

If You Are Poor, It is Better to be Rural: A Study of Mathematics Achievement in Tennessee

Theresa M. Hopkins
University of Tennessee

Part of a larger research project involving the study of mathematics achievement of middle and high school students in Tennessee, this report analyzes said achievement in terms of school locale and the percentage of disadvantaged (pdisadv) students enrolled in the school. Schools were designated as Rural, Large Central City, and Other Nonrural. Socioeconomic Status (SES) was determined by the percentage of students receiving federally subsidized free and reduced lunch. Schools were then placed into one of three economic categories: Low to moderate pdisadv (less than 50 percent of students receiving free or reduced lunch), High pdisadv (50-74.99 percent), or Highest (75 percent or greater). The findings involving SES and achievement were as expected, the higher the percentage of disadvantage, the lower the achievement. Interesting results involving locale as well as the intersection between locale and SES were also discovered. If a student is poor, the data suggests, it is better, in terms of mathematics achievement, to be rural. The possibility exists that close-knit, economically disadvantaged rural locales offer a sense of community not found in other economically disadvantaged locales which enables rural students to achieve at a higher level mathematically than their nonrural peers.

With the advent of the National Science Foundation (NSF)-funded Appalachian Cooperative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM), a more focused look at the intersection of mathematics and rural education has begun. Recent studies in the area of rural mathematics have shown that rural areas are not lagging behind nonrural schools in terms of mathematics. Winters (2003) found rural schools outscoring nonrural schools on three separate mathematics achievement measurement instruments (Tennessee Comprehensive Assessment Program (TCAP), Gateway Algebra Test, and ACT) in Tennessee. Examining mathematics achievement in rural Ohio, researchers found that when accounting for the socioeconomic status (SES) of the schools, rural Appalachian districts' mathematics achievement levels were at the same level as other nonrural districts in the state (Howley, Howley, & Hopkins, 2003). This article will disseminate the findings of a 2004 study with regards to mathematics achievement and school locale in the state of Tennessee (Hopkins, 2004).

Background Information

Rural Issues

The research addressing education in rural schools is mixed. Several researchers have found areas of deficit in rural education including lack of funding, lack of varied curriculum, lower scores on achievement tests, and higher drop out rates (Campbell & Silver, 1999; Barker, 1985). However, more recent studies indicate that achievement in rural areas is not quite as problematic as popular culture and former studies might lead one to believe (Edington &

Koehler, 1987; Howley & Gunn, 2000s; Lee & McIntire, 1999; Winters, 2003).

Winters' (2003) study of 8th and 12th grades students in Tennessee found the mean scores of rural schools were actually higher than scores in nonrural schools on three separate instruments (TCAP, ACT, Gateway Algebra Test), although the difference was significant with the TCAP only. These findings were similar to those of Lee and McIntire (1999) who found rural students scored at levels comparable to the national average in nearly all subjects tested. Howley and Gunn (2003) concluded, "On the basis of nearly 25 years of NAEP data, there is little evidence for the claim that rural mathematics achievement is deficient" (p. 89).

Other studies, however, include results that do not reflect as positively on rural education. Roscigno and Crowley (2001) concluded "students living in rural areas of the United States exhibit lower levels of educational achievement and a higher likelihood of dropping out of high school than do their nonrural counterparts" (p. 268). SAT data from 2003 appear to confirm this achievement gap. Table 1 shows the average SAT-M scores for the nation and the state of Tennessee for different locales (SAT, 2003). The possibility exists that a composite of Small Town and Rural mean scores might surpass the Large City mean, but the data was not disaggregated in that manner. Webster and Fisher (2000), analyzing the achievement of Australian students as measured by TIMSS (1994) found living in a rural area had a negative impact on student achievement. This is similar to the conclusions reached by Hobbs (1981) in his analysis on NAEP data from 1977. Hobbs found students categorized as extremely rural scored well below the national average in reading, writing, mathematics, and science.

Table 1.

