**42**	**43**
STEM Courses												
Statistics	0.49	0.61	0.65	0.72	0.63	0.49	0.46	0.34	0.26	0.45	0.15	0.07
Physics C: Mechanics	0.17	0.23	0.26	0.37	0.20	0.15	0.10	0.06	0.04	0.15	0.02	**0.00**
Physics C: Electricity	0.09	0.13	0.16	0.23	0.10	0.07	0.04	0.03	0.01	0.07	**0.00**	**0.00**
Physics B	0.35	0.46	0.48	0.54	0.47	0.35	0.27	0.21	0.19	0.33	0.09	0.04
Physics 2	0.10	0.15	0.19	0.20	0.14	0.14	0.06	0.03	0.03	0.09	0.01	**0.00**
Physics 1	0.28	0.44	0.43	0.50	0.40	0.33	0.23	0.16	0.14	0.28	0.06	0.02
Environmental Science	0.43	0.48	0.44	0.52	0.46	0.25	0.26	0.20	0.15	0.33	0.10	0.05
Computer Science AB	0.06	0.09	0.09	0.11	0.04	0.02	0.01	0.02	0.01	0.03	**0.00**	**0.00**
Computer Science A	0.21	0.30	0.35	0.41	0.32	0.20	0.16	0.11	0.07	0.20	0.05	0.02
Chemistry	0.48	0.65	0.70	0.77	0.68	0.56	0.49	0.42	0.37	0.55	0.20	0.08
Calculus BC	0.33	0.45	0.51	0.58	0.45	0.36	0.24	0.15	0.12	0.30	0.07	0.03
Calculus AB	0.66	0.77	0.83	0.88	0.83	0.78	0.76	0.71	0.61	0.78	0.44	0.23
Biology	0.61	0.70	0.78	0.82	0.75	0.65	0.64	0.53	0.46	0.66	0.31	0.15
NON-STEM Courses												
World History	0.41	0.43	0.46	0.50	0.42	0.32	0.34	0.23	0.17	0.34	0.12	0.04
U.S. History	0.68	0.79	0.80	0.86	0.81	0.75	0.70	0.62	0.51	0.71	0.36	0.18
U.S. Government & Politics	0.56	0.67	0.70	0.71	0.66	0.53	0.48	0.40	0.33	0.51	0.18	0.09
Studio Art: Drawing	0.34	0.43	0.45	0.53	0.40	0.30	0.23	0.17	0.14	0.29	0.06	0.02
Studio Art: 3D Design	0.19	0.30	0.28	0.33	0.26	0.19	0.14	0.09	0.10	0.19	0.03	0.01
Studio Art: 2D Design	0.33	0.43	0.47	0.52	0.42	0.32	0.26	0.18	0.15	0.30	0.08	0.02
Spanish Literature & Culture	0.24	0.20	0.13	0.20	0.08	0.09	0.06	0.03	0.03	0.07	0.01	**0.00**
Spanish Literature	0.22	0.16	0.11	0.16	0.07	0.09	0.04	0.03	0.02	0.04	**0.00**	**0.00**

Appendix A continued

Spanish Language & Culture	0.49	0.52	0.51	0.63	0.42	0.33	0.29	0.20	0.15	0.31	0.06	0.03
Spanish Language	0.47	0.53	0.51	0.61	0.44	0.33	0.29	0.20	0.17	0.30	0.06	0.03
Psychology	0.40	0.48	0.54	0.61	0.53	0.37	0.32	0.27	0.17	0.39	0.14	0.07
Music Theory	0.21	0.31	0.33	0.41	0.29	0.20	0.15	0.14	0.08	0.22	0.05	0.01
Microeconomics	0.17	0.25	0.28	0.32	0.27	0.19	0.15	0.11	0.08	0.17	0.05	0.02
Macroeconomics	0.27	0.38	0.40	0.41	0.33	0.23	0.16	0.13	0.12	0.23	0.06	0.03
Latin: Vergil	0.07	0.09	0.08	0.10	0.07	0.04	0.02	0.01	0.01	0.03	**0.00**	**0.00**
Latin Literature	0.04	0.06	0.04	0.06	0.05	0.01	0.01	0.01	0.01	0.02	**0.00**	**0.00**
Latin	0.08	0.09	0.09	0.12	0.08	0.04	0.02	0.02	0.01	0.05	0.01	**0.00**
Japanese Language & Culture	0.04	0.04	0.04	0.03	**0.00**	**0.00**	0.01	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Italian Language & Culture	0.02	0.01	0.01	0.07	0.01	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**
Human Geography	0.29	0.35	0.32	0.34	0.33	0.16	0.14	0.14	0.08	0.22	0.05	0.02
German Language & Culture	0.07	0.11	0.10	0.15	0.06	0.07	0.04	0.02	0.02	0.06	0.01	**0.00**
German Language	0.08	0.11	0.11	0.13	0.06	0.07	0.03	0.02	0.02	0.04	0.01	**0.00**
French Literature	0.02	0.03	0.04	0.03	0.01	0.01	0.01	0.01	**0.00**	0.01	**0.00**	**0.00**
French Language & Culture	0.21	0.30	0.32	0.41	0.22	0.17	0.12	0.08	0.05	0.15	0.02	0.01
French Language	0.20	0.31	0.30	0.38	0.20	0.18	0.10	0.07	0.05	0.12	0.02	**0.00**
European History	0.27	0.41	0.46	0.51	0.43	0.28	0.26	0.20	0.13	0.29	0.08	0.03

