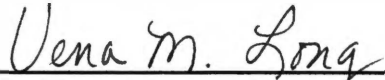
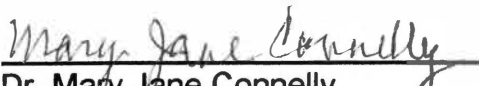


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I am submitting herewith a dissertation written by Joseph Jeremy Winters entitled "An Examination of Eighth and Twelfth Grade Students' Mathematics Achievement in Relation to School Locale, County Location, Looping Status, SES, Grade and Class Size, and Access to Upper-Level Mathematics Courses in Tennessee." I have examined the final paper copy of this dissertation for form and content and recommend that it be accepted for partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

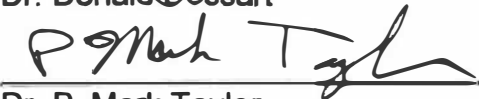

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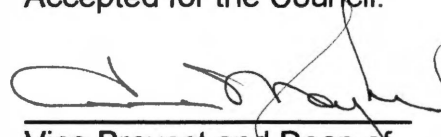

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**An Examination of Eighth and Twelfth Grade Students'
Mathematics Achievement in Relation to
School Locale, County Location,
Looping Status, SES, Grade and Class Size,
and Access to Upper-Level Mathematics Courses
in Tennessee**

**A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville**

Joseph Jeremy Winters

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ABSTRACT

The purpose of this study was two-fold. First, this study was conducted to examine the status of mathematics achievement in rural schools in Tennessee. The second purpose of this study was to understand the presence and effects of the educational practice of looping in terms of secondary level mathematics. In order to thoroughly investigate these topics, other potentially confounding variables were examined for their effects on students' mathematics achievement.

Five instruments were used to examine the mathematics achievement of eighth and twelfth grade students from Tennessee during the 2001-2002 school year. The Algebra 1 Gateway Test and the Mathematics Section of the TCAP Achievement Test were used for eighth grade students. The ACT Mathematics Test and two surveys developed by the researcher were used for the twelfth grade students. One survey was sent to the Mathematics Department Chairperson at a school, and the other survey was sent to students enrolled in mathematics courses above Geometry and Algebra 2 in three rural Appalachian counties.

This study was divided into four parts. Part One investigated the two instruments for eighth grade students mathematics achievement. Part Two investigated the ACT Mathematics Test for twelfth grade students. Part Three examined the Mathematics Department Chairperson survey. Part Four examined the student surveys. School means were used to examine the mathematics achievement of eighth and twelfth grade students. Descriptive and inferential statistics were used.

The findings indicated significant differences between rural and nonrural students on the Mathematics Section of the TCAP Achievement Test with rural schools outperforming nonrural schools ($p = .001$). Moreover, significant differences were found between Appalachian and non-Appalachian counties on this test with Appalachian schools outperforming non-Appalachian schools ($p < .001$). The locale-county interaction on the ACT Mathematics Test was significantly different. Rural Appalachian schools, rural non-Appalachian schools, and nonrural Appalachian schools had higher ACT Mathematics Test school means than nonrural non-Appalachian schools ($p = .023$, $p = .007$, and $p = .002$, respectively).

Although intentional looping does not occur in Tennessee high schools, unintentional looping was present. Looping was found in both rural and nonrural schools and Appalachian and non-Appalachian counties in Tennessee. The greatest percentage of looping that was reported occurred in rural Appalachia (62%). Looping and ACT Mathematics Test school means were not significantly related in this study ($p = .072$).

Other potentially confounding variables that were examined included Socio-Economic Status, twelfth and eighth grade class size, number of mathematics courses offered at a school, faculty size, and average mathematics class. A negative relationship with ACT Mathematics Test school means was found with Socio-Economic Status ($r = -.625$, $p < .001$) while positive relationships were found between ACT Mathematics Test school means and the other variables.

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Chapter I

INTRODUCTION

With recent national policies like “No Child Left Behind,” the need to understand achievement within the context of all schools is vital. This is true for even the often neglected context of rural education. The National Council for Teachers of Mathematics (NCTM) in *Principles and Standards* (2000) set forth six principles for school mathematics. One of these principles is the equity principle. This principle states, “Excellence in mathematics education requires equity—high expectations and strong support for all students.” High expectations and support are demanded for urban, suburban, and rural areas. Of these settings, rural students’ mathematics achievement appears to receive the least attention.

Research in the intersection of mathematics and rural education has been sparse. One researcher in describing the intersection jokingly asked if the intersection (as described with a Venn diagram) was a positive or negative area (National Advisory Board for the Appalachian Collaborative Center for Learning Assessment and Instruction in Mathematics, 2002). Although the comment was made in jest, the intersection in the research between the two is quite small. (Howley, 2002a; Silver, 2003) Therefore, information regarding achievement of rural students versus their counterparts has been largely assumed, not documented. (Chen & Fan, 1999) Many (Edington & Koehler, 1987; Howley, 2002b; Herzog & Pitman, 1995) indicate that rural education has been seen as a

"deficit model" where poor performance is expected. Hence, perceptions of rural students are that they achieve at a lower level than their peers. Several recent studies have indicated that this may not necessarily be the case (Lee & McIntire, 2001; Chen & Fan, 1999). This minimal attention has spurred recent efforts like the Appalachian Collaborative Center for Learning Assessment and Instruction in Mathematics (ACCLAIM) to emphasize and concentrate on mathematics within the rural context. Another National Science Foundation (NSF) center, the Center for Learning and Teaching (CLT) West, is also examining achievement within the rural context.

One problem facing researchers in this area is "What does rural mean?" Howley (2002a), in *A Mathematics Education Researcher's Brief Guide to Understanding Rural Education Research*, indicates the dilemma of defining what rural is has hindered researchers in the past. This problem was also indicated in other studies addressing rural achievement. (Stern, 1994; Bosak & Perlman, 1982; Chen & Fan, 1999) Various ways of defining rural include defining the context based on strict quantitative definitions of population density and location, based on economic activity of the setting, and based on more informal indicators like the culture of the people in the setting.

Howley indicates that from an ethnographic researcher's perspective, the best way to define rural is to ask the individuals if they think they are rural. "If you think you are rural then you probably are rural." (2002a; Howley, 2002c) DeYoung (1994b) spoke about the classification of nonmetro by the Department of Agriculture. The Department of Agriculture uses eight economic activities to

classify nonmetro (rural) counties. These activities include farming, mining, manufacturing, retirement, government services, federal lands, persistent poverty, and “unclassified.” Bosak and Perlman (1982) examined 178 sources from 1971-1980 to understand how each study defined rural. In Bosak’s findings, the definitions of rural were classified into four broad categories. These were “not stated, verbal, homemade quantitative, and external quantitative.” Finally, the National Center for Educational Statistics (NCES) indicated that at least three major classification codes exist. (2002) The three classification codes presented by NCES are Locale Codes, Beale Codes, and Metropolitan Statistical Area (MSA) Codes.

Another problem facing researchers in the intersection of mathematics and rural education is not only are the definitions diverse, but rural people are also diverse. When addressing issues with rural locales, one may look at isolation in rural Montana or poverty in rural Mississippi. In addition, rural Maine is quite different from rural Tennessee as a rural mining center is quite different from a rural farming center. When conducting research within a rural context, the diversity of rural areas must be addressed.

The United States has offered all children in this nation the opportunity of an education. This is true despite locale. Stern (1994) states, “All Americans have a stake in the status of education in rural America.” This statement is reinforced by Lee (2001) who indicates that rural America is a “barometer” for the rest of the country. In 2000, the state of Tennessee had 187,632 students enrolled in elementary and secondary schools designated as rural (NCES, 2002).

This accounts for twenty-one percent of the students in the state. In 2003, the percent of students attending rural school rose to twenty-five percent. (Beeson & Strange, 2003) Although the largest percentages of Americans (or Tennesseans) do not live in locales deemed as rural, this should not devalue rural education. Dewees (1999) stated that nearly half of the nation's 80,000 public elementary and secondary schools were in rural areas or small towns. Although students in rural locales appear less visible than their suburban and urban counterparts, the number of rural schools indicates that the rural context should not be neglected.

Despite stereotypes, rural education is not marked by low-achievement. Although many problems of the urban and rural locales are similar, the two have different needs when it comes to reform efforts. For example, recent reform efforts in urban schools include reducing class and school size. This is not a problem facing most rural schools. (Campbell & Silver, 1999) Access to upper level mathematics courses is a problem that rural students face that their counterparts do not. Moreover, educational resources are sparser in rural settings than in suburban or urban settings. (Lee & McIntire, 2001) For this reason, studying mathematics in the context of rural schools is important.

Another aspect of this study will be the examination of the mathematical achievement of students who are looped. Looping is the educational practice of a teacher progressing with their students to the next grade or subsequent course. Looping has roots in two places. In Germany, looping is linked with Rudolf Steiner who started the Waldorf Schools in Germany in the early 1900's. The

school was started in order to educate the children of the workers of the Waldorf Astoria cigarette factory. These schools had students placed with the same teacher for eight years (Grant, Johnson, & Richardson, 1996). In the United States, looping evokes images of the one-room schoolhouse (Bellis, 1999) and therefore the rural context. Looping has recently been resurging as an implemented educational practice. Although many elementary schools are beginning to purposefully implement the practice of looping, the number of middle and secondary schools who intentionally implement the practice is small. Nevertheless, de facto looping does exist. Many rural schools have few mathematics teachers. In the Appalachian area of Tennessee, some schools employ only one mathematics teacher for grades nine through twelve. Although these schools would not indicate they practice looping intentionally, the students of these schools are being looped. In addition, many schools assign a teacher to the accelerated classes in essence creating a loop. In this practice of looping, the school may have a teacher teaching the upper level or honors mathematics classes while the remaining teachers divide the other mathematics courses.

This study intended to examine the status of rural education and looping in the state of Tennessee. Both terms have recently received more national attention. Although the two terms seemingly have nothing in common, occasionally small rural schools loop students unintentionally. Understanding these terms and the mathematics achievement of students in relation with these terms can help reach the NCTM's goal of "Mathematics for All." (2000)

Purpose of the Study

The purpose of this study was to determine if relationships existed between mathematics achievement, school locale, and looping in the state of Tennessee. This study utilized data from the ACT Mathematics Test for twelfth grade students, two tests of the Tennessee Comprehensive Assessment Program (TCAP) for eighth grade students, and two surveys to investigate the practice of looping. The two tests for eighth grade students were the Algebra 1 Gateway Test and the Mathematics section of the Achievement Test. Other potentially confounding variables were examined to investigate possible relationships including grade and class size, Socio-Economic Status (SES), number of upper level mathematics courses, and number of mathematics teachers.

Research Questions

1. What relationship existed between eighth grade students' achievement on the Algebra 1 Gateway Examination in terms of school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?
2. Can Algebra I Gateway Test results be predicted by school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?
3. What relationship existed between eighth grade students' achievement on the Mathematics section of the TCAP Achievement Test in terms of school

locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?

4. Can the Mathematics section of the TCAP Achievement Test results be predicted by school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?
5. What relationship existed between twelfth grade students' achievement on the ACT Mathematics section in terms of school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and twelfth grade class size?
6. Can ACT Mathematics achievement be predicted by school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and twelfth grade class size?
7. Did looping occur in Tennessee public high schools and if so, where and with what type of students?
8. If looping was present, did a relationship exist in students' mathematics achievement when a student has the same mathematics teacher for two or more consecutive years in a mathematics course progression versus a student who has a different mathematics teacher for courses in the mathematics course progression?
9. What relationship existed in school means on the ACT Mathematics Test when compared with locale, county location, SES, twelfth grade class size, average mathematics class size, faculty size, and access to higher-level mathematics courses?

10. Is looping occurring in rural counties in Tennessee as reported by students?
11. If looping occurred, did it have an effect on student achievement?

Significance

This study presented information for educators, policy makers, and significant others on the status of mathematics achievement in rural locales in Tennessee. Adding to the knowledge base in the intersection of mathematics and rural education was an important element of this study's significance. Other significant factors that came from this study included research into the practice of looping, indications about grade and class sizes, and poverty level effects on achievement in various school locales.

Assumptions

In this study, the following assumptions were made. To begin, the Algebra 1 Gateway Examination has been field tested and implemented. This examination reflects information that the students have acquired in Algebra 1 and prerequisite courses. In addition, the Mathematics Test of the Achievement Test for TCAP and the ACT Mathematics subtest measures a student's ability in mathematics through the appropriate grade or course at which the test was taken. (see Appendices C and D for reliability measures and validity arguments)

This study assumed that students were looped with both good and poor teachers. The self-selected sample represented average teacher effects for all variables examined.

The self-selected sample of public schools which reported ACT Mathematics Test school means, Algebra 1 Gateway Test school means, and school means for the Mathematics Section of the TCAP Achievement Test was assumed to be a representative sample for schools in the southeast Appalachian states. Ninety-eight percent of public schools that contained twelfth grade students reported ACT Mathematics Test school means. Ninety-five percent of public schools that contained eighth grade students reported schools means for the Mathematics Section of the TCAP Achievement Test.

Surveys were distributed to all Tennessee mathematics department chairpersons and students from three rural counties in Appalachian Tennessee in upper level mathematics courses (above Geometry and Algebra 2). This study assumed that the self-selected sample was a representative sample for southeast Appalachian states and rural Appalachian Tennessee. The return rate for the Mathematics Department Chairperson Surveys was sixty percent. The number of students who returned the surveys versus those that did not return the surveys were not reported by the Mathematics Department Chairperson who collected the surveys. Moreover, the study assumed the self-reported information was accurate.

The data obtained from the Mathematics Department Chairperson Survey was collected during the 2002-2003 school year. This data was assumed

consistent with previous years so that this information could be applied to the ACT Mathematics Test school means from the 2002 School Report Card.

Summary

Mathematics achievement with the rural context has often been assumed but not documented. For this reason, this study examined the relationships between mathematics achievement and school locale (rural versus nonrural). To help further understand the mathematics achievement of students in Tennessee, the mathematics achievement was investigated for students living within the Appalachian region and those outside the Appalachian region. Two grade levels were chosen to examine. The eighth and twelfth grades were examined to help understand mathematics within the rural context.

The educational practice of looping was also investigated. Looping has connections with small rural schools where the number of faculty is small. Surveys were used to investigate this practice and its presence in the state of Tennessee. The self-selected sample provided information into the presence of this practice along with other potentially influencing factors on a student's mathematics achievement. These factors included the number of mathematics courses offered, the average mathematics class size, and the number of mathematics teachers.

These investigations were used to help provide research into two areas, rural education and looping, where documented empirical data is limited.

Chapter II provides a review of the literature on the terms rural and looping and

their connections with mathematics. Moreover, a review of the research concerning SES, school and class size, and access to upper level mathematics courses is presented. Chapter III presents the methodology used in the study. Chapter IV presents the data and statistics gathered for this study. Finally, Chapter V presents implications and a discussion of the findings.

Definitions

ACT	American College Test. The ACT Assessment® is designed to assess high school students' general educational development and their ability to complete college-level work. The test is comprised of four sections: English, mathematics, reading, and science reasoning. (www.act.org , 2002)
Appalachian	The Appalachian Regional Commission (ARC) lists the counties in the state of Tennessee that lie in Appalachia. Appalachian location in this study were those counties indicated from the ARC website. (www.arc.gov , 2003)
Average Mathematics Class Size	The arithmetic mean of students in a particular mathematics classroom.
County Location	The location of the school as either an Appalachian county or non-Appalachian county.
Grade Class Size	The total number of eighth or twelfth grade students in a particular school.

Looping	The progression of the teacher with the students to the next course. Also termed teacher-student progressions or multi-year teaching.
Non-Appalachian	Counties that were not indicated as being located in the Appalachian region by ARC. (see definition of Appalachian)
Nonrural	Nonrural was defined by the five remaining locale codes. They are large towns, large cities, mid-size cities, urban fringe of large city, and urban fringe of mid-size city. (see definition for rural)
Rural	“Educational researchers often use the locale types initially developed by Frank Johnson of the National Center for Education Statistics (Johnson, 1988). The codes were developed specifically to provide a locale descriptor for each of the nearly 85,000 schools in the United States. There are now eight locale codes, but three of the eight are relevant to rural: small-town schools, rural schools outside metropolitan areas, and rural schools within metropolitan areas.” (Howley, 2002)
School	An organization as listed in the Tennessee public school directory obtained at http://www.k-12.state.tn.us/SDE/default.asp .
School Locale	Locale code of the school as determined by geographic location, population, and population density. Eight locale

codes exist derived from the Census Data and available on the Common Core of Data website. Further explanation is presented in Chapter III.

School Means A school's arithmetic mean.

SES Socio-Economic Status. Low SES as a variable will be identified by the percent of students receiving free or reduced lunch. This is a standard measure in determining SES for a school.

