A STUDY COMPARING FIFTH GRADE STUDENT ACHIEVEMENT IN MATHEMATICS IN DEPARTMENTALIZED AND NON-DEPARTMENTALIZED SETTINGS

by

Karen Ann Nelson

Liberty University

A Dissertation Presented in Partial Fulfillment Of the Requirements for the Degree Doctor of Education

Liberty University

April, 2014
Copyright © 2014
by Karen Ann Nelson
A STUDY COMPARING FIFTH GRADE STUDENT

ACHIEVEMENT IN MATHEMATICS

IN DEPARTMENTALIZED AND NON-DEPARTMENTALIZED SETTINGS

by

Karen Ann Nelson

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

Liberty University, Lynchburg, VA

April, 2014

APPROVED BY:

REBECCA S. HARRISON, Ed.D., Committee Chair

JONATHAN BURTON, Ed.D., Committee Member

VICKI HOLLINSHEAD, Ph.D., Committee Member

SCOTT B. WATSON, Ph.D., Associate Dean of Advanced Programs
A STUDY COMPARING FIFTH GRADE STUDENT ACHIEVEMENT IN MATHEMATICS IN DEPARTMENTALIZED AND NON-DEPARTMENTALIZED SETTINGS

ABSTRACT

The purpose of this quantitative, causal-comparative study was to examine the application of the teaching and learning theory of social constructivism in order to determine if mathematics instruction provided in a departmentalized classroom setting at the fifth grade level resulted in a statistically significant difference in student achievement on the Virginia 2011 Grade 5 Mathematics Standards of Learning (SOL) Test when compared to the achievement of students in a non-departmentalized setting. Regular fifth grade education students, who attended non-Title 1, Pre-K through Grade 5 elementary schools in an urban eastern Virginia school district, participated in this study. A three-way between-groups analysis of covariance (ANCOVA) was conducted, utilizing students’ Virginia 2010 Grade 4 Mathematics SOL Test scores to control for previous achievement, comparing the mathematics achievement of departmentalized and non-departmentalized whole groups, as well as gender and racial minority/non-minority subgroups. The results of a three-way ANCOVA analysis, which incorporated the factors of classroom organizational structure, gender, and racial status, showed that using a departmentalized setting for instruction resulted in a statistically significant difference in student achievement in mathematics based upon classroom organizational structure. There was not a statistically significant difference in student achievement based upon the effect of gender or race, and additionally, there were no statistically significant interactions between gender, race, and structure, as measured by comparing
departmentalized and non-departmentalized whole group and subgroup performance.

Therefore, the results of this study suggest that there may be a cause-and-effect relationship between using a departmentalized setting to provide instruction in mathematics at the fifth grade level and higher student achievement in mathematics for all students.

Descriptors: analysis of covariance (ANCOVA), causal-comparative, departmentalized, racial minority subgroup, racial non-minority subgroup, fifth grade, gender, instruction, mathematics, non-departmentalized, non-Title 1, regular education, social constructivism, Virginia Standards of Learning (SOL) Mathematics Test, student achievement
DEDICATION

I would like to dedicate this dissertation to my husband, Thomas Michael Nelson, who has always been so supportive of me personally, encouraging me as an individual, and for always building me up and for believing in me and in what I could accomplish. He was always there supporting me as a professional, and as a student, as I took on new challenges, long after most people had finished school. I would also like to dedicate this dissertation to my children, Kathleen Erin and John Thomas, whom I could not love more and who have made my life complete.

I also dedicate this dissertation to my late mother, Theresa Carroll Lynch. She was such a kind, considerate, knowledgeable person, who truly loved me for who I was and who possessed a variety of intellectual and emotional gifts. I learned so much from her about how to persevere in difficult times and also about how to be a good mother myself. She had unyielding faith in God and taught me the power of prayer, as she often prayed to Jesus, Mary, Joseph and also to St. Jude, the Patron Saint of Hopeless Causes. My mother passed away in 1998, but I feel her presence every day, knowing that she, God above, and all the saints are supporting me and my family in this journey through life.

I would also like to dedicate this dissertation to my late dear mother-in-law, Shirley J. Nelson, and late father-in-law, John Thomas Nelson, who were so wonderful to me, accepting of me and loving me as their daughter-in-law. They made me feel like I was their own daughter, and losing them at such an early age was difficult, but Thomas and I have carried on and tried to do right by them in bringing up their two wonderful grandchildren, Kathleen and John, of whom we are so very proud.
Lastly, I would like to dedicate this dissertation to Our Lord Jesus Christ, who divinely inspired me to complete this dissertation. It amazed me how often I would wake up, having thought about solutions to problems related to my study, or how often pieces would fall into place so that I could make progress with my dissertation. There is no question that there was divine intervention that laid the foundation for the completion of my study and my dissertation. I only hope that through attainment of this doctorate that I am able to use this accomplishment to serve God by employing what I have learned to help my family and others as God intended.
ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to my wonderful Chair, Dr. Rebecca Harrison, for her enthusiastic support throughout the dissertation process. She was always, always supportive of me, encouraging me in difficult times, such as when I was delayed due to circumstances beyond our control, and I never gave up, knowing that she was there for me. Her positive feedback through the proposal stage and at the proposal defense laid the foundation for my future success in earning my doctorate. God had to be behind the scenes in helping me find Dr. Harrison as my Chair, and any future doctoral candidate would be fortunate to work with Dr. Harrison as his or her Chair.