National and Tennessee State SAT-M Averages for Different Locales

Locale	National	Tennessee
Large City	506	558
Medium City	516	560
Small Town	512	571
Suburban	539	575
Rural	501	546

However, Hobbs results are countered by Howley and Gunn (2003). The category Extreme Rural, removed from NAEP research since 1996, created a false picture of rural by including only a subset of rural which was comprised only of rural areas of extreme poverty, according to Howley and Gunn. The issue of economics is a confounding one when studying achievement issues in rural areas as the effects of SES on achievement are well noted.

Socioeconomic Status (SES)

A factor to consider in studying the mathematics achievement levels of rural students, as highlighted by the work of Howley and Gunn (2003) is the SES of the schools. In the state of Tennessee, over two million people live in rural areas with 14.7 percent of children in these areas living in poverty (The Rural School and Community Trust, 2003). According to the United States Department of Agriculture (2000, 2002), although poverty levels in rural areas were lower in America in the 1990s as compared with previous years, the levels were still higher than those found in urban areas. Several researchers have found a connection between low SES (as based on the percentage of students enrolled in the federal free and reduced lunch program) and lower achievement on state and national tests (Caldas & Bankston, 1997; Campbell & Silver, 1999).

Other researchers have corroborated the theory of the negative effects of low SES on educational matters (Alwin & Thornton, 1984; Guo, 1998; Lubienski, 2001; Mandeville & Kennedy, 1993; O'Brien, Martinez-Pons & Kopala, 1999; Tate, 1997). Tate (1997) studied achievement as measured by the SAT-M finding students with a family income of less than \$10,000 had an average score of 419, those with family income between \$30,000-\$40,000 averaged a full fifty points higher. Students with family incomes in the highest income bracket (\$70,000 and above) scored an average of 527, more than 100 points higher than those students in the lowest income bracket. Although scores have increased in all income brackets recently, as reported by SAT (2003), the discrepancy between the brackets continues, with more than 120 points separating the highest and lowest income brackets.

The research of Mandeville and Kennedy (1993) found similar negative effects of low SES on mathematics achievement. In their study of South Carolina schools, they found that as the percentage of low SES students in a South Carolina school increased, the average achievement of the school decreased. These results are not limited to public schools. A study of parochial students showed significant correlation between SES and PSAT scores, with students of lower SES scoring lower than their more affluent peers (O'Brien, Martinez-Pons, Kopala, 1999). Given the connection between SES and achievement, care must be taken when studying achievement in rural areas in that differences in achievement might be attributable to SES rather than locale.

Overview of Study

The purpose of the larger study was to examine what connection, if any, exists between mathematics achievement of students in Tennessee and gender, the locale of the school (Rural, Large Central City, Other Nonrural), or the location of the school (Appalachian or Non Appalachian) attended by the students. Additionally, the effects of SES on any existing achievement/locale/location and/or gender connections were to be investigated. This report focuses on any possible connections between locale and achievement discovered during the study. Therefore, the following questions were asked:

1. Are there significant differences in mathematics achievement of students as measured by the ACT with regards to locale?
2. Are there significant differences in mathematics achievement of middle school students as measured by the TCAP test by locale?
3. When accounting for SES, are there significant differences in mathematics achievement of students as measured by the ACT by locale?
4. When accounting for SES, are there significant differences in mathematics achievement as measured by the TCAP for middle school students by locale?

Data Collection

The data collected from this study reported scores for the 2002-2003 school year. Data collected included Tennessee Comprehensive Assessment Program (TCAP) mathematics scores for each school enrolling 6th, 7th, and/or 8th grade students in Tennessee, ACT scores of Tennessee high school students, school locale, and the socioeconomic status of the school.

The mathematics composite score of the TCAP, which combines the computation and problem solving scores, was used to measure mathematics achievement of middle school students for the study. School TCAP results are posted on the Tennessee State Department of Education website annually and are accessible to the public.

Analysis of high school mathematics achievement was completed using the mathematics subtest score of the ACT college placement test. The test score of every high school student taking the test during the 2002-2003 school year was provided by the Tennessee State Department of Education. Data were disaggregated by school and gender. Student names were not included. These scores were then tabulated and a mean score was computed for each school.