TCAP This is the state mandated student assessment program. The TCAP currently includes the elementary achievement test (Achievement Test), the Writing Test, the Competency Test, and the Gateway Tests.
(<http://www.state.tn.us/education/tsintro.htm>, 2002)

Chapter II

REVIEW OF THE LITERATURE

Introduction

This study aims to deeply understand from the context of mathematics education two broad terms drawing recent attention. These two terms are rural and looping. Although these terms seemingly have nothing in common, one premise of this study is that rural schools occasionally practice looping as an unintentional consequence of size. In addition, some of the literature on small rural schools indicates teacher student relationships as a potential benefit that is also present in the looping literature. (DeYoung, 2002; Burke, 1997) This review of the current literature seeks to provide definitions for these two terms, describe topics related to the terms, and present research in the area of these terms in general and with regard to mathematics. In addition, literature regarding other confounding variables in this study will be reviewed.

The Rural and Mathematics Intersection

“A system of schooling responsive to rural issues can potentially help students and teachers realize the variety of meaningful mathematics latent in the lifeworld of rural places.” (ACCLAIM, 2003) One goal of the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM) is to understand mathematics within rural settings. Previously, the

desire to understand mathematics within the rural context has been unapproached by researchers. (Howley, 2001) This section of the literature review focuses on issues of rural areas and rural mathematics.

Appalachia

According to the Appalachian Regional Commission (ARC), the Appalachian region is 200,000 square-miles of land that runs from southern New York along the Appalachian Mountains to Northern Mississippi. (2003) The region includes 410 counties in thirteen states. Of the 23 million people that live in the Appalachian region, 42 percent are in rural locations. The Appalachian region is not only characterized by rurality, but also poverty. (Beeson & Strange, 2003) Natural extraction of the resources, like farming and mining, was the primary source of employment. Current economic activity is becoming more service oriented with a developing economy in tourism. Although manufacturing in select industries and coal mining are still prevalent, these industries do not provide the amount of employment as in the past.

What Does Rural Mean?

One major problem facing researchers investigating the rural context is, "How to define rural?" (Howley, 2002a; Howley, 2002c) The *Condition of Education in Rural Schools* (Stern, 1994), states, 'few issues bedevil analysts and planners concerned with rural education more than the question of what actually constitutes rural.' Bosak and Perlman (1982) in examining 178 sources

in rural sociology from 1971 to 1980 found approximately 250 definitions of rural. These definitions were classified into four broad categories. These were “not stated, verbal, homemade quantitative, and external quantitative.” (1982) Not stated definitions were ones that the author did not specifically indicate which definition of rural was being used. Verbal definitions relied on qualitative rather than quantitative criteria. Homemade quantitative and external quantitative both used quantitative criteria. The difference between the two was in the source of the definition. Homemade definitions did not use an external source while external definitions were derived from external sources. Khatri, Riley, and Kane (1997) state that the four most commonly used definitions of rural are from the United States Bureau of the Census, the Office of Management and Budget (OMB), the United States Department of Agriculture’s Economic Research Service (ERS), and the National Center for Education Statistics (NCES). These definitions would be classified as external quantitative.

Another way in which rural has been defined is by the economic activity of the place. The Economic Research Service of the United States Department of Agriculture uses eight economic activities to classify nonmetropolitan counties. (DeYoung, 1994a; Howley, 2002c; Cook & Mizer, 1994; Economic Research Service (ERS), 2002) These activities include farming, mining, manufacturing, retirement, government services, federal lands, persistent poverty, and “unclassified.”

Defining rural as “if you think you are rural, you are” is the definition that Howley states is the most important for researchers conducting ethnographic or

case studies. (2002a; 2002c) This definition takes into account the diversity of the meaning of being rural. Howley states, "This conveys the properly internalized sense of reality that qualitative researchers prize (educational ethnographers in particular)." Although Howley indicates this may be the ideal definition for rural, this definition is one way that leads to the obscurity of the term as found in Bosak and Perlman's investigation.

Other ways to define rural include code classification systems used by the United States Department of the Census and other federal agencies. The National Center for Education Statistics (NCES) website lists the following classification systems. (2003) They are the Beale Codes, Metropolitan Statistical Codes, and the Locale Codes. Although the Beale Codes are noted as the most widely used, the locale codes are the most useful for conducting research with the school as the unit of analysis. (Howley, 2002c) Frank Johnson developed the locale codes in 1989 for the United States Census Bureau. These codes are based on population, population density, and geographic location. (NCES, 2003; Goldsmith, Puskin, & Stiles, 1993; Johnson, 1989) Johnson states, "These codes are intended to describe the size and metropolitan status of the place in which the school is located." (1989) Howley notes that rural in the locale codes are what are left over after other locales have been defined. (2002c) Johnson acknowledges this in defining the codes. He states,

The Bureau of the Census defines urbanized areas as consisting of a central city and surrounding densely settled territory with a combined population of 50,000 or more inhabitants. Places designated as urban by census are within

these urbanized areas or in places of 2,500 or more inhabitants outside these areas. All other areas are classified as rural.

The codes developed by Johnson are large city, mid-size city, urban fringe of large city, urban fringe of mid-size city, large town, small town, and rural. Since the development of these codes, the last classification of rural has been split into two codes. They are rural inside a metropolitan area and rural outside a metropolitan area. (Howley, 2002c; NCES, 2003)

The locale codes serve as the best classification system for research in which the school is the unit of analysis. (Howley, 2002a; Howley, 2002c; NCES, 2003) These codes provide a more accurate look at the culture of the school. These codes allow schools within the same district to be classified in different ways. Howley indicates his primary work in rural research uses the locale codes to define rural places.

Rural and Nonrural Settings

Prior to the Industrial Revolution, all schools were rural. (DeYoung, 1994b) This changed because rural schools were deemed inadequate to serve the children in the growing city populations. (Kannapel & DeYoung, 1999) Today, many people do not distinguish between the needs of rural versus nonrural students. (Howley, 1997; Arnold, 2002) Many assume that mathematics is the same despite the context. They also assume that all schools perform inadequately and address each equally with this mindset. Distinguishing between rural and nonrural schools is very important. Kannapel and DeYoung

(1999) indicate that rural and urban students in general are different. Not only is rural different from nonrural, but rural places and people can also differ from other rural places and people. (Lee & McIntire, 2000) These differences may be economic differences, degrees of isolation, or cultural differences.

In the past, famous philosophers like Thoreau and Emerson have distinguished between rural and urban in the following way. They indicated that “the urban world was a place of purposeless noise, commotion, and filth... while in the countryside, they thought, could life take on a truly human meaning--a life in which the best qualities of humankind could flourish.” (Theobald, 1992) This idyllic view of the rural life has since been replaced by negative images, attitudes, and stereotypes. (Herzog, 1996) The following are some similarities and differences between rural and nonrural schools and communities.

Similarities and Differences Between Rural and Urban Areas

Rural and urban schools are often treated with as deficit models. The *ACCLAIM Theoretical Framework* states, “Educators and researchers see rural and urban settings as a deficiency from which the students and communities need to be saved.” (2003) Despite the notion of a deficit model, the differences between the two outnumber the similarities. The primary similarities between the two settings are among the impoverished students. In both rural and urban settings, impoverished students suffer from low student performance. (Campbell & Silver, 1999) Moreover, depressed financial conditions hinder both settings. Beeson and Strange (2003) reinforced this point by indicating “poverty rates in

rural areas are as high as urban centers.” Although many researchers indicate these similarities between impoverished rural and nonrural students, Khatri, Riley, and Kane (1997) indicate that a small research base exists between the elementary differences between the poor rural and poor nonrural students.

The literature on the differences between the two settings is more prolific than the similarities. As stated earlier, rural and nonrural schools are just generally different. (Kannapel & DeYoung, 1999) Rural communities and schools are diverse in terms of economic, social, and demographic aspects from other rural schools much less their urban and suburban counterparts. The following are some findings from the literature of the rural and nonrural differences.

Student achievement, educational attainment, and educational resources are areas that reveal many rural and nonrural differences. To begin, the rural areas have a lower high school completion rate and higher dropout rate than their nonrural counterparts. (Campbell & Silver, 1999) Moreover, the highest level of educational attainment in formal education is lower for the rural areas. (Kannapel & DeYoung, 1999; Khatri, Riley, & Kane, 1997) Rural areas also have less access to educational resources. (Herzog & Pittman, 1995; Lee & McIntire, 1999) One reason for the reduced educational resources or educational opportunities is financial. Cost of providing these resources and opportunities in rural schools are higher per pupil than in urban areas. (Campbell & Silver, 1999) In addition, the small size of rural schools prohibits upper level mathematics course offerings. (Children's Defense Fund, 1992) Another factor differentiating

rural and nonrural areas is geographic isolation of some rural settings.

(DeYoung, 1994a) This isolation can diminish support and resources that help enhance student performance. Although some resources like computers and technology are more prevalent in nonrural settings, computer usage was found to be similar in both settings. (Greenberg, 1995; Ballou & Podgursky, 1995; Howley & Howley, 1995)

In terms of teachers, Mayeske, et al. (1966) indicated that nonrural teachers were better trained and better paid. This was also indicated in *Why Rural Matters* (2003). In 1996, Lippman et al. found that teacher salaries were significantly different depending on location, rural versus nonrural. Recently, three state Supreme Courts have found funding to rural schools to be unconstitutional with Tennessee being one of the three states. (Beeson & Strange, 2003) Contrary to the disadvantages of pay, urban principals reported a harder time hiring and keeping teachers in urban schools, and absenteeism was significantly greater in urban schools as compared to rural schools. (Lippman, et al., 1996)

In describing the commitments of rural and nonrural places, Howley (1997) lists the following as differences between the two.

Nonrural Commitments

- increase the level of students' aspirations,
- overcome resistance to consolidation and school closure,
- overcome the disadvantages of students' backgrounds,
- implement state and national reforms,
- offer a broad and deep high school curriculum,
- insulate the school from local politics,

- implement "best practice" (i.e., nationally validated methods and programs), and
- change the local culture.

Rural Commitments

- senses of and attachment to rural places,
- the relationship between school and community sustainability,
- proper aims for an education committed to rural community,
- rural pathways to rural adulthoods,
- community engagement in rural schools,
- rural community and educational stewardship,
- curricula to sustain rural places,
- small-scale organization in rural schooling and community, and
- cultivation of appropriate local meanings, knowledge, and commitments.

The last commitments (change the local culture versus cultivation of appropriate local meanings) from the nonrural and rural lists are a very important difference between the two groups. This "sense of place" is a component of rural education. (DeYoung, 1994a) This sense of place is connected with a strong presence of a tight, connected community. This is one area that is commonly identified as an advantage of rural schooling. (Khatri, Riley, & Kane, 1997) This connection causes a greater amount of parental involvement in their child's education and lives than in urban settings. This connection is not only with the people of the community but also with the land and nature. Theobald (1992) and Berry (1986) mention nature as a key difference for rural and nonrural settings. Rural students need to understand the importance of conservation and preservation of resources while nonrural students are involved with notions of

mass consumption. Therefore, Theobald and Berry indicate that the educational needs of these two groups should be different.

Significant Studies in Rural Mathematics Education

The research on rural mathematics is limited. (Schultz, 2002) The Editor of the *Journal for Research in Mathematics Education* labeled the lack of research in the intersection of mathematics and rural education as an "Attention Deficit Disorder." (2003) Research on completion rates and college attendance rates are more consistent than research on student achievement. In both cases, the nonrural students have a higher high school completion rate and a higher percentage of students that attend college. (Chen & Fan, 1999)

The studies that have been conducted on rural and nonrural achievement in mathematics indicate mixed results. Chen and Fan (1999) found that rural students performed as well or better than their nonrural counterparts. In their findings, they indicated that rural students did not seem to be disadvantaged by where they lived or went to school. Alspaugh also found no difference between rural and nonrural students' mathematics achievement. (1992) Haller, Monk, and Lien (1993) found that although rural students did not have access to the number of mathematics courses as their nonrural counterparts, they were still doing as well on higher order thinking skills. Although Lubienski (2002) indicated gaps among U.S. students compared with other nations on National Assessment of Educational Progress (NAEP) mathematics results were decreasing from 1990-2000, this reduced gap was not true of low socio-economic status (SES)

students. Contrary to some research, Silver and Castro (2002) indicate that although achievement gaps seem to be narrowing between rural and nonrural counterparts that these results are due to procedural tasks rather than conceptual ones. They indicate that rural students are still performing below their nonrural counterparts in areas like mathematical reasoning, thinking, and problem-solving.

Lee and McIntire (2000) found that rural students outperformed their nonrural counterparts nationally on mathematics achievement, but differences between rural and nonrural students varied from state to state at the eighth grade levels on the NAEP mathematics test. This study, in addition to Chen and Fan's, defined rural by the locale indicators from the United States Census Bureau. This is one way Chen and Fan suggest in order to eliminate some of the variation in the results of research on rural versus nonrural students. Besides examining student achievement, Lee and McIntire examined schooling conditions. Six schooling conditions were examined to determine differences in rural and nonrural student achievement. Safe orderly climate, collective support, and instructional resources were the schooling conditions that impacted achievement. Algebra offerings, progressive instruction, and professional training were the schooling conditions that did not provide significant evidence of influencing achievement. These schooling conditions, like mathematics achievement, for rural and nonrural students varied from state to state with regard to their impact on achievement. Howley (2002b) indicated that the origin of the rural and nonrural differences in mathematics achievement is situated around 1975 with

the reporting of NAEP data. Today, Howley indicates the gap only persists in forty percent of the states with twenty percent favoring nonrural students and twenty percent favoring rural students.

Some studies have found that nonrural student performance is higher than rural students. Internationally, two studies in Australia indicated that nonrural students significantly outperformed their rural counterparts in mathematics and science achievement. (Young, 1998; Tesse, Savies, Charlton, & Poleskel, 1995) This was true even when controlling for variables in student background. A study in Tennessee also found similar results. Pinkerton (1996) studied rural and nonrural students' achievement on the ACT from the school year 1993-1994. This study found significant differences in the mathematics and science achievement on the ACT in favor of nonrural students.

Why Rural Matters (2003) was a report that examined the status of rural schools in the United States. Beeson and Strange who wrote the report indicated, "Rural America has gone unnoticed too long." This report examined various indicators and ranked each state on the need for policy makers to employ more policies directed at helping rural schools. This report indicated that the Tennessee Supreme Court ruled funding of rural schools as unconstitutional. The Supreme Courts of Arkansas and Ohio also had similar rulings. Descriptive statistics from this report indicated that forty-three percent of the nation's public schools are in rural communities or small towns. Moreover, thirty-one percent of school-age children attend these schools. Two gauges were analyzed as importance and urgency for a state to develop rural educational policies. On the

first gauge, Tennessee was ranked in the very important category for policy makers needing to address rural school issues. The second gauge placed Tennessee in the crucial list for policy makers needed to develop explicit rural education policies. Combining the two gauges, Tennessee was placed in the leading category with other Appalachian states like Mississippi, Alabama, Kentucky, West Virginia, and other non-Appalachian states. This overall ranking placed Tennessee eleventh out of the fifty states as needing to make rural education a priority. Other descriptive results from the study were that in Tennessee one-third of the schools are in rural locations, one-fourth of the students attend these rural schools, and 14.7 percent of rural students live in poverty. Although the indicators from this report seem bleak, another report from Bottoms and Feagin (1999) indicated that Appalachian schools in the Appalachian Regional Commission (ARC) area that were using the High Schools That Work (HSTW) framework were found to be increasing student achievement in mathematics and science.

Looping

The connection between rural schools and looping is not apparent in the literature. This connection is evident though when considering the small size and personalization that occurs in rural schools. Moreover, faculty sizes can cause looping to occur even if the school does not intentionally implement this practice.

Teacher-student and teacher-parent relationships are being suggested as a way of helping to improve schools. Vander Ark says, "Learning is about

constructing relationships in which students connect with teachers or subjects.” (2002; Zahorik & Dichanz, 1994) This idea of tight relationships is also present in the rural literature. (DeYoung, 1994b; Howley, 1997) One area of focus for educational reform in the nineties was the notion that small schools help to counter the crippling effects of poverty. (Howley & Bickel, 1999) Vander Ark suggests that this is due to the personalization that the students receive. One of the reform movements to help personalize education is the practice of looping. This review will define the practice of looping, describe the origin of looping, examine where looping is being practiced, look at some research being conducted on looping, and describe the positive and negative aspects of looping.

What is Looping?

Looping is the practice that allows single-grade teachers to remain with the same class for a period of two or more years. (Forsten, Grant, Johnson, & Richardson, 1997; Yang, 1997) Other terms that are synonymous with looping include multiyear teaching, teacher-student progression, two-cycle teaching, and the twenty-month classroom. An example of this practice in simplest terms is a kindergarten teacher who teaches a group of students then progresses with these same students (with some exceptions of new students, leaving students, and students requesting change) to first grade. The first grade teacher drops to kindergarten to pick up students and then proceeds to first grade with them. This two-teacher cycle moves the teacher to kindergarten then to first and then back to kindergarten.