APPENDIX B. DESCRIPTIVE STATISTICS OF # OF AP COURSES AND TOTAL STUDENTS BY LOCALE

Urban-centric Locale	N Obs	Variable	Mean	Std Dev	Minimum	Maximum	Variance
11-City: Large	1665	Total Students	1078.0	883.7	43.0	4664.0	780876
		% free/reduced lunch	68.8	24.4	0.0	99.8	594
		# subjects	12.4	10.5	0.0	42.0	110
12-City: Mid-size	656	Total Students	1328.6	767.9	48.0	3845.0	589614
		% free/reduced lunch	56.5	25.4	0.0	99.9	646
		# subjects	15.2	10.4	0.0	40.0	107
13-City: Small	779	Total Students	1325.4	712.4	51.0	4774.0	507514
		% free/reduced lunch	47.0	22.2	0.0	99.9	493
		# subjects	15.8	9.6	0.0	41.0	93
21-Suburb: Large	3338	Total Students	1421.7	790.0	39.0	4869.0	624151
		% free/reduced lunch	38.2	25.5	0.0	99.9	651
		# subjects	17.9	9.6	0.0	42.0	92
22-Suburb: Mid-size	444	Total Students	1090.3	627.2	40.0	3387.0	393433
		% free/reduced lunch	41.4	20.7	4.8	99.0	429
		# subjects	14.3	8.9	0.0	39.0	80
23-Suburb: Small	275	Total Students	939.6	571.4	32.0	3207.0	326541
		% free/reduced lunch	41.0	20.6	0.0	99.3	423
		# subjects	11.2	8.1	0.0	32.0	66
31-Town: Fringe	534	Total Students	758.0	418.5	45.0	2730.0	175106
		% free/reduced lunch	41.3	19.7	0.0	99.6	387
		# subjects	9.6	7.1	0.0	35.0	50
32-Town: Distant	1070	Total Students	662.0	378.5	40.0	2873.0	143238
		% free/reduced lunch	49.7	18.5	0.0	99.7	343
		# subjects	7.7	6.6	0.0	37.0	43
33-Town: Remote	803	Total Students	600.0	391.6	34.0	2252.0	153315
		% free/reduced lunch	49.5	19.7	0.0	99.8	388
		# subjects	6.2	6.0	0.0	30.0	36
41-Rural: Fringe	1927	Total Students	833.7	547.9	37.0	4138.0	300221
		% free/reduced lunch	41.6	21.7	0.0	99.9	469
		# subjects	10.9	8.3	0.0	38.0	69
42-Rural: Distant	2304	Total Students	321.9	228.4	36.0	2200.0	52169
		% free/reduced lunch	46.4	20.2	0.0	99.7	409
		# subjects	3.8	4.8	0.0	31.0	23
43-Rural: Remote	1653	Total Students	175.0	126.5	31.0	935.0	15992
		% free/reduced lunch	49.8	19.6	0.0	99.4	385
		# subjects	1.7	3.2	0.0	29.0	10

APPENDIX C. RACIAL/ETHNIC MAKEUP PER LOCALE NATIONALLY

Urban-centric Locale	N Obs	Variable	Mean	Std Dev	Minimum	Maximum
11-City: Large	1665	% Black	34.65	32.57	0.00	100.00
		% Hispanic	38.58	30.78	0.00	100.00
		% White	16.48	20.59	0.00	89.80
12-City: Mid-size	656	% Black	29.89	30.27	0.00	99.64
		% Hispanic	26.74	25.80	0.00	99.85
		% White	33.98	25.77	0.00	88.72
13-City: Small	779	% Black	18.15	22.58	0.00	99.81
		% Hispanic	19.87	22.03	0.00	99.36
		% White	52.22	26.05	0.00	96.94
21-Suburb: Large	3338	% Black	15.37	21.27	0.00	100.00
		% Hispanic	20.55	23.88	0.00	100.00
		% White	54.69	30.60	0.00	99.35
22-Suburb: Mid-size	444	% Black	9.74	13.81	0.00	96.54
		% Hispanic	16.49	20.59	0.00	99.72
		% White	66.33	25.34	0.28	97.95
23-Suburb: Small	275	% Black	7.93	12.81	0.00	77.97
		% Hispanic	14.44	20.43	0.00	96.49
		% White	71.10	24.83	0.88	99.39
31-Town: Fringe	534	% Black	5.95	11.81	0.00	94.10
		% Hispanic	14.75	22.81	0.00	99.02
		% White	73.68	25.84	0.75	99.23
32-Town: Distant	1070	% Black	10.82	19.85	0.00	99.35
		% Hispanic	13.19	20.77	0.00	99.90
		% White	70.92	26.64	0.00	100.00
33-Town: Remote	803	% Black	8.76	19.71	0.00	99.29
		% Hispanic	16.65	22.99	0.00	99.04
		% White	65.65	28.44	0.00	99.51
41-Rural: Fringe	1927	% Black	10.12	18.16	0.00	100.00
		% Hispanic	11.99	19.26	0.00	100.00
		% White	72.39	26.38	0.00	100.00
42-Rural: Distant	2304	% Black	5.84	15.65	0.00	100.00
		% Hispanic	6.73	12.93	0.00	98.67
		% White	82.01	22.27	0.00	100.00
43-Rural: Remote	1653	% Black	3.98	13.87	0.00	99.81
		% Hispanic	8.87	16.27	0.00	99.28
		% White	77.60	26.12	0.00	100.00