Information concerning school locale was collected using the National Center for Educational Statistics (NCES)

Public School Locator. The NCES uses 8 locale codes based on 1990 census data, which were then collapsed into three for this study. The codes used by NCES are Large Central City (Central area of a large Metropolitan Statistical Area (MSA) with a population at or exceeding 250,000); Mid-size Central City (central area of a mid-size MSA with population less than 250,000); Urban Fringe of a Large Central City (placed within a large MSA and defined as urban by the Census Bureau); Urban Fringe of a Mid-Size Central City (placed within a mid-size MSA and defined as rural by the census bureau); Large Town (town not within a MSA with a population at or exceeding 25,000); Small Town (town not within a MSA with a population between 2,500 and 25,000); Rural Outside MSA (a place with less than 2500 people, coded rural and outside an MSA by the Census Bureau) and; Rural Inside MSA (a place with less than 2500 people, coded rural and inside an MSA by the Census Bureau). For the purposes of this study, Rural schools defined as those coded Small Town, Rural Inside MSA, and Rural Outside MSA. Large Central Cities comprised the second category, Other Nonrural, grouped the remaining categories of Mid-size Central City, Urban Fringe of both Large Central and Mid-Size Cities, and Large Town. Table 2 illustrates the number of public schools in each category for the state of Tennessee.

Table 2.

Summary of the Number of Schools in each Locale Defined by NCES as well as the Locales Defined by this Study

Locale	High School	Grades 6, 7, and/or 8
Large Central City (LCC)	45	117
Other Nonrural		
Mid-Size City (MSC)	30	59
Urban Fringe (LCC)	24	44
Urban Fringe (MSC)	28	50
Large Town	3	5
Other Nonrural Total	85	158
Rural		
Small Town	53	87
Rural (Outside MSA)	61	202
Rural (Inside MSA)	27	83
Rural Total	141	372

A school's Socioeconomic Status (SES) was based on the percentage of students receiving federally subsidized free or reduced lunch. This information was accessed via the Tennessee State Department of Education. Schools that failed to report this information to the state were excluded from the study, but this amounted to less than ten percent of the middle schools and less than five percent of high schools. Schools were then categorized according to the percentage of disadvantaged students (receiving subsidized

free or reduced lunch) as Low to Moderate (less than 50 percent of students disadvantaged), High (50 to 74.99 percent disadvantaged), and Highest (75 percent or greater).

Data Analysis

The middle school TCAP Mathematics Composite score and the high school ACT score were used in the analysis of the data. A General Linear Model (GLM) Repeated

Measures test was run to determine if significant differences existed. The average score of the school was selected as the within-subject factor, while locale and location (Appalachian or Non Appalachian) were between-subject factors. The tests were rerun with SES as an additional between-subject factor. When a significant interaction between locale and SES was discovered by the GLM Repeated Measures Test, a Tukey HSD post hoc test was run to investigate the difference.

Results

Analysis of the data showed both expected and unexpected results. There was consistency in the results between the analysis of middle school data and high school data, whether SES was included or removed from the analysis. The results for each research question follow.

Are there significant differences in mathematics achievement of middle school students as measured by the TCAP test by locale?

The results of this study showed consistency in the mathematics achievement of students across the three

middle school grades as well as the high school ACT scores. Across the middle school grades the achievement ranking of schools by locale was consistent. Among all grades, schools categorized as Other Nonrural were the ranked highest in achievement, followed by schools categorized as Rural. Schools categorized as Large Central City scored the lowest on the mathematics composite of the TCAP. The effect of locale was significant at each grade level, with $p < 0.001$ for each level. Further analysis was conducted using a Tukey HSD test to discover between which specific locales the differences were significant.

Again, results were consistent across the three grade levels. In all cases, Other Nonrural scored higher than Rural, but the differences were not significant at any grade level. However, there was a significant difference between the aforementioned categories and the third category, Large Central City. In all three grade levels, Large Central City schools scored significantly below Rural and Other Nonrural. A summary of the results for eighth grade students is located in Table 3.