Vander Ark describes some broader terms in which looping is one aspect.

These educational terms which encompass looping include houses, academies, schools-within-a-school, and small autonomous schools. The following are definitions of these as presented by Vander Ark.

- Houses group 90 to 120 students with a team of teachers. Best practices include two-year looping, team teaching, and integrated curriculum.
- Academies come in many varieties. At best, they are themed houses such as career academies. At worst, academies are glorified departments with a few extra offerings.
- Schools-within-a-school programs typically offer a full course of study around a theme or area of focus with some level of curriculum, budget, and staffing autonomy.
- Small autonomous schools operate in their own facility or as a tenant in a larger building, such as the Cregier Multiplex in Chicago that houses three schools, or the Julia Richman Education Complex in New York City that houses six schools. (2002)

One additional clarification in vocabulary is with the terms multiyear teaching and multiage teaching. Multiyear teaching is synonymous with looping. Multiage teaching is the educational practice where a teacher teaches two (or more) different grade levels in the same classroom. For example, a teacher may teach a 3-4 classroom which is composed of 24 students which half are in the third grade and the other half are in the fourth grade. This is a more complex form of looping (or multiyear teaching). Multiage teachers teach two or more curriculums simultaneously. (Grant, Johnson, & Richardson, 1996)

The origin of the practice of looping

One suggested origin of looping begins with the Austrian educator and philosopher, Rudolf Steiner. (Grant, Johnson, & Richardson, 1996; Barnes, 1991; Zahorik & Dichanz, 1994) Steiner started the Waldorf Schools in Germany in the early 1900's in order to educate the children of the workers of the Waldorf Astoria cigarette factory. Over 750 Waldorf schools in 40 countries still exist today, and they continue to follow the original ideas prescribed by Steiner. (Barnes, 1991; Ogletree, 1998) In the United States, around 100 Waldorf schools and six training centers are in existence. These schools were founded on Steiner's philosophy called "Anthroposophy." This philosophy and type of education is centered on learning by experience. The tenth tenet of the Waldorf schools is the practice of continuous teaching by one teacher in grades one through eight. (Ogletree, 1998) The Waldorf schools still use this grade one through eight loop while the length of the loop in other schools varies.

The Waldorf schools appeared in the United States in 1928. (Burke, 1997) Previously, looping occurred without the specific name looping in the one room schoolhouse during the early history of the United States. (Bellis, 1999) This link is connected with rural schooling. (DeYoung, 2002) The one room schoolhouse was similar to multiage classrooms. The same teacher taught multiple grades, and the students had the same teacher for successive years. Although the practice of looping has not been a dominant force in the United States, looping was mentioned in a memo in 1913. The Officer of Education

from the United States Department of Education addressed looping with the following statement.

Shall teachers in city graded schools be advanced from grade to grade with their pupils through a series of two, three, four or more years, so that they may come to know the children they teach and be able to build the work of the latter years on that of the earlier years, or shall teachers be required to remain year after year in the same grade while the children promoted from grade to grade are taught by a different teacher each year? This I believe to be one of the most important questions of city school administration.
(1996)

The memo proceeds to discuss the advantages of looping, outlining some of the same advantages that teachers advocate today. Although the practice of intentionally looping students has not been a part of mainstream education in the United States as long as other countries, interest in the United States has increased. The first school mentioned in the literature for intentionally implementing looping in the modern era was in New York in 1974. (1999) Since that time, several additional schools have begun to implement this educational practice. (Burke, 1996)

Where is looping being practiced?

The practice of looping is currently being used in a variety of ways and locations. Looping is being used at all grade levels, although the majority of the literature places looping in the elementary and middle grades. (Mazzuchi & Brooks, 1992; Jacoby, 1994; Flinders & Noddings, 2001) In many ways, there is no pattern to locations or models of looping. The diversity of models can even

occur within a school district. For example, one school may loop students for two years while another school may use a three-year model. Curriculum may also differ within models. Some schools use a traditional curriculum, while others use a modified curriculum expanded across two years. (Forsten, Grant, Johnson, & Richardson, 1997)

According to location, looping can be seen around the world. Overseas, looping has taken greater emphasis than in the United States, but interest in looping is increasing. The Waldorf schools, which are located in several countries, including the United States, still loop students through eighth grade. (Barnes, 1991; Burke, 1997) Germany, where looping originated, now loops students in grades one through four with the same teacher. (Grant, Johnson, & Richardson, 1996; Barnes, 1991) This is an example of a four-year loop. Japan and Israel loop students at both the elementary and secondary levels. At the secondary levels, a student will have the same math teacher for Algebra, Geometry, and Algebra 2. Japan typically utilized a three-year loop. Sweden used a K-3 loop and then a 4-7 loop. Due to a drop in achievement at the fourth grade level, Sweden changed to a K-7 loop. In the United States, a two-year loop is typically the norm. Programs in the United States where looping is occurring includes Project F.A.S.T. (Families Are Students and Teachers) in Ohio, Less Summer Loss in New York, Teachers Advance with Students in Mississippi, Tailored Looping in Michigan, District-Wide Program in Attleboro, Massachusetts, and a State-Wide Program in Kentucky. (Gelman, 2001)

What are the positive and negative aspects of the practice of looping?

According to *The Looping Handbook* (1996) and *Looping Q and A* (1997), the benefits of looping exceed the negatives. The literature appears to support the emotional and psychological benefits of looping, but the literature for the cognitive benefits is mixed.

The following is a list of potential benefits for the practice of looping as posed by the writers of *Looping Q and A*. They include

1. personal relationship with student and teacher;
2. time-efficient;
3. cost-efficient (as far as reform movements go);
4. strong parent-teacher relationship;
5. increase in student attendance;
6. decrease in the number of special education referrals;
7. reduces (but does not decrease) grade retention; and
8. improves classroom discipline.

Joseph Rappa, Superintendent of a looping school in Attleboro, Massachusetts and others, supports these benefits. (Hanson, 1995; Burke, 1997) Rappa states, "Students that have the same teacher for two years tend to enjoy school more, have fewer discipline problems, fewer absences, are referred to special education placement less often, and are less apt to be retained in a grade for lack of academic achievement." (Forsten, Grant, Johnson, & Richardson, 1997; Flinders & Noddings, 2001)

Crosby states, "Since we see so much of our students, we get to know their strengths and weaknesses, and can target acceleration or remediation based on individual needs. We also gain precious instructional time." (1998; Mazzuchi & Brooks, 1992) Instructional time is gained by the removal of the

getting to know you stage the first few weeks of school. (Grant, Johnson, & Richardson, 1996) This getting to know you period consists of rules, procedures, and review of content. In addition, it is the period where the teacher learns the students' names, strengths, weaknesses, and learning styles. Looping eliminates this. In addition, the summer is used for specific projects. (Crosby, 1998)

Vann in his article, *Leveling about Looping* (1997), says that the perceived benefits of looping justify its implementation without the need for research. He sees the benefit of saved time, personal relationships, and attitudes as the reasons to implement looping. These benefits were also indicated by Yang. (1997)

Some negative aspects of looping, as stated by *the Looping Handbook* and *Looping: Q & A*, include poor implementation, poor teachers, and personality conflicts among teacher, parent, and/or child. Another negative aspect is conflicts among students with fellow classmates. Vann stresses the need for voluntary adoption, not mandates. Vann suggests, "If participation is voluntary on the part of students and teachers, the majority of the disadvantages are negligible."

Those in favor of looping refute many of the disadvantages. For instance, the argument of a child being stuck with a poor teacher for two or more years is refuted by the following statement as given in the memo in 1913 talked about above. It states, "The inefficient teacher should be eliminated. The man or woman who is unable to teach a group of children through more than one year

should not be permitted to waste their money, time and opportunity through a single year." The chance of a poor teacher still causes many to consider this a disadvantage of looping despite the point made in 1913.

Relevant Studies on the Practice of Looping

Studies of perceptions and attitudes of students, parents, and teachers toward looping support the implementation of looping. (Skinner, 1998; McAllister, 2001; Herr, 2002; Jordan, 2001) Many studies of this form are found in the literature of the topic. The following studies are ones that differ from the vast majority of the research in this area. The first is a study of attitude that is negative rather than positive towards looping, and the others examine looping from a quantitative perspective.

Lauer (2000) studied a district that used multiage classrooms. The study gathered data in the form of interviews and surveys. The study found that the schools in which data was gathered were dissatisfied with the multiage classrooms. The main reason for dissatisfaction was the mandating of the practice. Other reasons included inadequate professional development, not enough materials, and too little time for teacher collaboration.

Skinner (1998) used the MMAT (Missouri Mastery and Achievement Test) and an Elementary Attitude Towards School Test to determine if significant differences could be determined between elementary students in looping programs versus students who were not looped. The study found no significant difference in any area except in language arts. In this area, the looping students

outperformed their nonlooping counterparts. The researcher stated that the difference may have been due to the relationships and time spent on this subject, but not much attention was given to this difference. This study also gathered information about attitudes towards looping through surveys. To show an example of the typical findings for looping, this study's findings in the area of attitudes towards looping are presented. The results indicated, "Parents were very supportive and felt looping promoted the cognitive, affective, and social growth and development of their children. Parents felt their children experienced less stress, felt more comfortable with the teacher, and had a positive attitude toward school due to caring relationships. Teachers saw many social benefits involving student and parent relationships."

Patterson (2000) examined the effects of looping versus a traditional single year program on reading achievement. The Terra Nova Tennessee Comprehensive Assessment Program (TCAP) standardized achievement test in reading from the school years 1997–98 and 1998–99 for elementary students was utilized to investigate the effects of looping. In this study, no statistically significant differences were found between the groups using an ANOVA test of significance at the .05 level. In addition, the study stated, "Educational backgrounds and professional experience of teachers were examined to determine if those factors could have influenced the outcome of student reading achievement. Data analysis indicated no statistically significant differences between teachers of looping classrooms and teachers of traditional, single-year classrooms existed based on education, local teaching experience, or total

experience in the profession.” This is the only study found that looked at the teacher’s influence in the results of the effects of looping. Other studies make a blanket claim that this is a variable beyond the control of the study (for example, Skinner above).

Swanson (1999) used the Stanford Achievement Test, Ninth Edition scores, reading levels, and Directed Writing Performance Assessments to analyze the effectiveness of looping on second and third grade students in California. In this study the researcher made the following claim. “Although the emotional and psychological benefits of multiyear teaching are well documented, the effect it has on student achievement has not been thoroughly researched.” In all three measures, the looped students statistically outperformed the nonlooped students. In a similar study, Curry (2002) using SAT scores from fourth and fifth grade Alabama students found no significant differences in looped and nonlooped students. Curry controlled for gender, race, SES, and ability levels.

Other research studies on looping have found favorable results for looped students based on achievement. Flinders and Noddings (2001) found a positive correlation between looping and student achievement. Burke (1997) stated that looping students performed better in the area of mathematics. Moreover, no data found by Flinders and Noddings indicated that looped students did not do as well as nonlooped students. Project F.A.S.T. conducted in Cleveland, Ohio in conjunction with Cleveland State University studied multiyear teaching. Students in the multiyear classes outperformed students in the traditional classes in

reading and mathematics on standardized test even when the same teachers taught both groups. (Burke, 1997)

Significant Studies Related to Other Confounding Variables

This study seeks to examine the relationship between mathematics achievement, locale, and looping. In order to thoroughly investigate the effects of locale and looping on mathematics achievement, other confounding variables that may influence the effects must be considered. Chen and Fan (1999) indicated that socio-economic status and access were two major differences between rural and nonrural students. The following are significant studies on socioeconomic status (SES); school, grade, and class size; and access to higher level mathematics courses.

Socio-Economic Status (SES)

In 1966, the first study investigating the link between student achievement, family background and SES was conducted by Coleman. Coleman's study found that SES was the greatest factor influencing students' test scores. Since the Coleman Report, many studies have investigated the effects of SES on student achievement and have found similar results. (Mayeske, et al., 1968; Jencks, 1968; Coladarci & Cobb, 1996) Research on the effects of SES on urban students has been well documented. (Bartelt, 1996) Research on SES or the effects of poverty placing students at a greater risk of educational failure in rural

locations is less prevalent and less clear. (Sherman, 1992; Stern, 1994; DeYoung, 1992)

In 1993-1994, the poverty rates of students enrolled in mid to high poverty schools was 56% for rural areas and 62% in urban areas. In high poverty schools alone, the rates were 26% for rural locations and 40% for urban locations. (Lippman, et al., 1996) *Why Rural Matters* (2003) indicated that the amount of rural students living in poverty in the state of Tennessee was 14.7%. Khatri, Riley, and Kane (1997) stated the poverty rates in rural and urban settings were placing students in these locales at a high risk of educational failure.

Achievement in high-poverty schools has shown to be significantly lower than achievement in low-poverty schools. (Abt Associates, 1993) Since rural areas have high poverty rates especially in the rural South (Stern, 1994), the need for research of effects of poverty in rural areas is needed. One reason for the minimal amount of research in rural locations may be due to the small variance in SES within rural locations. (Fan & Chen, 1999) Free and reduced priced lunch percents have been used as an indicator in several of these studies. (Alspaugh, 1992; Braswell, et al., 2001)

One idea presented as a combatant of poverty is the notion of social capital proposed by Coleman. (1988) Social capital may help to overcome financial discrepancies among poor rural and poor urban communities. Social capital is the benefits an individual receives from being a part of a community. The worth an individual perceives of him or herself is derived from this membership in a community. The community may be a family, church, or school.

Another combatant developed from the findings of the Coleman report.

Programs like "Title I" and "Head Start" were adopted to help alleviate the harmful effects of poverty. (LaBrecque, 1973)

Friedkin and Necochea (1988) found a school size and achievement relationship based on SES. They found a negative relationship between size and achievement in poor areas and a positive relationship in more affluent areas. This was also found in studies by Howley (1996) and in the Matthew Project (Howley & Bickel, 1999). Alspaugh, in studying the achievement of fifth graders in Missouri, found free and reduced price lunch percents to be the best predictor of urban achievement, but due to the homogeneity of rural schools this was not a predictor. (1992) Alspaugh also indicates that SES may play a more significant role in effecting the achievement of nonrural locations than in rural locations.

SES and mathematics achievement research indicates that students in low SES schools do not do as well as students in higher SES schools. Lubienski (2002) stated that despite the rise in mathematics achievement on NAEP assessments from 1990-2000, low SES students did not experience these gains. The Education Trust (2001) in a summary of Tennessee students reported a gap in mathematics achievement on eighth graders results on NAEP tests between low-income and high-income eighth grade students. A study that held poverty rates the same found that rural students of poverty outperformed urban students of poverty on the NAEP assessment, but both groups performed lower than that of suburban students of poverty. (Khatri, Riley, & Kane, 1997; Greenberg & Teixeira, 1995) Finally, Mayeske, et al. (1968) summarized their study by

indicating the importance of SES on student achievement. In addition, they indicated that achievement was linked with class size, which transitions this review to the next section.

School and Class Size

Research into size whether school size or class size has found relationships among size and achievement. Distinguishing between effects of school or class size on achievement and SES on achievement is difficult as indicated by Mayeske, et al. (1998) Howley and Bickel 1999) found that when addressing school size one must consider the SES level of the community and school. They indicated that the high poverty schools need smaller school sizes, but this is not necessarily true for low poverty areas. (see also Haller, 1992) This is consistent with other findings. One of the most noted citations from the literature is Lee and Smith's study of school size. (1996) They concluded that poverty exerts strong negative effects on achievement. Their study found that schools with 301 students or less greatly reduced the negative effects of poverty on achievement. Moreover, they advocated high school sizes between 601 and 900 students, with all else being equal, as resulting in the highest student achievement.

Other studies that produced optimal sizes for high schools include Conant (1959) who suggested a minimum of 400 students and Bickel and Howley (2000) who indicated a maximum per grade of 250 students. These levels were indicated for schools with zero poverty levels. Similar to other results found for

impoverished students, Bickel and Howley's study found that in Georgia small school size and small district size was beneficial for student performance. Other studies that indicate small schools increase the student achievement for impoverished students are Howley (1989) and Raywid (1999). In 1993-1994, over half of the nation's districts were rural. (NCES, 1997) Khatri, Riley, and Kane (1997) reported that rural schools and districts were smaller due to isolation and less population than nonrural schools and districts. School consolidation is causing rural school sizes to grow. Some of the benefits associated with small rural schools include a sense of community, a positive school climate, a safe and orderly environment, and a higher level of student engagement in school activities. (Kearney, 1994; Thompkins & Deloney, 1994) La Sage and Ye (2000) found that smaller school sizes and smaller class sizes benefited teachers as well as students by allowing the teachers to better understand and work with their students. The Matthew Project examined school size in Georgia, Montana, Ohio, and Texas. Findings from the project revealed the following benefits of small school size,

- Higher achievement;
- Lower achievement gaps across races;
- Lower dropout rates;
- Lower student suspension rates;
- Less drug abuse; and
- Less vandalism. (Howley & Bickel, 1999)

In general, research suggests that rural students benefit from small school sizes. The school-community relationship of these small schools is presented as a possible reason for this benefit. (Khatri, Riley, & Kane, 1997) Lindberg,

Nelson, and Nelson (1985) found that small rural schools performed worse than large urban schools in mathematics achievement. La Sage and Ye found negative relationships between school size and achievement for both males and females at the high school level. Luyten (1994) examined secondary school size and mathematics achievement in three countries: Netherlands, Sweden, and the United States. Luyten found little evidence to link school size to achievement.

Finally in studies of class sizes, Grantham (2000) looked at elementary schools and found that reducing class size improved student achievement. Finn (1990) in a study of Tennessee elementary schools found similar results. Reducing class sizes was especially beneficial for disadvantaged students. A project in Tennessee called STAR (Student Teacher Achievement Ratio) reduced Kindergarten class sizes. Results from this study found increased mathematics scores. Nye (1992) examined data from the STAR project and found that these students in the STAR project continued to benefit from the time in small classes even after proceeding to the next grade in classes with more students. These results held true for urban, suburban, and rural locations.

Access to Higher Level Mathematics Courses

Access to higher-level mathematics courses is an area where rural and nonrural students encounter great discrepancies. (Whitehouse & Sullivan, 1992) Availability of courses and courses taken by students have been shown to be powerful predictors of academic achievement and college enrollment. (Lee, Bryk, & Smith, 1993; Pelavin & Kane, 1990) Possible reasons for this

discrepancy may be limited funding, fewer resources, and less experienced teachers. In addition, small school size was indicated to result in reduced course offerings. (Herzog & Pitman, 1991; Howley, 1996; Barker, 1985; Greenberg, 1995) Another possibility presented by DeYoung (2002) is the amount of importance placed on education. DeYoung indicates that in the past the idea of high schools and higher education was unimportant in the rural areas. The work these students would be engaged in did not require skills taught in high school or above. Although this mindset is changing, this past may still have lingering effects when considering course offerings.

Several studies have found that rural students have less access to higher-level mathematics than their nonrural counterparts do. Silver and Castro (2002) indicated that rural students have less access due to the small number of students desiring an upper level mathematics course. This small number makes the course offering not feasible for the school. Moreover, they found that schools in rural areas were less likely to participate in Advanced Placement (AP) programs where Calculus is often offered. Descriptively, Sherman (1992) reported that while half of the urban schools and two-thirds of the suburban schools offered calculus, only one-third of rural schools offered the course. Similar findings were also indicated by Ballou and Podgursky (1998). Besides rural students, they also indicated that inner-city students were less likely to have access to advanced mathematics courses.

A study of mathematics achievement for twelfth grade students in Mississippi revealed that the number of mathematics courses taken was a

significant predictor of achievement on the ACT. (Raley, 1992) Two studies mentioned earlier involving the intersection of rural and mathematics education also addressed this issue of access. Haller, Monk, and Lien (1993) when studying higher order thinking skills found that rural schools offered fewer courses in upper level mathematics. Despite the lack of course offerings, the rural schools were able to instill higher order thinking skills in the limited courses that were offered as well as their nonrural counterparts. Lee and McIntire (1999) attributed limited course offerings and limited resources as causing smaller achievement gains for rural students.

When comparing rural and urban areas, the following differences are mentioned in the literature on access. Monk (1987) indicated that the courses that were offered were less diverse and less in-depth as the courses offered at urban locations. Kannapel and DeYoung (1999) also found that rural schools offered fewer educational opportunities than urban schools.

Conclusion

This review of the literature has defined the terms rural and looping. Although the connection between the two does not explicitly appear in the literature, overlapping features that characterize each persist. These characteristics fall into the broad category of personalization. A sense of community is an important aspect of rural education and in the practice of looping. In addition, the existing research on these topics was presented. The intersection in rural and mathematics is sparse similar to the empirical data on

the practice of looping. Research on rural mathematics over the past few years shows that students in these locations are performing at levels equal to or above their counterparts. Looping literature indicates that students who are looped do as well if not better than their nonlooped counterparts. Other areas reviewed were studies on SES, school and class size, and access to upper level mathematics course. These variables were reviewed in terms of their potential effects on rural and mathematics education.

Chapter III

METHODS AND PROCEDURES

This study was composed of four parts. Part One investigated the relationships between eighth grade students' achievement on two tests of the Tennessee Comprehensive Assessment Program (TCAP), school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), socio-economic status (SES), and eighth grade class size. The two tests were the Algebra I Gateway Test and the Mathematics Section of the Achievement Test. Relationships were analyzed using school means as reported on the 2002 Tennessee School Report Cards.

Part Two investigated relationships between twelfth grade students' achievement, school locale, county location, SES, and twelfth grade class size. The test used to measure the achievement for the twelfth grade students was the ACT Mathematics Test. The school means obtained from the 2002 Tennessee School Report Cards were used to analyze relationships.

Part Three examined various factors relating to potential influences on secondary mathematics achievement. The primary investigation was to determine the amount of looping that occurs in secondary mathematics. Other potential influences investigated were the number of mathematics courses offered at a school, the number of mathematics teachers in the school, and the average mathematics class size. The school means for the ACT Mathematics Test from Part Two were used to investigate these relationships.

Finally, Part Four further investigated looping by surveying high school students (see Appendix B for Student Survey). Students indicated whether they had been looped or not in high school mathematics courses. They also self-reported their ACT Mathematics Test scores. These students were grouped into looped versus nonlooped categories and analyzed with the reported score.

Participants

Part One included all public middle schools in the state of Tennessee from the school year 2001-2002 that reported school means for the Algebra I Gateway Test and for the Mathematics Section of the TCAP Achievement Test. This group was a self-selected sample from the population of middle schools in the southeast Appalachian region. Figure 3.1 shows the percentage of schools by locale that were used in this sample from Tennessee.

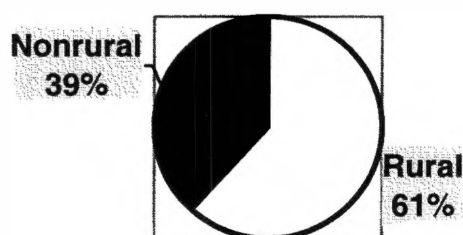


Figure 3.1
Percentage of Public Middle Schools by Locale in Tennessee.

Five hundred and twenty (520) public middle schools reported a school mean for either the Algebra 1 Gateway Test or the Mathematics section of the TCAP Achievement Test on their 2002 School Report Card. Table 3.1 shows the number of schools and students for rural and nonrural locales used in the sample. This table also indicates the number of schools and students in Appalachia or non-Appalachia for these two locales.

Part Two investigated 288 public high schools in the state of Tennessee that reported ACT Mathematics Test school means on the 2002 School Report Card. This self-selected sample was used to draw inferences for the population of Appalachian high schools in the southeast.

Table 3.1
Number of Public Middle Schools and Students Examined from Tennessee.

Locale	Location	Number of Public Schools	Number of Eighth Grade Students
Rural		338	28,214
	Appalachian	194	14,959
	Non-Appalachian	144	13,255
Nonrural		210	35,332
	Appalachian	80	12,149
	Non-Appalachian	130	23,183
Total		548	63,546

Figure 3.2 shows the percentage of schools by locale in Tennessee used in this sample.

Table 3.2 indicates the number of schools and students classified as rural and nonrural. This table also subdivides these two locales into Appalachia versus non-Appalachia locations.

Surveys were sent to 288 public high schools in the state of Tennessee to be completed by the mathematics department chairperson (see Appendix A for Mathematics Department Chairperson Survey). Surveys were available for completion on paper or electronically. This was used as a sample from the population of Appalachian high schools in the southeast.

Part Four sent surveys to three rural Tennessee counties in Appalachia.

These three counties were used as a sample from the population of Appalachian counties in Tennessee. Each high school in these three counties was sent surveys to be completed by high school students in mathematics classes above Geometry and Algebra 2. Five schools in these three counties participated in the student survey research. The students for this part were grouped into two categories, looped or not looped.

Instrumentation

Five instruments were used to obtain data for this research study. These included the Tennessee Comprehensive Assessment Program's (TCAP) Achievement Test Mathematics Section, the Algebra 1 Gateway Test, the ACT Mathematics Test, and two surveys developed by the researcher.

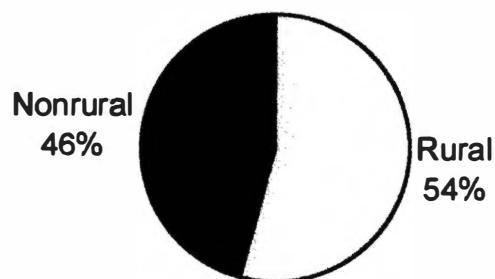


Figure 3.2
Percentage of Public High Schools by Locale in Tennessee.

Table 3.2
Number of Public High Schools and Students Examined from Tennessee.

Locale	Location	Number of Public High Schools	Number of Twelfth Grade Students
Rural		156	20,452
	Appalachian	83	11,291
	Non-Appalachian	73	9,161
Nonrural		132	27,749
	Appalachian	49	9,354
	Non-Appalachian	83	18,395
Total		288	48,201

Part One used the TCAP's Algebra 1 Gateway Test and the Mathematics Section of the Achievement Test (see Appendix C for reliability measures and Appendix D for validity arguments). Students in third through eighth grade take an achievement test every spring. The test is used to measure the basic academic skills in reading, vocabulary, language, language mechanics, mathematics, mathematics computation, science, social studies, spelling and word analysis. (<http://www.state.tn.us/education/tstcapachievement.htm>, 2003)

The Achievement Test is a multiple-choice test with a time limit for each section. The test is designed to measure content knowledge along with application of that knowledge. The TCAP Achievement Test is published by CTB/McGraw-Hill. This test provides both performance information by objective and norm-referenced information. The 2002 School Report Card publishes a school's Median National Percentile Score. (<http://www.k-12.state.tn.us/rptcrd02/index.asp>, 2003)

The school receives a score for Reading Composite, Language Arts Composite, Mathematics Composite, and Science Composite for each grade level. The Mathematics Composite score for grade eight was used for Part One.

The Tennessee Department of Education began implementing a calibration process for the Algebra I Gateway Test in the spring of 2001. (<http://www.state.tn.us/education/gateway.htm>, 2003)

Administration of the Algebra 1 Gateway Test began during the 2001-2002 school year. Beginning with the freshman class of 2001-2002, Tennessee students are required to earn

a score deemed proficient by the state in order to earn a high school diploma. A proficient score is set for each testing date. For the Fall of 2002, a score of 60 percent was considered proficient. This test is given to students at the end of the fall, spring, and summer terms following a course in Algebra 1. Students who do not pass the test may take the test multiple times until a proficient score is earned. The Algebra I Gateway Test is a multiple-choice test composed of fifty items.

Tennessee, for school years 2001-2002 and prior, required all graduating students to take one of three standardized tests (ACT, SAT, or WORKKEYS) in order to receive a high school diploma. These tests were paid for by the state. Seventy-nine percent of graduates took the ACT in the 2001-2002 school year. (www.act.org, 2003) For this reason, the ACT Mathematics Test was used to investigate Part Two of the study (see Appendix C for the reliability measure and Appendix D for the validity argument). This data reflects the majority of Tennessee students, not just those that are college bound. Traditionally the ACT is a national college/university entrance exam. The test consists of sections in English, Reading, Mathematics, and Science Reasoning. The ACT Mathematics Test is a one-hour, 60-question multiple-choice test. The test is designed to assess a student's mathematical knowledge in Pre-Algebra, Algebra I and 2, Geometry, and Trigonometry. (2003)

Two surveys were developed to examine Parts Three and Four of this study. The survey for the school's mathematics department chairperson

contained seven questions. Two questions asked about the presence of looping. The remaining questions solicited the number of mathematics course offerings, the number of mathematics teachers, average mathematics class sizes, type of school schedule, and school locale. The survey was developed by the researcher. The doctoral committee reviewed the survey and recommended changes. After the changes were made, the survey was field tested with selected mathematics teachers. The survey took the teachers about five minutes to complete. No teachers had any questions or trouble completing the survey during the field testing.

Student surveys contained two questions. These two questions asked the students if they had the same teacher for consecutive mathematics courses, and their ACT Mathematics Test Score. See Appendices A and B to view the two surveys.

Procedures

Parts One and Two

Mathematics achievement data for all public schools which contained eighth and twelfth grades were obtained from the Tennessee Department of Education's 2002 School Report Card. The free and reduced lunch percentages were recorded and determined SES. These data were placed into an Excel spreadsheet along with school locale, county location, and eighth or twelfth grade class size information. The school locales of all public schools and eighth or twelfth grade class sizes were obtained from the NCES "CCD Build a Table"

section available on the NCES website (<http://nces.ed.gov/ccd/bat/>). The county location of Appalachian or non-Appalachian was obtained from the Appalachian Regional Commission's (ARC) website (<http://www.arc.gov>). The school locale and county location data were coded.

For this study, the definition of rural being utilized falls into the external quantitative category presented by Bosak (1982). Using the suggestion presented by Howley (2002) and the research of Lee and McIntire (2000), rural was defined by three of the eight locale codes. These three codes were small-town schools, rural schools outside metropolitan areas, and rural schools within metropolitan areas. The remaining five Locale Codes were coded as nonrural. With this definition, the mathematics achievement of rural students was examined. After the school locale was coded, the schools were also coded for county location. The school was given a code as being situated within Appalachia or outside Appalachia. The Appalachian Regional Commission's (ARC) website contained a list of Appalachian counties that was utilized for this coding. (<http://nces.ed.gov/ccd/bat/>)

Part Three

Prior to sending the mathematics department chairperson surveys, permission was sought from all district directors to contact schools. (see Appendix A for Mathematics Department Chairperson Survey) Subsequently, packages containing information for completing the survey, the survey, and a pre-addressed stamped envelope were sent to public high schools in Tennessee.

The survey was available for completion via the World Wide Web. This survey was produced with Microsoft Front Page and uploaded to the web. An outside source wrote the code for the survey.

Surveys were to be returned in the pre-addressed, stamped envelopes or electronically, The ACT Mathematics Test school mean, the school locale code, and the school county location code were retained from Part Two, and the survey data was added. The survey information for questions 1-5 was recorded on the existing excel spreadsheet beside the appropriate school. Questions six and seven were mined for future research.

Part Four

Permission from district directors and school principals from the five rural schools was obtained prior to sending the student surveys. (see Appendix B for Student Survey) After permission was granted, the student surveys were sent to the five schools' mathematics department chairpersons. Directions for completing the survey and signing the consent forms were included. After sending the packets containing the survey, the school was called and a date was set to pick up the student surveys and consent forms from parents and students. Once the surveys were collected, the data were placed into two columns of an Excel spreadsheet. These columns were labeled "looped" and "not looped." ACT Mathematics Test scores were entered into the appropriate column.

Null Hypotheses

For Part One, the null hypotheses will be separated into two sections.

Section A is the null hypotheses for school means on the Algebra 1 Gateway Test. Section B is the null hypotheses for the school means on the Mathematics section of the TCAP Achievement Test. The following null hypotheses were investigated in this research study.

- $H_{0\text{Part1A.1}}$: There is no significant difference between school means for eighth grade mathematics achievement on the Algebra 1 Gateway and locale (rural versus nonrural) or county location (Appalachian or non-Appalachian).
- $H_{0\text{Part1A.2}}$: There is a correlation of zero between school means for eighth grade mathematics achievement on the Algebra 1 Gateway and SES or eighth grade class size.
- $H_{0\text{Part1A.3}}$: There is no relationship between school means for eighth grade mathematics achievement on the Algebra 1 Gateway when compared with rural and nonrural schools, county location, SES, and eighth grade class size.
- $H_{0\text{Part1B.1}}$: There is no significant difference between school means for eighth grade mathematics achievement on the Mathematics section of the TCAP's Achievement Test and locale (rural versus nonrural) or county location (Appalachian or non-Appalachian).