Table 3.

Tukey HSD Post Hoc Test of Eighth Grade Mathematics Achievement as measured by TCAP, by Locale

Locale	N	Subset	
		<u>1</u>	<u>2</u>
Large Central City	70	39.23	
Rural	324		59.02
Other Nonrural	129		61.05

Note. Means in different columns differ at $p < .05$ in the Tukey honestly significant difference comparison.

Are there significant differences in mathematics achievement of students as measured by the ACT with regards to locale?

Similar results were found when analyzing ACT data from Tennessee high schools, with one exception. While the pattern of Other Nonrural scoring the highest, followed by

Rural and then Large Central City continued, the differences between all three were statistically significant. The average mathematics achievement score, as measured by the ACT for Other Nonrural was 19.7326, for Rural, 19.0562, and for Large Central City, 16.7079. The summary of this analysis is located in Table 4.

Table 4.

Tukey HSD Post Hoc Test of High School Mathematics Achievement as measured by the Mathematics Subtest of the ACT, by Locale

Locale	N	Subset		
		<u>1</u>	<u>2</u>	<u>3</u>
Large Central City	42	16.7079		
Rural	137		19.0562	
Other Nonrural	84			19.7326

Note. Means in different columns differ at $p < .05$ in the Tukey honestly significant difference comparison.

When accounting for SES, are there significant differences in mathematics achievement as measured by the TCAP for middle school students by locale?

This second segment of the study included the additional between-subject factor of the percentage of disadvantaged students (pdisadv). The purpose of including pdisadv in the analysis is due to the strong connection between achievement and SES. The possibility existed that the significant differences calculated by the initial analysis might, in fact, be due not to locale, but rather to SES.

The second analysis showed that for all three middle school grades, locale was still significant at $p < 0.001$. However, a significant interaction was found between locale (locale4) and the percentage of disadvantaged students (pdisadv). In the sixth grade locale4*pdisadv, $p = 0.045$, for seventh grade, $p < 0.001$, and for the eighth grade, locale4*pdisadv, $p < 0.001$. For all three grades, the pattern of interaction between locale and percent disadvantaged was consistent.

As shown in Figure 1, across all three locales, schools with Low to Moderate pdisadv (less than 50 percent) scored the highest, with Other Nonrural schools outscoring both Rural and Large Central City. For schools with High pdisadv (50-74.99 percent), scores were lower, but Rural schools outscored Other Nonrural and Large Central City schools. Although the data points are disjointed, connectors were included to highlight the interaction. This pattern continued for schools with Highest pdisadv (75 percent or more), with the difference between Rural and Other Nonrural even greater.

The other result of note is the greater range of scores by pdisadv in the Large Central City and Other Nonrural schools. The difference across pdisadv categories in the Rural category (at each grade level) is between 5 and 10 points, while differences in Large Central City the range is between 20 to 30 points and Other Nonrural between 20 and 35 points.

When accounting for SES, are there significant differences in mathematics achievement of students as measured by the ACT by locale?

Again, the general pattern established in the mathematics achievement levels of the middle grades was repeated in the analysis of the high school data. The interaction between pdisadv and locale4 was significant at $p < 0.001$. As seen in Figure 2, the range of scores by pdisadv was larger for schools in Large Central City or Other Nonrural (approximately 5.5 and 3.5, respectively) than in Rural schools (approximately 1.2). Although the general pattern remained the same, there were differences between the mathematics achievement of middle school and high school students.

At the middle school level, in the Low to Moderate pdisadv category, Other Nonrural schools scored the highest. However, at the high school level, Large Central Cities scored higher than Rural and other Nonrural. At the middle school, in the High pdisadv category, Rural schools scored the highest, narrowly outscoring Other Nonrural. At the high school level Other Nonrural schools scored the highest, narrowly outscoring Rural schools (see Figure 2).