- H_{0Part1B.2}:** There is a correlation of zero between school means for eighth grade mathematics achievement on the Mathematics section of the TCAP's Achievement Test and SES or eighth grade class size.
- H_{0Part1B.3}:** There is no relationship between school means for eighth grade mathematics achievement on the Mathematics section of the TCAP's Achievement Test when compared with locale, county location, SES, and eighth grade class size.
- H_{0Part2.1}:** There is no significant difference between school means for twelfth grade mathematics achievement on the ACT Mathematics section and locale (rural versus nonrural) or county location (Appalachian versus non-Appalachian).
- H_{0Part2.2}:** There is a correlation of zero between school means for twelfth grade students' mathematics achievement on the ACT Mathematics Test and SES or twelfth grade class size.
- H_{0Part2.3}:** There is no relationship between school means for twelfth grade students' mathematics achievement on the ACT Mathematics Test when compared with locale, county location, SES, and twelfth grade class size.
- H_{0Part3.1}:** The proportion of the presence of looping in rural locales is no different than the proportion of the reported presence of looping in nonrural locales.

- H_{0Part3.2}:** The proportion of the presence of looping in Appalachian counties is the same as the proportion of the reported presence of looping in non-Appalachian counties.
- H_{0Part3.3}:** There is no relationship between school means on the ACT Mathematics Test with comparison to students who are looped versus students who are not looped, number of mathematics courses, number of mathematics teachers, and average mathematics class size.
- H_{0Part3.4}:** There is no relationship between school means on the ACT Mathematics Test with comparison to locale, county location, SES, twelfth grade class size, students who are looped versus students who are not looped, number of mathematics courses, number of mathematics teachers, and average mathematics class size.
- H_{0Part4.1}:** There is no significant difference between a student's ACT Mathematics Test score and being looped or not looped in mathematics courses.

Data Analysis

Analysis of Variance (ANOVA), Pearson *r* correlation test, and multiple regression analyses were conducted to complete Parts One and Two. These tests were used to explore relationships between mathematics achievement, school locale, county location, SES, and eighth or twelfth grade class size. School means for mathematics achievement were obtained.

Spearman Rho Correlation test and multiple regression analysis were used to determine if relationships existed between mathematics achievement for twelfth grade students and the amount of looping, number of mathematics courses offered, number of mathematics teachers, and average mathematics class sizes. All these analyses were used with the school as the unit of analysis. Finally, Part Four used *t*-tests to determine if differences existed between students that were looped and those that were not looped in mathematics courses. Descriptive statistics were also used in this study.

Chapter IV

RESULTS

Introduction

This chapter presents the data and statistical analyses used to examine the research questions and null hypotheses. The Statistical Package for the Social Sciences (SPSS v 11.5) was used to calculate the data. Both descriptive and inferential statistics were used to investigate the research questions and null hypotheses. A discussion and tables presenting the data will occur based on each part of the study. Part One that investigated the eighth grade students in Tennessee will be divided into two subparts. Part One A examined the research questions involving the Algebra I Gateway test. Part One B examined the research questions involving the Mathematics section of the TCAP Achievement Test. Part Two examined the research questions involving twelfth grade students' ACT Mathematics Test Results. Part Three described and examined the surveys completed by the Mathematics Department Chairperson's from public high schools in the state (see Appendix A). Finally, Part Four examined the surveys completed by high school students in upper-level mathematics courses from three rural Appalachian counties (see Appendix B).

Visual Representations of Data for Parts One B and Two

Figures 4.1 and 4.2 present the data collected for Part One B and Part Two. Each map of the state of Tennessee indicates the mathematics achievement for a school and either the school locale (rural or nonrural), county location (Appalachian or non-Appalachian), or the locale-county interaction. The maps for eighth grade students' mathematics achievement is based on school means from the Mathematics section of the TCAP Achievement Test. The twelfth grade students' mathematics achievement is based on school means from the ACT Mathematics Test.

Part One A

Research Questions:

1. What relationship existed between eighth grade students' achievement on the Algebra 1 Gateway Examination in terms of school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?
2. Can Algebra I Gateway Test results be predicted by school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?

Null Hypotheses:

1. There is no significant difference between school means for eighth grade mathematics achievement on the Algebra 1 Gateway and locale (rural versus nonrural) or county location (Appalachian or non-Appalachian).
2. There is a correlation of zero between school means for eighth grade mathematics achievement on the Algebra 1 Gateway and SES or eighth grade class size.

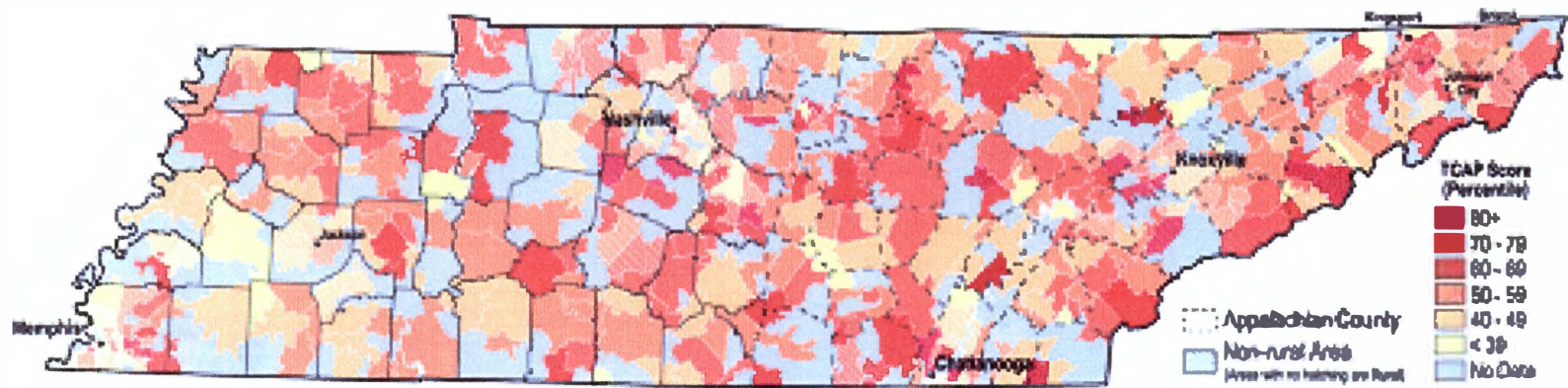


Figure 4.1

Mathematics Section of the TCAP Achievement Test school means by school locale (rural or nonrural) and county location (Appalachian or non-Appalachian).

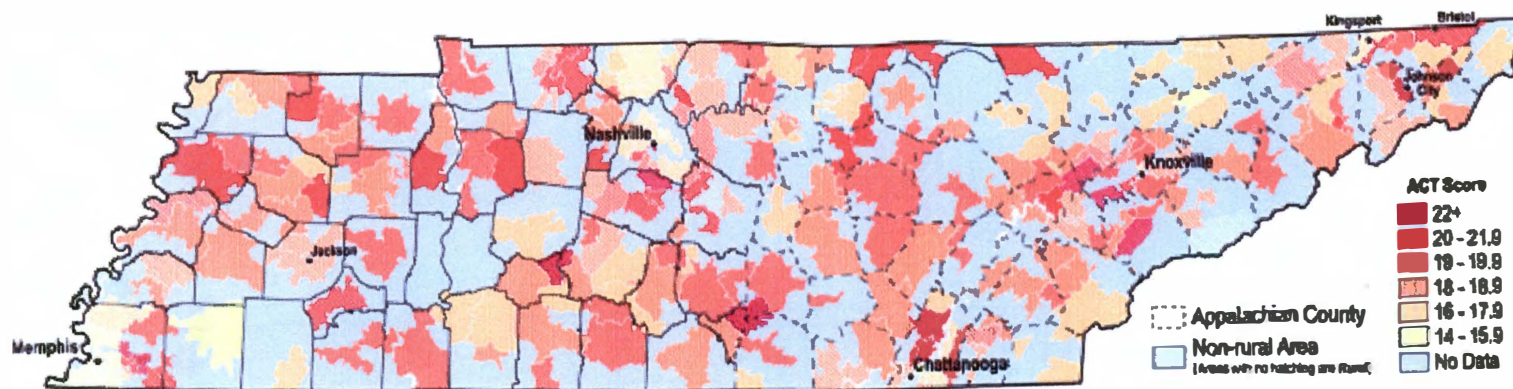


Figure 4.2
ACT Mathematics Test school means by locale-county interaction.

3. There is no relationship between school means for eighth grade mathematics achievement on the Algebra 1 Gateway when compared with rural and nonrural schools, county location, SES, and eighth grade class size.

Figure 4.3 gives a visual representation of the data collected for the Algebra 1 Gateway Test in public middle schools in Tennessee as reported on the 2002 Tennessee School Report Cards.

Due to the skewness of the results (which indicates a non-normal distribution), nonparametric statistics were calculated. A Mann-Whitney Test and Spearman Rho Correlation Coefficient were calculated. Results of the Mann-Whitney did not indicate a significant difference between Algebra I Gateway Test school means for rural versus nonrural schools ($r = .339$) or Appalachian versus non-Appalachian locations ($r = .437$). Table 4.1 shows the distributions, means, and standard deviations by locale and county location.

Spearman's Rho Correlation Coefficient Test indicated a significant negative relationship between Algebra 1 Gateway school means and SES percents ($r = -.341$, $p < .001$). Moreover, the test indicated a significant positive relationship between Algebra 1 Gateway school means and eighth grade class size ($r = .228$, $p = .001$).

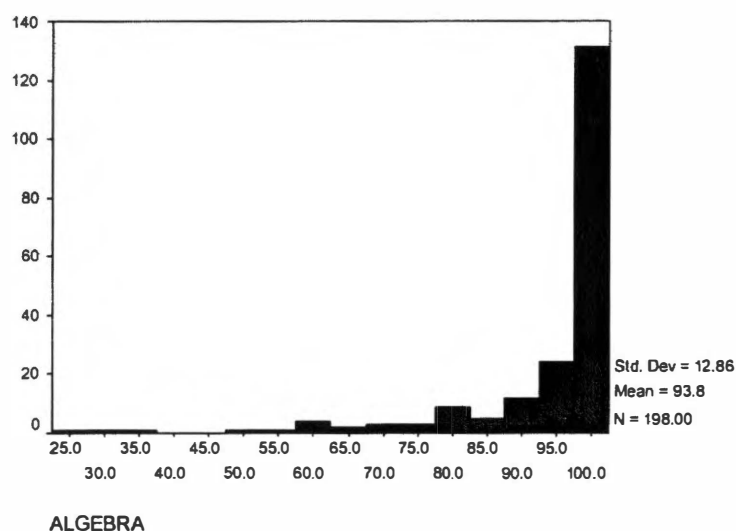


Figure 4.3

Distribution of school means on the Algebra 1 Gateway Test.

Table 4.1

Distributions, extremes, means, and standard deviations by locale and county location for the Algebra 1 Gateway Test.

Locale	County	N	Min	Max	Mean	Std. Dev.
Rural		79	49	100	95.58	9.314
	Appalachian	50	49	100	95.74	8.981
	Non-Appalachian	29	59	100	95.32	10.019
Nonrural		119	27	100	92.64	14.674
	Appalachian	43	34	100	93.06	14.090
	Non-Appalachian	76	27	100	92.41	15.082

Part One B

Research Questions:

1. What relationship existed between eighth grade students' achievement on the Mathematics section of the Achievement Test from the Tennessee Comprehensive Assessment Program (TCAP) in terms of school locale, rural versus nonrural, county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?
2. Can TCAP Mathematics Test results be predicted by school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size?

Null Hypotheses:

1. There is no significant difference between school means for eighth grade mathematics achievement on the Mathematics section of the TCAP's Achievement Test and locale (rural versus nonrural) or county location (Appalachian or non-Appalachian).
2. There is a correlation of zero between school means for eighth grade mathematics achievement on the Mathematics section of the TCAP's Achievement Test and SES or eighth grade class size.
3. There is no relationship between school means for eighth grade mathematics achievement on the Mathematics section of the TCAP's Achievement Test when compared with locale, county location, SES, and eighth grade class size.

In order to answer the research questions and null hypotheses a Two-Way Analysis of Variance (ANOVA), Pearson r Correlation Tests, and a multiple regression analysis were conducted.

Results of the Two-Way ANOVA indicated significant differences between school means on the TCAP Mathematics Test based on locale (rural versus nonrural) and county location (Appalachian versus non-Appalachian). The analysis indicated that rural schools had a higher mean TCAP percentile score than nonrural schools. Moreover, Appalachian schools had a higher mean TCAP percentile score than non-Appalachian schools. Table 4.2 shows the school

Table 4.2

Distributions, extremes, means, and standard deviations by locale and county location for school means on the Mathematics Section of the TCAP Achievement Test.

Locale	N	Min	Max	Mean	Std. Dev.
Rural	318	18	93	56.57*	12.326
Nonrural	202	12	93	50.91	18.268
County					
Appalachian	266	16	93	56.09*	14.266
Non-Appalachian	254	12	93	52.57	15.861

* significantly different at the .05 level

means by locale and county location along with the sample sizes, extremes, and standard deviations.

The Pearson r Correlation Coefficients Test indicated one significant relationship within the data. TCAP Mathematics Test school means were calculated as a significant negative relationship with SES ($r = -.487, p < .001$). TCAP Mathematics Test school means were not significantly related to eighth grade class size ($r = .042, p = .361$).

Lastly, a multiple regression analysis was conducted to determine relationships among all the variables. The analysis indicated a significant model ($R^2 = .312$). Locale, county location, and SES were the variables significantly related to TCAP school means. Table 4.3 is the ANOVA table produced by the regression analysis.

Table 4.3*Multiple Regression ANOVA table for TCAP Mathematics Section school means.*

	Sum of Squares	df	Mean Square	F	Sig.
Regression	34674.083	5	6934.817	43.465	<.001
Residual	76424.330	479	159.550		
Total	111098.412	484			

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	74.479	1.908	39.043	<.001
SES	-.321	.025	-12.932	<.001
GRADE	.008	.007	1.158	.247
LOCALE	-6.199	1.850	-3.350	.001
COUNTY	-5.469	1.518	-3.602	<.001
Locale*County	-.125	2.458	-.051	.959

Part Two

Research Questions:

1. What relationship existed between twelfth grade students' achievement on the ACT Mathematics section in terms of school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and twelfth grade class size?
2. Can ACT Mathematics achievement be predicted by school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and twelfth grade class size?

Null Hypotheses:

1. There is no significant difference between school means for twelfth grade mathematics achievement on the ACT Mathematics section and locale (rural versus nonrural) or county location (Appalachian versus non-Appalachian).
2. There is a correlation of zero between school means for twelfth grade students' mathematics achievement on the ACT Mathematics Test and SES or twelfth grade class size.
3. There is no relationship between school means for twelfth grade students' mathematics achievement on the ACT Mathematics Test when compared with locale, county location, SES, and twelfth grade class size.

Table 4.4 presents the distributions, extremes, means, and standard deviations for twelfth grade school means on the ACT Mathematics Test in terms of locale and county location.

A Two-Way ANOVA was calculated to analyze the relationship between ACT Mathematics Test school means with locale and county location. A significant difference for school means in county location and the interaction between locale and county location was found ($p = .006$ and $p = .001$, respectively). Table 4.5 is the ANOVA table produced from these variables.

Post Hoc analysis using Independent Sample t-tests revealed three significant differences. First, a significant difference existed between nonrural

Table 4.4

Distributions, extremes, means, and standard deviations by locale, county location, and locale-county interaction for school means on the ACT Mathematics Test.

Locale	County	N	Min	Max	Mean	Std. Dev.
Rural		156	15.7	23.0	18.7	1.20
Nonrural		132	14.1	25.8	18.3	2.41
	Appalachian	131	15.2	23.4	18.8*	1.43
	Non-Appalachian	157	14.1	25.8	18.3	2.13
Interaction						
Rural	Appalachian	82	15.8	22.8	18.6*	1.15
Rural	Non-Appalachian	74	15.7	23.0	18.7*	1.26
Nonrural	Appalachian	49	15.2	23.4	19.2*	1.76
Nonrural	Non-Appalachian	83	14.1	25.8	17.8	2.61

* significantly different at the .05 level

Table 4.5

ANOVA Table for locale and county location based on ACT Mathematics Test school means.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	65.863	3	21.954	6.708	<.001
Intercept	95075.456	1	95075.456	29051.394	<.001
LOCALE	1.838	1	1.838	.562	.454
COUNTY	25.592	1	25.592	7.820	.006
LOCALE * COUNTY	38.770	1	38.770	11.847	.001
Error	929.437	284	3.273		
Total	99729.870	288			
Corrected Total	995.300	287			

a R Squared = .066 (Adjusted R Squared = .056)

Appalachian and nonrural non-Appalachian school means on the ACT Mathematics Test ($p = .002$) with nonrural Appalachia having significantly higher school means. Second, rural Appalachian had significantly higher school means as compared to nonrural Appalachia on the ACT Mathematics Test ($p = .023$). Finally, a significant difference was found between rural non-Appalachian and nonrural non-Appalachian school means on the ACT Mathematics Test ($p = .007$) with rural non-Appalachian school means being significantly higher. The difference between rural Appalachian and rural non-Appalachian was not significant ($p = .467$). Figure 4.4 is presented as a visual representation of the locale-county interaction on ACT Mathematics Test school means.