Figure 1

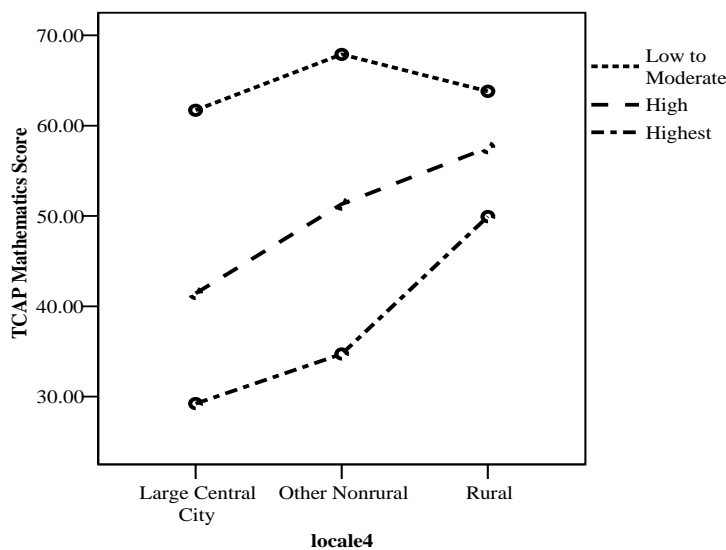


Figure 1. Comparison of eighth grade mathematics achievement, as measured by the TCAP mathematics composite score (maximum score 100), by locale and the percentage of disadvantaged students.

Figure 2

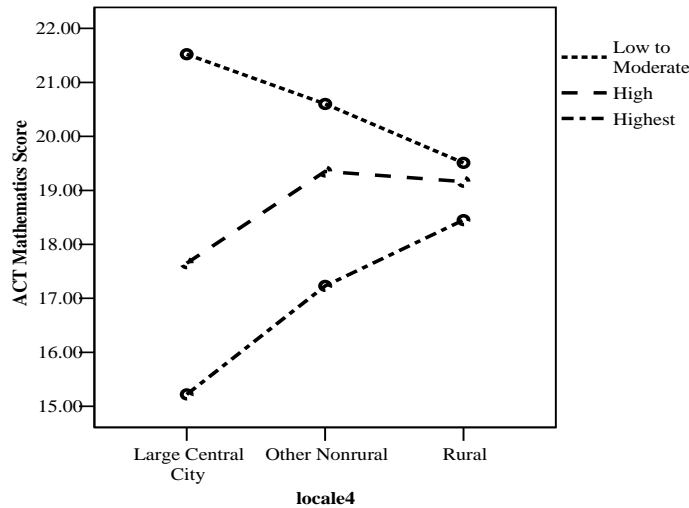


Figure 2. Comparison of high school mathematics achievement, as measured by the mathematics subtest of the ACT (maximum score 36), by locale and the percentage of disadvantaged students.

Discussion

The results of the analysis of middle school data contradicts Hobbs (1981), whose analysis of NAEP data found rural students scoring lower than their nonrural counterparts. Finding no significant differences in mathematics achievement between Rural and Other Nonrural is analogous to the research of Edington and Koehler (1987), Howley and Gunn (2003), and Winters (2003). However, the reverse is true of the analysis of high school ACT scores, where Other Nonrural students significantly outscored students in the Rural category.

Perhaps the most interesting information resulting from this research is the interaction between locale and the percentage of disadvantaged students. There is a much greater spread in scores among the differing economic categories in the Large Central City and Other Nonrural locales than in the Rural locale category. Additionally, in schools with the Highest percentage of disadvantaged students, Rural locales outscore both Large Central City and Other Nonrural locales, across all grade levels tested.

With this pattern prevalent over both middle and high schools, it is apparent that there are characteristics of rural schools that improve achievement among the most disadvantaged schools versus other locales. Exactly what these characteristics are as well as how they are affecting rural achievement are not clear. The most puzzling aspect of these characteristics might not be merely defining them, but rather why the characteristic allows Rural schools in the Highest category of percent of disadvantaged students to score higher than their counterparts while the same cannot be said of Rural schools with Low to Moderate percentages of disadvantaged students.