Next, Pearson r Correlation analysis was conducted to investigate the relationship between ACT Mathematics Test school means, SES, and twelfth grade class size. Results indicated a significant negative relationship between school means and SES ($r = -.625, p < .001$). A significant positive relationship was found between school means and twelfth grade class size ($r = .331, p < .001$). Finally, a significant negative relationship was found between SES and twelfth grade class size ($r = -.397, p < .001$).

The last analysis conducted for twelfth grade students was a multiple regression analysis. The analysis indicated a significant model with $R^2 = .479$. The regression analysis indicated that the locale-county interaction, SES, and twelfth grade class size had a significant relationship with ACT Mathematics Test school means. Table 4.6 is the ANOVA table produced from the multiple regression analysis.

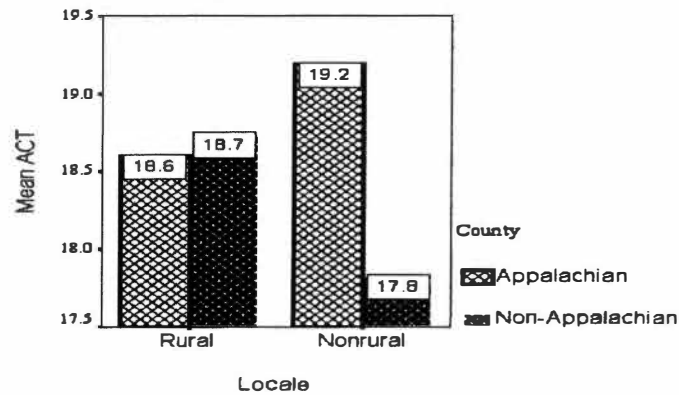


Figure 4.4

Locale-County Interaction on the ACT Mathematics Test school means.

Table 4.6

Multiple Regression ANOVA table for ACT Mathematics Test school means.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	469.093	5	93.819	50.123	<.001
Residual	525.971	281	1.872		
Total	995.064	286			

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	19.943	.286	69.787	<.001
Locale	.057	.251	.228	.820
County	-.178	.223	-.797	.426
Locale*County	-1.076	.339	-3.173	.002
Grade Size	.003	.001	3.905	<.001
SES	-.042	.004	-11.100	<.001

Part Three

Research Questions:

1. Did looping occur in Tennessee public high schools and if so, where and with what type of students?
2. If looping was present, did a relationship exist in students' mathematics achievement when a student has the same mathematics teacher for two or more consecutive years in a mathematics course progression versus a student who has a different mathematics teacher for courses in the mathematics course progression?
3. What relationship existed in school means on the ACT Mathematics Test when compared with locale, county location, SES, twelfth grade class size, average mathematics class size, faculty size, and access to upper-level mathematics courses?

Null Hypotheses:

1. The proportion of the presence of looping in rural locales is no different than the proportion of the reported presence of looping in nonrural locales.
2. The proportion of the presence of looping in Appalachian counties is the same as the proportion of the reported presence of looping in non-Appalachian counties.
3. There is no relationship between school means on the ACT Mathematics Test with comparison to students who are looped versus students who are not looped, number of mathematics courses, number of mathematics teachers, and average mathematics class size.
4. There is no relationship between school means on the ACT Mathematics Test with comparison to locale, county location, SES, twelfth grade class size, students who are looped versus students who are not looped, number of mathematics courses, number of mathematics teachers, and average mathematics class size.

Investigation for Part Three was based on data collected from surveys sent to mathematics department chairpersons in all of Tennessee's public high schools. (See Appendix A for Mathematics Department Chairperson Survey) A return rate of 59% was obtained. The number of surveys returned by locale and county location are presented in the same table with the looping information.

In order to understand the amount of looping that was occurring in Tennessee, Table 4.7 provides descriptive data collected from the survey on the occurrence of looping.

In order to test null hypotheses one and two, a Two Proportions Test for Independent Samples was used. The test was used to compare the proportion of looping reported in rural versus nonrural schools, and in the presence of looping occurring in Appalachian versus non-Appalachian counties. The test for rural versus nonrural schools indicated that the presence of looping in rural schools is significantly higher than the proportion of the presence of looping in nonrural schools ($p < .001$). Moreover, the test revealed significant differences for looping being present in Appalachian versus non-Appalachian counties with Appalachian counties having a significantly higher proportion ($p = .036$).

To answer the second question and investigate the third null hypothesis, correlation tests for nonparametric data and multiple regression analyses were conducted with ACT Mathematics Test school means. Since the data from the survey was ordinal, Spearman's Rho Correlation Coefficients test was used. Correlation coefficients were determined between ACT Mathematics Test school means and number of mathematics courses offered, faculty size, average mathematics class size, and looping percent. A correlation coefficient was also calculated for the relationship between mathematics courses offered and faculty size.

Table 4.7

Looping Information Reported on the Mathematics Chairperson Surveys (N = 173).

General Information			
Location	Surveys Returned	Looping Reported	% of Looping
Rural Appalachia	55	34	61.8%
Rural Non-Appalachia	46	23	50.0%
Nonrural Appalachia	34	12	35.3%
Nonrural Non-Appalachia	38	9	23.7%
Totals	173	78	45.1%

Number of Schools by Looping Percentage Reported		
Location	100% Looped	50% or more
Rural Appalachia	4	16
Rural Non-Appalachia	5	13
Nonrural Appalachia	2	3
Nonrural Non-Appalachia	0	1
Totals	11	33

Type of Students Being Looped			
Location	All Types	Honors Only	Remedial Only
Rural Appalachia	22	11	1
Rural Non-Appalachia	14	7	2
Nonrural Appalachia	6	6	0
Nonrural Non-Appalachia	2	5	2
Totals	44	29	5

Amount of Looping in Schools with 1-2 Math Teachers		
Location	1-2 Teacher w/ Loop	1-2 Teacher w/o Loop
Rural Appalachia	9	2
Rural Non-Appalachia	5	2
Nonrural Appalachia	1	0
Nonrural Non-Appalachia	1	0
Totals	16	4

All correlation coefficients were statistically significant with the exception of ACT compared with looping percent. Table 4.8 lists the Spearman's Rho Correlation Coefficients and the corresponding significance values. The correlation coefficient when determining the relationship between the number of mathematics courses offered and the faculty size was .609, which indicated a significant relationship at the 0.05 level ($p < .001$).

The first multiple regression analysis calculated with all of the above categories except looping percent revealed a significant model with $R^2 = .241$. The number of mathematics courses offered was the only significant predictor of ACT Mathematics Test school means. The analysis indicated that as the number of mathematics courses offered increased, the ACT Mathematics Test school mean increased. Table 4.9 is the ANOVA table developed from the regression analysis.

Table 4.8

Spearman's Rho Correlation Coefficients and Significance by Category as calculated with ACT Mathematics Test school means.

Category	Correlation Coefficient	Sig.
Math Courses Offered	.474*	<.001
Faculty Size	.215*	.005
Class Size	.166*	.030
Looping Percent	-.138	.072

*. Correlation is significant at the 0.05 level.

Table 4.9

Multiple Regression ANOVA Table for ACT Mathematics Test school means compared with survey information.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	113.482	3	37.827	17.678	<.001
Residual	357.355	167	2.140		
Total	470.837	170			

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	17.147	.285	60.154	<.001
MATHNUM	.646	.096	6.701	<.001
FACNUM	-.226	.134	-1.691	.093
CLASSSIZE	.031	.074	.418	.677

The second multiple regression analysis used locale, county location, the locale-county interaction, SES, average mathematics class size, number of mathematics courses offered, faculty size, and twelfth grade class size as predictors for ACT Mathematics Test school means. This was also a significant model with $R^2 = .553$. The analysis indicated that locale-county interaction, SES, and the number of mathematics courses offered were significant predictors of ACT Mathematics Test school means. Table 4.10 is the ANOVA table developed from the regression analysis.

Table 4.10

Multiple Regression ANOVA table for ACT Mathematics Test school means and all predictor variables.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	260.281	8	32.535	24.888	<.001
Residual	210.471	161	1.307		
Total	470.752	169			

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	19.776	.393	50.327	<.001
MATHNUM	.369	.084	4.386	<.001
FACNUM	-.167	.130	-1.292	.198
CLASSSIZE	.001	.060	.019	.985
SES	-.041	.005	-8.334	<.001
COUNTY	-.393	.238	-1.652	.100
LOCALE	-.018	.265	-.069	.945
GradeSize	.001	.001	.435	.664
Locale*County	-.805	.372	-2.165	.032

Part Four

Research Questions:

1. Is looping occurring in rural counties in Tennessee as reported by students?
2. If looping occurred, did it have an effect on student achievement?

Null Hypothesis:

1. There is no significant difference between a student's ACT Mathematics Test score and being looped or not looped in mathematics courses.

In order to answer these research questions and test the null hypothesis, surveys were sent to three rural Appalachian counties to be distributed to public high school students enrolled in upper-level mathematics courses. (see Appendix B for Student Survey) These courses were any mathematics course offered above Algebra 2 and Geometry in a mathematics course progression. Table 4.11 presents the distributions, means, and standard deviations for looped and nonlooped students in the three rural Appalachian counties.

Table 4.11

Distributions, Means, and Standard Deviations for Looped and Nonlooped Students' ACT Mathematics Test score in three rural Appalachian counties.

Looping Status	N	Mean	St. Dev.
Looped	65	24.7	4.2
Nonlooped	21	22.2	3.7

After receiving the surveys and finding looping being practiced in these counties, an Independent Samples *t*-Test was run to determine if significant differences existed between the groups. The results of the *t*-test indicated no significant difference between students that were looped and those that were not looped based on the ACT Mathematics Test ($t = 1.805$, $df = 84$, $p = .075$).

Summary

Chapter IV presented the results from the calculations of the data collected in this study. The results were presented in five sections. Part One of the study was divided into two subparts in order to examine the different instruments used to represent the mathematics achievement of eighth grade students in Tennessee. Each section was composed of the corresponding research questions, null hypotheses, and the results from the statistical analyses. The data were analyzed both descriptively and inferentially. Part One A, which examined schools means based on the Algebra 1 Gateway Test, did not find statistical differences between school locale (rural versus nonrural) or county location (Appalachia versus non-Appalachian). All school means for this instrument were above ninety percent. Part One B found differences in mathematics achievement based on the Mathematics Section of the TCAP Achievement Test when comparing school locale, county location, and SES. The results for the school means on the ACT Mathematics Test in Part Two revealed differences between county location, the locale-county interaction, SES, and twelfth grade class size. Part Three further investigated school means from the

ACT Mathematics Test by using information gathered from a survey sent to high school Mathematics Department Chairpersons. This investigation indicated differences in ACT Mathematics Test school means for the locale-county interaction, the SES indicator, and the number of mathematics courses offered. When the survey data was added, the county location no longer indicated a significant difference. Finally, Part Four did not indicate a significant difference between students that were looped versus students that were not looped.

Chapter V

CONCLUSION

With national goals like “Mathematics for All” set forth by the National Council of Teachers of Mathematics (2000), research into the mathematics achievement within various contexts is important. Stern (1994) and Lee (2001) indicated that the rural context provides an important indicator as to how well the rest of the country is performing. Howley (2002a) stated the research into the mathematics achievement for rural locales has been minimal. For these reasons, one purpose of this study was to further understand mathematics achievement in terms of school locale (rural versus nonrural).

One problem facing research of the rural context has been how to define “rural.” (Howley, 2002a; Howley, 2002c; Bosak & Perlman, 1982; Fan & Chen, 1999) In the past, definitions of rural have been associated with economic activity of the location, population density, proximity to a major urban center, and in numerous other ways. Bosak and Perlman (1982) found approximately 250 different definitions in a study they conducted. This variability in the definition has caused the research into rural education to produce mixed results. (Khatri, Riley, & Kane, 1997) Using the recommendation presented by Howley (2002a), this research defined rural locales by the Locale Codes developed by Johnson in 1989. Johnson’s Locale Codes define locale at the school level based upon population, population density, and geographic location. (1989)

The second major investigation in this study focused on the educational practice called “looping.” Looping is the practice where a teacher progresses with the students to the next grade or course. Other names for looping include teacher-student progressions, multiyear teaching, or two-cycle teaching. (Forsten, Grant, Johnson, & Richardson, 1997) Although secondary schools in Tennessee do not intentionally loop students, this study hypothesized that looping did occur unintentionally especially in small rural schools where faculty sizes are small.

Investigations for this study were conducted for eighth and twelfth grade students in the state of Tennessee. Data were collected using the 2002 Tennessee School Report Cards, the NCES “CCD Build a Table,” the Appalachian Regional Commission’s list of Appalachian counties, and two surveys. This chapter presents a summary of the study, findings from the study, the limitations of the study, and a discussion of the findings, a conclusion, and implications for future research.

Summary of the Study

This study was conducted to add to the limited knowledge base in the intersection of rural education and mathematics education. Moreover, the limited evidence on the presence and effectiveness of the educational practice of looping was investigated in terms of mathematics achievement. In order to better understand mathematics achievement in terms of locale (rural versus nonrural) and looping status, other potentially confounding variables were examined.

These variables included Socio-Economic Status (SES), eighth or twelfth grade class sizes, access to upper-level mathematics courses, number of mathematics faculty, and average mathematics class sizes. The county location of Appalachian or non-Appalachian was also examined. These variables were examined to investigate the status of mathematics achievement for eighth and twelfth grade students in the state of Tennessee for the 2001-2002 school year.

Part One of this study investigated mathematics achievement in terms of school means based on two Tennessee Comprehensive Assessment Program (TCAP) tests for eighth grade students. These two tests used to measure mathematics achievement at the eighth grade level were the Algebra 1 Gateway Test and the Mathematics Section of the TCAP Achievement Test. Relationships among these school means with the school locale (rural versus nonrural), county location (Appalachian versus non-Appalachian), SES, and eighth grade class size were examined to determine their effects on mathematics achievement. This self-selected sample of schools containing eighth grade students in Tennessee was used to draw inferences to the population of schools containing eighth grade students in the southeast Appalachian region.

Part Two utilized school means on the ACT Mathematics Test for twelfth grade students in Tennessee. These school means were also analyzed in relationship to school locale, county location, SES, and twelfth grade class size. This self-selected sample of schools containing twelfth grade students in Tennessee was used to draw inferences to schools containing twelfth grade students in the southeast Appalachian region.

Parts Three and Four each used a survey to gather data about the educational practice of looping. These surveys were developed by the researcher and are presented in Appendices A and B. Part Three sent surveys to all Mathematics Department Chairpersons (Appendix A) in public high schools in the state of Tennessee. The survey was composed of seven questions designed to gather information on the presence of looping and other various demographic information about the mathematics program in the school. The survey data was analyzed in relationship to the school means from the ACT Mathematics Test. Moreover, the survey data was combined with the data from Part Two to investigate significant predictors of ACT Mathematics Test school means. This self-selected sample of high schools in Tennessee was used to draw inferences to high schools in the southeast Appalachian region.

Part Four distributed surveys to high school students enrolled in mathematics courses above Geometry and Algebra 2 in three rural Appalachian counties in Tennessee (Appendix B). This survey was composed of two questions that asked the students if they had the same teacher for consecutive mathematics courses in high school and their ACT Mathematics Test Score. This data was analyzed to determine if differences existed between ACT Mathematics Scores for students who were looped as opposed to students who were not looped. This self-selected sample was used as a representative sample from the population of rural Appalachian students in the state of Tennessee.

Findings

This section presents the findings of the analyses used to investigate the research questions and null hypotheses presented for each part of the study in Chapter IV. The findings will be presented based upon the results for locale and county location, looping, Socio-Economic Status (SES), eighth or twelfth grade class size, access to upper-level mathematics courses, and average mathematics class size.

Locale and County Location

Similar to the findings of Lee and McIntire (2000) and Chen and Fan (1999), this study found that rural schools had higher means than nonrural schools in terms of mathematical achievement on three instruments examined. Although the rural school means were higher, the only significant difference between rural and nonrural schools was found on the Mathematics Section of the TCAP Achievement Test. The research by Lee and McIntire was expanded in this study to also investigate county location (Appalachian versus non-Appalachian) and twelfth grade students. This examination led to more significant differences in mathematics achievement based on school location.

The examination of the mathematics achievement of eighth grade students that used the Algebra I Gateway Test did not find any significant differences between school locale (rural versus nonrural) or county location (Appalachian versus non-Appalachian). For both locale and county location, all school means were high.

Data from the Mathematics Section of the TCAP Achievement Test found that rural students were significantly outperforming their nonrural counterparts. Moreover, the mathematics achievement also differed based upon the county location of a school. This study found that schools within Appalachian counties as determined by the Appalachian Regional Commission (www.arc.gov) had significantly higher TCAP Mathematics scores than schools not located in Appalachian counties.