One possible reason Rural schools outscore Large Central City and Other Nonrural schools with Highest percent of disadvantaged students (pdisadv) is the social capital of smaller communities. Social capital is defined by Coleman (1987) as the social networks, the interactions between children and adults within the family and within the community. In his analysis of the differences in higher achieving religious schools (as opposed to public or non-religious private schools), Coleman suggested that as “religious organizations are among the few remaining organizations in society, beyond the family, that cross generations...they are among the few in which the social capital of an adult community is available to children and youth” (p. 37). In rural communities, where a child is often described in terms of lineage (i.e. That is Frank and Helen Jones’ son, Helen is a Smith, etc), there exists the cross-generational community similar to that which Coleman describes in his study. While this explains the difference in scores for the Highest pdisadv, Coleman’s theory does not describe why the difference is not reflected in those schools with Low to Moderate pdisadv, nor the change in the High pdisadv (where Rural middle school students have an advantage, but Rural high school students do not). To explain these discrepancies, Pierre Bourdieu’s theory of cultural capital must be included.

Bourdieu (1977) stated that “academic success is directly dependent on cultural capital” (p. 504). Cultural capital in the form of regular theater, concert, or cinema attendance; reading and purchasing books; museum attendance, etc. provides an “apprenticeship” for students that allows for more success in school. This theory can explain the discrepancy of Rural schools outscoring other schools of Highest pdisadv but scoring lower if the schools

have Low to Moderate pdisadv. In schools where poverty is not as great a concern, the opportunities, i.e. cultural capital, families can provide will be more easily accessible and plentiful in cities and suburbs than in more rural areas. This cultural capital gives an advantage to students living in these areas. This difference is not seen in schools with Highest pdisadv as financial constraints would limit attendance to these opportunities, no matter how numerous.

The effects of cultural capital can also explain why, in middle schools with High pdisadv, Rural schools outscore Other Nonrural schools, but in high schools the opposite occurs. The cumulative effect of the opportunities available to students in cities and suburbs enables students in high school to better access the school culture. Bourdieu (1976) proposes the level of education is nothing more than “the accumulation of the effects of training acquired within the family and the academic apprenticeships which themselves presupposed this previous training” (p. 493). That is, schools are organized to educate in a manner advantageous to those students possessing cultural capital. That the advantages of cultural capital are cumulative is not surprising.

Implications for Policy and Practice

The consistent pattern of interaction between locale and SES in regards to mathematics achievement is significant. The possibility exists that the positive effects of the social capital found in rural, communities can overcome the lack of cultural capital in areas where economic conditions are poor. The question for policy and practice then becomes, what exactly are the components of social capital in rural schools that are aiding in achievement and how can these components be integrated into economically disadvantaged schools in urban and suburban settings? Is it possible to create “mini” towns or clans in these more largely populated areas that could act similarly to the populations in small towns? Could the answer be agencies outside the school, churches, boys and girls clubs, that could create social capital that, while different from that found in rural areas, would create the same positive achievement in mathematics?

On the other hand, where the economic situation is not so dire, the positive effects of social capital seem unable to overcome the shortage of the advantages of cultural capital. The concern for policy makers in these not-as-poor rural schools with little available in the way of cultural capital, as well as poor urban and suburban schools unable to take advantage of available cultural capital, is how to bring this capital into the schools. Certainly, technology can provide a measure of cultural capital. For example, students could visit the websites of museums to see works of art and read about the artists. With software similar to those businesses use for cross-country or international meetings, students could interact with students from other areas of the country

and exchange information about how their lives compare and contrast.

Further studies must be conducted to see if the achievement patterns found in this study hold true for content areas other than mathematics, as well as other locations. If they do, the challenge for policy makers to implement changes in their school will depend upon their locale and economic condition. Those in rural areas, with little or no access to cultural capital will need to continue to build on the strength of their social capital while searching for ways to introduce cultural capital to their community. Policy makers in poor suburban and urban schools also need ways to introduce cultural capital to their students, who, due to their economic situation, cannot access the capital on their own. In addition, these schools must look to the rural schools for ideas to create a social capital network within their setting.

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