Part Two investigated mathematics achievement for school means on the ACT Mathematics Test. Initial investigation indicated differences in mathematics achievement based on county location, but not school locale. When regression analysis was calculated, the county location was no longer a significant predictor of mathematics achievement. Although significant differences did not occur between rural and nonrural settings, the locale-county interaction did determine differences. In this finding, nonrural Appalachia had the highest ACT Mathematics Test school means. Rural Appalachia, rural non-Appalachia, and nonrural Appalachia all scored significantly higher than nonrural non-Appalachia.

Looping

The findings in this study did not substantiate the academic benefits of intentional looping. Unlike the research reviewed for this study (Skinner, 1998; Patterson, 2000; Swanson, 1999), the practice of looping in this study was unintentional. Although the academic benefits of looping were not found, the presence of looping was found for all locales and county locations in Tennessee.

This research provided initial steps into understanding the effects of teacher-student relationships in the form of unintentional looping. The premise that looping would be present in small rural schools was confirmed. By examining the proportion of looping that occurred as reported from the Mathematics Department Chairperson surveys, the proportion of looping was significantly higher in rural schools than nonrural schools. Moreover, the presence of looping was also found to be greater in Appalachian counties than non-Appalachian counties. The greatest percentage of looping occurred in rural Appalachia followed by rural non-Appalachia. Overall, looping was reported as occurring in 78 of the 173 surveys that were returned (about 45%).

In Part Four, a more focused investigation of looping was conducted. This research indicated that the students who were looped in three rural Appalachian counties had a higher mean ACT Mathematics Test score than students who were not looped. Although this difference was not found to be statistically significant, further investigation indicated that significant differences might be detected if the sample size would have been tripled. Similar to the findings from the Mathematics Chairperson Surveys, the presence of looping was found. Of the 86 respondents, sixty-five reported being looping during high school mathematics courses.

SES

The well-documented negative effects of poverty on mathematics achievement were found in this study. Similar to the Coleman Report (1966), this

study found that as the SES percentage increased, the mathematics achievement decreased. This was true for both grade levels examined and all three instruments used. At the twelfth grade level, SES was negatively related to twelfth grade class size. Thus as the size of the school increased, the poverty level decreased. Since the majority of small schools were rural, this finding seemed to reinforce the research of Beeson and Strange in *Why Rural Matters* (2003).

Eighth and Twelfth Grade Class Size

Findings on eighth grade class size indicated a significant positive relationship when examining the school means on the Algebra 1 Gateway Test. As the eighth grade class size increased, the Algebra 1 Gateway Test school means increased. There was no significant relationship found between school means on the Mathematics Section of the TCAP Achievement Test and eighth grade class size.

The twelfth grade findings like those from the Algebra 1 Gateway Test indicated a positive relationship between twelfth grade class size and mathematics achievement. These findings indicated that as the twelfth grade class size increased the school means on the ACT Mathematics Test increased. The findings on the Algebra 1 Gateway Test and on the ACT Mathematics Test were in contrast to the findings of La Sage and Ye (2000) and Howley and Bickel (1999) that indicated that small schools positively effect academic achievement, but these findings were similar to Lindberg, et al (1985).

Access to Upper-Level Mathematics Courses

The most significant relationship found when examining the data from the Mathematics Department Chairperson Survey was between the number of mathematics courses offered at a school and school means on the ACT Mathematics Test. The findings indicated that as the number of mathematics courses offered at a school increased, the school means on the ACT Mathematics Test increased. This finding was similar to Lee et al (1993) and Pelavin and Kane (1990) that indicated that availability of courses and courses taken were a powerful predictor of academic achievement. Moreover, this study agreed with Raley's findings that the number of mathematics courses at a school were a powerful predictor of success on the ACT Mathematics Test. (1992)

Besides the relationship with mathematics achievement, the number of mathematics courses offered at a school was related to the size of the mathematics faculty. This result indicated that as the size of the faculty increased the number of courses offered increased. This result adds evidence to the argument that course offerings at small rural schools are limited because of staff size. (Herzog & Pitman, 1991; Howley, 1996; Barker, 1985; Greenberg, 1995)

Average Mathematics Class Size

The effects of the average mathematics class size on mathematics achievement were only tested at the twelfth grade level. The average

mathematics class size for a school was analyzed using data from the Mathematics Department Chairperson Survey. The analysis of this variable indicated a positive relationship between average mathematics class size and mathematics achievement. Hence as the average number of students in a mathematics class increased, this study indicated that the mathematics achievement also increased. This finding was in contrast to the research reviewed for this study. (for example, Grantham, 2000; Finn, 1990)

Limitations

This section begins with a discussion of the overarching limitations for each part of the study, and then a more detailed discussion for each part.

Overarching Limitations

Data collected to analyze the research questions were reported over varying years. The locale information and eighth or twelfth grade class sizes were obtained from the NCES website's "CCD Build a Table" option. The information reported from this source was gathered in the 2000 National Census. Since a national census is not taken yearly, this information was assumed to be consistent until the next national census. The school means reported on the 2002 Tennessee School Report Cards were based on the 2001-2002 school year. Finally, the survey information that was used in connection with the twelfth grade data was collected during the 2002-2003 school year. Although the years

for the data varied, the information was assumed to be consistent so that the analyses would represent an accurate picture of mathematics achievement in Tennessee. This assumption of consistency of the data may be considered a limitation to this study.

Another limiting factor in the study was missing data on the 2002 Tennessee School Report Cards. Some schools did not report either a school mean, SES level, or both on the school report card. Any information that was provided was retained. Moreover, some schools have been opened since the start of this study, and some schools have been closed. Thus, the data may contain additional or lack some school means.

Two other potential limitations to the study include the following. One, the use of a self-selected sample and self-reported data for Parts Three and Four were limitations of this study. Two, mathematics instruction was assumed to include both high and low quality mathematics instruction for all students. For this reason, the quality of mathematics instruction was assumed similar for all participants in this study. Due to the variability in faculty sizes in rural and nonrural schools, this assumption may have been a limiting factor to the findings.

Part One

The lack of variability in the Algebra 1 Gateway Test scores limited the investigation into the relationship with mathematics achievement and school locale for this instrument. Moreover, the scores reported for Algebra 1 Gateway Test school means may have occasionally included seventh grade students.

Part Two

ACT school means are not provided for groups with less than 30 students. Six of the school means used in this study were from schools where the twelfth grade size was less than thirty students. These school means were used because the twelfth grade class size was obtained from the 2000 Census. Hence, the size could have changed slightly to provide the sample the needed thirty students. All school means that were used were within ten students of the needed thirty. This may be considered a limitation of the study.

Part Three

The self-selected sample used to investigate the population of southeast Appalachian schools may not have provided a true representation of the presence or the effectiveness of the status of looping since the return rate was sixty percent. The reliability measure of the survey was not calculated. Thus, questions from the surveys may have permitted inconsistent responses from different responders. For example, schools with seven mathematics teachers and schools with fourteen mathematics teachers would have responded with the same answer of "7 or more" on the survey. The average mathematics class size also may not have been a true representation of the actual mean class size. Respondents to this question may have presented a rough estimate rather than the true mathematical mean class size. Lastly, the question that asked for looping percentage presented abrupt categories (0%, 25%, 50%, 75%, and

100%). Some respondents made side comments that indicated the presence of looping was ten percent for example, but checked zero percent due to rounding. Knowing whether respondents rounded high or low is a limitation of this study; and although some respondents indicated a looping percentage of zero, looping may have occurred in that school.

Part Four

The small number of students that responded as being “not looped” limited the examination of the mathematics achievement between looped and non-looped groups. Although this provided very important information on the presence of looping, this limited the evidence on the effectiveness of looping. Moreover, another limitation of the self-selected sample was that the return rate for the student surveys was not able to be determined. The self-reported ACT Mathematics Test scores also was a limitation. The students were asked without penalty to complete the survey. The validity of the information reported on the survey was a potential limitation.

Discussion

This section contains the researcher’s thoughts and reactions to the study. Overall, the study did add significant findings to the research base on rural mathematics education and the practice of looping in mathematics.

The most significant aspect of this study was the empirical evidence that rural students are performing as well or better than their nonrural counterparts at

two grade levels in Tennessee. This evidence shows that the stereotypes of rural as being “dumb and backwards” are not merited. These results do not imply that rural locales can be neglected. Like the findings of Beeson and Strange (2003), Tennessee must make rural education a priority. Although this study documents the achievement of rural locales, it does not address the inadequacies of rural funding and rural facilities that may be significantly different from nonrural settings.

Another significant aspect of this study was the documentation on the presence of looping. Looping was reported as occurring by both Mathematics Department Chairpersons and by students from three rural Appalachian counties. Although the proportion of looping is greater in rural locales than nonrural locales, looping was found in all locales across the state of Tennessee. Despite not finding significant relationships between students that were looped and those that were not looped, the large percentage of schools that indicated the presence of looping warrants a more detailed study of this practice's effectiveness.

One possible reason for not finding a significant relationship between schools that indicated looping and those that did not was Question Four of the Mathematics Department Chairperson Survey (Appendix B). This question may have limited the understanding on the effectiveness of looping. Since the respondents had to choose between five percentages, the ability to research the effects of looping was diminished. The p -value for the relationship between looping and ACT Mathematics Test school means was .072. If a respondent would have been able to write a specific percent for looping present rather than

choose between five percentages listed, a significant relationship may have been able to be detected. Some schools indicated the presence of looping, but responded with zero percent because the amount of looping present was closer to zero percent than twenty-five percent. Another observation from the Chairperson survey data was that rural schools tended to loop all types of students while the nonrural schools tended to loop only the honor students. Looking at the school means where all students are looped as compared with schools that do not loop may provide more valuable information on the effectiveness of looping. If the benefits of looping as presented in the review of literature are accurate, this may imply that all types of nonrural students (especially urban students) should be involved in looping, and not just honor students.

The findings for the Algebra 1 Gateway Test were predictable. In Tennessee, an Algebra 1 course offered at the eighth grade would be for mathematically advanced students. Therefore, high scores would be anticipated. The significance of the findings was that rural students were averaging as high as nonrural students on Algebra 1 Gateway Test school means. One area that was not examined in this study was the difference in access to Algebra 1 between rural and nonrural students. Descriptively, the study found the number of rural schools that reported Algebra 1 Gateway Test school means were two-thirds that of nonrural schools. Although this may not be a statistically significant amount, the issue of access for rural eighth graders may potentially be a

contributing factor to later success in mathematics and future access to upper-level courses in mathematics.

Another aspect of the study that was predictable based upon the review of literature was the effect of high poverty on eighth and twelfth grade mathematics achievement. High poverty for both groups meant lower mathematics achievement. Knowing the significant effects of SES on mathematics achievement, this researcher questions whether the results would have been similar if one large nonrural, non-Appalachian district would have been extracted from the analyses. This district which contained high SES percentages appeared to lower the school means for nonrural, non-Appalachian schools.

The effects on mathematics achievement by the number of mathematics courses offered were also not surprising. As the number of course offerings increased, so did the mathematics achievement. Since the ACT Mathematics Test covers topics ranging up to Trigonometry, the opportunity to learn these topics in upper-level mathematics courses would seemingly increase a student's ability to obtain a higher score.

The effects of eighth and twelfth grade class size and the effects of the average mathematics class size were two surprising findings from this study. The majority of the research reviewed in Chapter II indicated that smaller schools and small classes were more effective in terms of achievement. The findings of this study indicated that mathematics achievement increased as eighth and twelfth grade class size and the average mathematics class size increased. Possible reasons for this relationship may be that larger schools are able to offer

Algebra 1 or more upper-level mathematics courses (which was found to be a significant factor on mathematics achievement) or that larger schools have more mathematics faculty (which may offer the opportunity for more course and more exposure to higher quality mathematics instruction). Another possibility may be the relationship found between SES and twelfth grade class size. This relationship indicated that as twelfth grade class sizes increase, the poverty levels decreased. Similar to the research presented by Haller (1992), the effects of size on mathematics achievement may be related more to SES. Since the findings of this study indicated that increasing grade and class size increased mathematics achievement while lowering poverty levels, determining whether the effects of achievement were due to increased size or lowered SES is difficult.

Conclusion

This study added to the research base of two areas that are minimally documented, rural mathematics education and the practice of looping. The study presented data to help understand the status of these areas in the state of Tennessee. Information was gathered for eighth and twelfth grade students for the 2001-2002 school year. The research indicated that the assumed rural label of "backwards or dumb" was inaccurate. Rural eighth and twelfth grade students in terms of mathematics achievement are performing as well or better on three tests of mathematical achievement in the state of Tennessee. Moreover, the Appalachian region of Tennessee is performing as well or better than their non-Appalachian counterparts on the same three measurements. The presence of

looping in the state of Tennessee was found in this study. Although no high schools in the state have purposefully implemented this educational practice, it does exist. The presence of looping is greater in rural schools than nonrural schools and in Appalachian schools than non-Appalachian schools. Other factors that were found to influence mathematics achievement in this study were SES, eighth and twelfth grade class size, the number of upper-level mathematics courses offered at a school, and the average mathematics class size.

Implications for Future Research

General Research

1. Replication of this study in other southeast Appalachian regions needs to be conducted.
2. Replication of this study in the state of Tennessee in subsequent years needs to be conducted in order to examine if trends exist and to determine if educational policies cause shifts in the differences between rural students and their counterparts.

Rural and Mathematics Education Research

1. A more specific examination comparing rural schools to suburban and urban schools rather than a broad sweep investigation of rural versus nonrural schools needs to be conducted.
2. Case studies examining the aspects of looping that positively impact mathematics achievement.

3. Research is needed to examine the status of teaching mathematics in varying school locales. This examination needs to be two-fold focusing on one, curriculum and two, teacher preparation and qualifications.
4. Research to determine if access to Algebra 1 is greater in nonrural than rural schools. If the access is greater, what effects does this have on later mathematics achievement and access to upper-level mathematics achievement?

Looping

1. Further investigation into the unintentional practice of looping in small rural schools and the effects of this practice on mathematics achievement in Tennessee and southeast Appalachian regions is needed.
2. Studies need to be conducted that repeat Part Four of this study with a larger sample. The power analysis for this section indicated that the sample needed to be tripled to determine significant differences between students who were looped and those who were not looped. Thus, future research would want to increase the number of counties from three to nine in order to determine differences.
3. Research examining schools with one to two mathematics teachers that have the presence of looping versus those that do not is needed.
4. The development of an experimental design so that some students are looped and some are not in order to determine the effectiveness of the

practice of looping while controlling for teacher effectiveness in schools with two mathematics teachers is needed.

5. Methodology needs to be developed in order to investigate the effectiveness of intentional and non-intentional looping.
6. Determining if the proposed benefits of intentional looping are present in schools where looping is unintentionally practiced.
7. Determining if the proposed benefits of intentional looping are present when students have the same teacher for consecutive courses, but in a school with an alternative school schedule than the traditional six to seven class period day.

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APPENDICES

Appendix A

Mathematics Department Chairperson Survey Spring 2003

High School Code: _____

All the information provided by this survey will remain strictly confidential.

1. Place an X by the courses that are offered at your school.

_____ Advanced Algebra and Trigonometry	_____ Statistics
_____ Discrete Mathematics with Statistics and Probability	_____ Calculus
_____ PreCalculus	_____ Calculus AB
	_____ Calculus BC
	_____ AP Statistics
	_____ Calculus 2

2. How large is your mathematics department?

_____ 1-2 Teachers	_____ 5-6 Teachers
_____ 3-4 Teachers	_____ 7 or more Teachers

3. What is the average (arithmetic mean) class size for the upper level mathematics courses (above Algebra 2 and Geometry) at your school?

_____ Under 15	_____ 25-27
_____ 16-18	_____ 28-30
_____ 19-21	_____ Above 30
_____ 22-24	

4. Looping is the practice in which students have the same teacher for consecutive courses. (For example, Mrs. Smith teaches the same group of students in Algebra 1 and then Geometry.)

What percentage of the students are looped at your school?

_____ 0%	_____ 75%
_____ 25%	_____ 100%
_____ 50%	

5. If looping occurs, what type of students are looped?

_____ Honors only	_____ N/A (looping does not occur)
_____ Remedial only	
_____ All	

How would you classify your school?

____ Rural
____ Suburban
____ Urban

6. What type of schedule does your school follow?

____ Traditional
____ 4x4 Block

____ AB Block
____ Other

Appendix B

Student Survey Spring 2003

High School Code: _____

The information that you are giving is important to the study being conducted by this researcher. Please be sure to give accurate information. All responses given will be kept anonymous. Thank you for your participation.

1. Have you had the same mathematics teacher for two or more consecutive mathematics classes (for example Algebra 1 then Geometry, or Algebra 1 then Algebra 2)?

_____ **Yes**

_____ **No**

2. What was your most current ACT Mathematics score? _____

Appendix C

Reliability Measures for the Algebra 1 Gateway Test, the Mathematics Section of the TCAP Achievement Test, and the ACT Mathematics Test.

Instrument		Statistical Test	Coefficient
*Algebra 1 Gateway Test	Fall 2001 Form A	Cronbach's Alpha	0.92
	Spring 2002 Form B	Cronbach's Alpha	0.92
**Mathematics Section of the TCAP Achievement Test (Grade 8)		Kuder-Richardson KR20	0.89
***ACT Mathematics Test		Not Stated	0.90

Citations:

- * Gateway Operational 2001-2002 Technical Manual
- ** TCAP M Technical Report
- *** 1997 ACT Assessment Technical Manual

Appendix D

Validity Arguments for the Algebra 1 Gateway Test, the Mathematics Section of the TCAP Achievement Test, and the ACT Mathematics Test.

- * Algebra 1 Gateway Test
(Gateway Operational 2001-2002 Technical Manual, p. 19-22.)

Part 4: Validity

"Validity refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests. Validity is, therefore, the most fundamental consideration in developing and evaluating tests. The process of validation involves accumulating evidence to provide a sound scientific basis for the proposed score interpretations" (AERA, APA, NCME, 1999).

The purpose of test validation is not to validate the test itself but to validate interpretations of the test scores for particular purposes or uses. Test validation is not a quantifiable property but an ongoing process, beginning at initial conceptualization and continuing throughout the lifetime of an assessment. Every aspect of an assessment provides evidence in support of its validity (or evidence to the contrary), including design, content specifications, item development, and psychometric quality.

The Gateway tests have been designed as end-of-course tests that Tennessee students must pass as part of the requirements for earning a high school diploma; beginning with incoming high school freshmen in 2001-02 who will graduate in 2004-05⁴. The results can also be used in a criterion-referenced manner to analyze the strengths and weaknesses of a student's achievement in each content area, to plan for further instruction, to plan for curriculum development, and to report progress to parents. The results can also be used as one factor in making administrative decisions about program effectiveness, class grouping, and needs assessment.

Content-Related Validity

Content-related validity in achievement tests is evidenced by a correspondence between test content and instructional content. To ensure such correspondence, developers conducted a comprehensive curriculum review and met with educational experts to determine common educational goals and the knowledge and skills emphasized in curricula.

Construct Validity

Construct validity—what test scores mean and what kinds of inferences they support—is the central concept underlying the Gateway test validation process. Evidence for construct validity is comprehensive and integrates evidence from both content- and criterion-related validity. For example, to demonstrate comprehensiveness, Gateway tests must contain items that represent essential instructional objectives. Items were developed to reflect the skills expected of high school graduates.

Minimization of Construct-Irrelevant Variance and Under-representation

Minimization of construct-irrelevant variance and construct under-representation is addressed in the steps of the test development process: 1) specification, 2) item writing, 3) review, 4)

⁴ See <http://www.state.tn.us/ae/highschooltests.html>

field testing, 5) test construction, and 6) calibration. Construct-irrelevant variance refers to error variance that is caused by factors that are unrelated to the constructs measured by the test. For example, when tests are not administered under standardized conditions (e.g., one administration may be timed, but the other administration may be untimed), these different conditions may lead to differences in student performance.

A final step in minimizing construct-irrelevant variance is careful specification of content, and review of the items representing that content. Empirical evidence, especially item-level data, is used to infer construct irrelevance. Items with poor statistical fit or distractors with positive point biserial correlations may indicate that an item is tapping an ability that is irrelevant to the construct being measured. Differential item functioning with respect to subgroups might indicate construct irrelevance. Items that have these attributes are not selected or are given a lower priority for selection at the test construction stage.

Construct under-representation occurs when the content of the assessment does not reflect the full range of content that the assessment is expected to cover. Gateway represents a state curriculum; content is driven by the Performance Level Indicators established by the Tennessee Department of Education. The specification and review steps, in which test blueprints are developed and reviewed, are the primary steps in the development process designed to ensure that content is equitably represented.

Speededness

Examining the percentage of students who respond to the last items in the test can assess the degree to which a test is speeded. Tables 5 and 6 display the proportions of students who did not respond to the last 10 calibration items on the tests. The omission rates for each of the last 10 items were small and consistent with one another, suggesting that students had sufficient time to complete the entire assessment. If speededness were a concern, one would expect higher omit rates towards the end of the assessment.

Divergent (Discriminant) Validity

Measures of different constructs should not be highly correlated with each other. Divergent validity is a subtype of construct validity that can be estimated by the extent to which measures of constructs that theoretically should not be related to each other are, in fact, observed to not be related to each other. Typically, correlation coefficients among measures are examined in support of the divergent validity. Most recent Reporting Category Performance Indicators (RCPIs) and scale scores were obtained for each student by matching Mathematics and Science data for Fall 2001, Spring 2002, and Summer 2002. Only students who had scores for both Mathematics and Science were retained ($N=17,556$). The mean scale score for these students was 525 ($SD=50$) for Mathematics and 522 ($SD=50$) for Science.

The correlation between Mathematics and Science scale scores was 0.66. This correlation shows that individual student scores for Mathematics and Science are related moderately. The correlation is not so low as to call into question whether these two tests are tapping into achievement constructs, and not so high as to arouse suspicion that the intended constructs are not distinct. It is worth mentioning that the typical correlation between *TerraNova* Mathematics composite and Science scores is around 0.67.

Mathematics Section of the TCAP Achievement Test (TCAP M Technical Report, p. 3, 6.)

Part 2: Content Rationale/Test Construction

Establishing the Content Rationale

To establish the content for TCAP (*TerraNova*), assessment developers met with advisory panels composed of classroom teachers, administrators, and content specialists from all parts of the country and asked what they would like to see in assessments. Comprehensive reviews were conducted of curriculum guides from almost every state, and many districts and dioceses to determine common educational goals. Assessment developers carefully examined the content of recently published textbook series, instructional programs, and national standards publications. Contributions from these advisory panels and results of the curriculum reviews defined the following principles guiding the development of TCAP (*TerraNova*):

- to provide valid, equitable measurement of achievement in the areas of reading, language, mathematics, science, and social studies;
- to offer multiple ways of measuring student progress;
- to give information useful for improving instruction;
- to reflect current curricula and national standards; and
- to engage and motivate students so they will perform their best work.

The TCAP tests sample commonly taught processes, skills, and knowledge. They do not measure all of the skills that make up an educational domain, nor define the curriculum, which cover the domains in greater depth and breadth. Teachers should avoid gearing instruction to specific test content in TCAP because doing so may cause distortion in assessment scores and could lead to an inaccurate reflection of overall achievement.

Curriculum reviews and the advice of educational experts also led to development of different ways of gauging what students can do. New selected-response item formats that measure a wide variety of thinking skills were designed. One of the most compelling results of collaborating with educators was the work conducted on page layout and graphic design. This research showed that these components play an important part in student performance. Many changes in design were made because of this usability research.

thinking skills and critical judgment in making decisions about how to best convey meaning in written English.

Testing materials for primary levels are designed to follow a literacy continuum. Each level recapitulates some skills measured at the preceding level before moving on to assessment of the next stage in literacy achievement.

Mathematics. Development of the Mathematics test was aligned with the National Council of Teachers of Mathematics (NCTM) Standards. More emphasis was placed on a balance of skills, concepts, knowledge, and problem solving than on procedural and computational processes. This emphasis produced assessment materials rich and varied in context and relevant to students' lives.

Non-routine problem-solving items are included for every test objective. Items are not limited to a single objective dealing with one- and two-step word problems. Estimation and pattern recognition are underlying skills that represent more than a single objective. The test also reflects a greater balance among the areas of numeration, number theory, data interpretation, pre-algebra, measurement, and geometry. Using tools such as calculators and rulers is an integral part of the assessment.

Mathematics is presented as a useful tool for making sense of the world. Items reinforce the connections between mathematical principles and their applications in everyday life. A broadening and deepening of higher-order thinking skills accompany adherence to NCTM Standards, as does an emphasis on the contextual integration of mathematics with other content areas such as social studies and science.

Chapter 4 Validity Evidence for the Tests of Educational Development

Overview

According to the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1985), "The concept [of validity] refers to the appropriateness, meaningfulness, and usefulness of the specific inferences made from test scores" (page 8). Arguments for the validity of an intended inference made from a test may contain logical, empirical, and theoretical components. A distinct validity argument is needed for each intended use of a test.

The potential interpretations and uses of ACT Assessment scores are numerous and diverse, and each needs to be justified by a validity argument. In this chapter, validity issues are discussed for five of the most common interpretations and uses: measuring college-bound students' educational development in particular subject areas, making college admissions decisions, making college course placement decisions, evaluating student progress between the sophomore and senior years of high school, and evaluating student progress during the first two years of college.

Measuring Educational Development

Content Validity Argument for ACT Assessment Scores

The ACT Assessment tests of educational development are designed to measure students' problem-solving skills and knowledge in particular subject areas. The usefulness of ACT Assessment scores for this purpose provides the foundation for validity arguments for more specific uses (e.g., course placement).

The guiding principle underlying the development of the ACT Assessment is that the best way to predict success in college is to measure as directly as possible the degree to which each student has developed the academic skills and knowledge that are important for success in college. Tasks presented in the tests must therefore be representative of scholastic tasks. They must be intricate in structure, comprehensive in scope, and significant in their own right, rather than narrow or artificial tasks that can be defended for inclusion in the tests solely on the basis of their statistical correlation with a criterion. In this context, content-related validity is particularly significant.

The ACT Assessment tests contain a proportionately large number of complex problem-solving exercises and few measures of narrow skills. The tests are oriented

toward major areas of college and high school instructional programs, rather than toward a factorial definition of various aspects of intelligence. Thus, ACT Assessment scores are directly related to student educational progress and are easily interpreted by instructional staff, parents, and students.

As described in chapter 2, the test development procedures include an extensive review process with each item being critically examined at least twenty times. Detailed test specifications have been developed to ensure that the test content is representative of current high school and university curricula. All test forms are reviewed to ensure that they match these specifications. Hence, there is an ongoing assessment of the content validity of the tests during the development process.

The standardization of the ACT Assessment tests is also important to their proper use as measures of educational development. Because ACT Assessment scores have the same meaning for all students tested on national test dates,¹ they can be interpreted without reference to these characteristics. The courses students take in high school and the grades they earn are also measures of educational development, but these variables are not standardized measures. The reason they are not standardized is that course content varies considerably among schools and school districts, and grading policies certainly vary among instructors. Therefore, while high school courses taken and grades earned are measures of educational development, their interpretation should properly take into account differences in high school curricula and grading policies. ACT Assessment scores, because they are standardized measures, are more easily interpreted than are courses taken and grades earned.

Comparison of Groups Differing in Educational Background

Table 4.1 provides information from the 1988 nationally representative sample about the relationship among scores, academic level, and educational plans. In this table, the means for the college-bound group are greater than the means for the national group for all four test scores, seven subzones, and the Composite score. This finding indicates that, as expected, ACT Assessment scores are related to educational plans: Students with higher educational aspirations earn higher scores. Also as expected, ACT Assessment scores are related to grade level: Examinees in higher grades earn higher test scores.

¹ ACT scores obtained before October 1988, however, are not directly comparable to scores obtained in October 1988 or later. A new version of the ACT Assessment was released in October 1988 (the "enhanced" ACT). Although scores on the current and former versions are not directly comparable, approximate comparisons can be made using a concordance table developed for this purpose (American College Testing Program, 1988b).

Groups of examinees who were presumed to differ in their educational development for reasons other than grade level were also compared. Examinees in the Academic Skills Study (see chapter 3) were asked to indicate the number of high school English and mathematics courses they had taken and/or planned to take. For first-semester seniors, this information provides an indica-

tion of how many courses they had taken or were enrolled in (as contrasted to how many courses they planned to take). Of the 5,058 twelfth-grade examinees, only 50 had invalid or missing responses to the item concerning English courses, and only 63 had invalid or missing responses to the item concerning mathematics courses. For each item, the remaining examinees were grouped into

three categories: those who had taken and/or planned to take 3½ or more years of the subject, those who had taken and/or planned to take 2½ or 3 years of the subject, and those who had taken and/or planned to take 2 years or less of the subject.

Table 4.2 displays the ACT Assessment scale score means and standard deviations for these three groups of twelfth graders by years of English and mathematics course work taken/planned to take. For the ACT Assessment English Test, it can be seen that the largest score differences are, not unexpectedly, between those who have taken and/or are planning to take at least 3½ years of English and those who have taken and/or are planning to take 2 years or less. Those who have taken and/or are planning to take between 2½ and 3 years performed more similarly to the 2-year-or-less group than to the 3½-or-more group. This pattern is also true for the ACT Assessment Mathematics Test. Results are presented in more detail in Harris and Kolen (1999).

These findings—that students who have taken and/or plan to take more English and mathematics courses (and in the fall of grade twelve, students can plan for only one semester of courses at most) have higher English and Mathematics Test scores and outcomes—support the interpretation that the ACT Assessment is a curriculum-based achievement test. However, it is also conceivable that able students take more English and mathematics classes and score higher on all types of English and mathematics tests.

Statistical Relationships between ACT Assessment Scores and High School Course Work and Grades

The ACT Assessment tests are oriented toward the general content areas of high school and college curricula. Students' performance on the ACT Assessment should therefore be related to the high school courses they have taken and to their performance in these courses.

The Course/Grade Information Section (CGIS) of the ACT Assessment collects information about 30 high school courses in English, mathematics, social studies, natural sciences, languages, and arts. Many of these courses form the basis of a college-preparatory (high school) curriculum and are frequently required for college admission or placement. For each of the 30 courses, students indicate whether they have taken or are currently taking the course, whether they plan to take it, or do not plan to take it. If they have taken the course, they indicate the grade they received (A–F). Self-reported coursework and grades collected with the CGIS have been found to be accurate relative to information provided on student transcripts (see "Validity Evidence for High School Course Grades," page 58).

The college-preparatory core curriculum is defined by ACT as at least four years of English and at least three years each of mathematics, social studies, and natural sciences. As shown in Table 4.3, students who have taken or plan to take the core curriculum tend to achieve higher

ACT Assessment scores than those who have not completed the core curriculum. From 1991–92 through 1995–96, the ACT Assessment Composite scores of students who completed the core curriculum averaged about 3 scale score units higher than the scores of those who did not. Table 4.4 shows that those students who had higher course grades also tended to achieve higher ACT Assessment scores.

Noble, Crouse, Sawyer, and Gillespie (1992) showed that, in general, course work and high school grades are strongly associated with performance on the ACT Assessment. They used a stratified random sample of 40,000 ACT-tested high school students (juniors and seniors) for the academic year 1989–90. The sample included 400 high schools selected on the basis of their mean ACT Assessment Composite score, locale (rural, urban, suburban), control (public, private), region, ACT test volume, and proportion of all students who completed the ACT Assessment.

Data from the CGIS were used to create several independent variables to quantify students' high school course work and grades. The results from Noble and McNeely (1990) were used to identify initial course work variables, including patterns of courses taken and grade averages within each subject area. Additional specific course work and grade variables were developed that took into account the level of difficulty of each course taken and the grades received.

Other student factors were studied, including family income; self-reported needs for help in reading, mathematics, writing, and study skills; class level (junior or senior); ethnicity (African American/Black, Caucasian American/White, Hispanic [Mexican American/Chicano, Puerto Rican, Cuban, other Hispanic], or Asian American/Pacific Islander); gender; and four variables reflecting educational plans (certainty of college major, highest level of education planned, self-estimate of first-year college grade average, and enrollment in a college preparatory curriculum). Dummy variables were created to represent high school attended.

Preliminary linear multiple regression models were developed for estimating the five ACT Assessment scores (English, Mathematics, Reading, Science Reasoning, and the Composite). Models were developed for the total group, pooled across ethnic group, gender group, and high school. Independent variables having the highest simple correlations with ACT Assessment scores and those associated with the least amount of missing data were included. The independent variables were studied in groups: (1) course grades or grade average, courses taken, grade level at time of testing; (2) educational plans and background variables (excluding ethnicity and gender), given group 1 variables; (3) dummy variables representing high school attended, given variables from groups 1 and 2; and (4) ethnicity or gender, given variables from groups 1, 2, and 3. Statistically nonsignificant ($p \geq .001$) and collinear independent variables, and those not increasing

VITA

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Jeremy would spend most of his college life at Harding University in Searcy, Arkansas. At Harding, he would earn a Bachelor's of Arts in Mathematics and a Master's of Education in 1996 and 1997 respectively.

Upon graduation from Harding University, Jeremy took a teaching position at Christian Home and Bible School in Mt. Dora, Florida. He taught middle school and high school mathematics in Mt. Dora for three years before returning to his home state to start on a doctorate degree.

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