I also would like to sincerely express my appreciation to my committee members, Dr. Vicki Hollinshead from Emmanuel College and Dr. Jonathan Burton from Liberty University, who provided valuable feedback to me during this journey and who worked with me during a process that took longer than we had originally planned!

I am also deeply grateful to Dr. Kim Love-Myers from the University of Georgia for her extremely kind and generous support as my statistician. She was so interested and enthusiastic about taking on my project, and her willingness to discuss my study in detail and then work tirelessly on my project was fantastic. Her statistical knowledge and talent, along with her prompt replies to my numerous emails, were absolutely wonderful as we worked together on the statistical analysis for my study.

I would also like to acknowledge the past support I have received from Dr. Jill Jones, late Professor of Education at Liberty University. I was in Dr. Jones’ last intensive class in 2010 before she passed, and she had a profound impact upon me. Dr. Jones was a gifted educator who possessed a deep faith and challenged her students to stretch
themselves as they strived to achieve excellence in their work. She told us to “run
towards the roar,” encouraging us to bravely face the challenges that we would encounter
while working to complete our doctoral work. I know that Dr. Jones has been looking
down upon me from above, encouraging me and supporting me spiritually along the way.

I would like to recognize my third grade teacher, Miss Walsh, from Our Lady Of
Loreto School in East Providence, Rhode Island. I had been very ill in kindergarten and
second grade, which made it very difficult for me to succeed academically. Miss Walsh
was such a wonderful teacher and inspired me to want to be a better student as I
developed a deep love of learning. I would also like to thank all of the teachers at St.
Mary’s Academy, Bay View, in Riverside, Rhode Island for an absolutely wonderful
experience in high school, which allowed me to thrive personally and academically.

I would also like to acknowledge my good friend, Gail Painter, from May Howard
Elementary School in Savannah, Georgia, who helped me develop a closer relationship
with God through her Bible Study class, as we worked towards our National Board
Teaching Certification together.

Finally, I would like to sincerely acknowledge the contributions of Martha
Maurno, a teacher in the field of secondary and post-secondary education and of whom I
am proud to call my best friend, for believing in me and for supporting me throughout
this process. Her thoughtfulness and understanding have been an inspiration to me as I
worked over the years to attain my personal, academic, and professional goals.

Again, thank you to everyone I have recognized who played a part in my life for
their generous, uplifting, and steadfast support throughout the years, which contributed to
my happiness and success.
### Table of Contents

Abstract ............................................................................................................................... ii

Dedication ........................................................................................................................... iv

Acknowledgements ........................................................................................................ vi

List of Tables ...................................................................................................................... xi

List of Figures .................................................................................................................. xii

List of Abbreviations ..................................................................................................... xiii

CHAPTER ONE: INTRODUCTION .................................................................................. 1

  Background ..................................................................................................................... 2

  Problem Statement ....................................................................................................... 12

  Purpose Statement ...................................................................................................... 13

  Significance of Study ................................................................................................. 14

  Research Questions ................................................................................................... 18

  Hypotheses ................................................................................................................ 20

  Identification of Variables ......................................................................................... 22

  Definitions .................................................................................................................. 24

CHAPTER TWO: LITERATURE REVIEW .................................................................... 28

  Theoretical Framework ............................................................................................... 30

    Social Interaction, Cognitive Development, and Learning ................................... 39

    Facilitation of Cooperative Learning .................................................................. 41

  Review of the Literature ........................................................................................... 43

    Elementary Instruction in Virginia ....................................................................... 55

    Teacher Preparation and Expertise ....................................................................... 62

  viii
Departmentalized Instruction ................................................................. 69
Implementation of Departmentalization ........................................... 73
Non-Departmentalized Instruction ...................................................... 76
Mathematics Instruction and Closing the Achievement Gap ............. 78
Summary ............................................................................................. 87

CHAPTER THREE: METHODOLOGY .......................................................... 89
Design .................................................................................................. 91
Questions and Hypotheses ................................................................. 93
Participants ........................................................................................ 97
Setting ................................................................................................. 100
Instrumentation .................................................................................. 106
Procedures .......................................................................................... 114
Data Analysis ....................................................................................... 119

CHAPTER FOUR: FINDINGS ................................................................. 125
Questions and Hypotheses ................................................................. 125
Descriptive Statistics .......................................................................... 129
Assumption Testing ............................................................................. 136
Statistical Results by Hypothesis ....................................................... 140
Summary ............................................................................................... 145

CHAPTER FIVE: DISCUSSION ................................................................. 147
Summary of Findings ........................................................................... 147
Discussion of Findings ......................................................................... 152
Social Constructivism, Learning, and Achievement ....................... 152
List of Tables

Table 1: Cronbach’s Alphas for the 2011 Grade 5 Virginia Mathematics SOL Test….113

Table 2: Departmentalized 2010 Mathematics SOL Test Score Extreme Observations .................................................................130

Table 3: Non-Departmentalized 2010 Mathematics SOL Test Score Extreme Observations .................................................................130

Table 4: Mean and Standard Deviation of 2010 and 2011 Mathematics SOL Test Scores ........................................................................131

Table 5: Mean and Standard Deviation of 2010 and 2011 Mathematics SOL Test Scores by Departmentalized Whole Group ........................................132

Table 6: Mean and Standard Deviation of 2010 and 2011 Mathematics SOL Test Scores by Non-Departmentalized Whole Group ........................................132

Table 7: Descriptive Statistics for Departmentalized Comparison Subgroups ............133

Table 8: Descriptive Statistics for Non-Departmentalized Comparison Subgroups ......133

Table 9: Mean 2011 Math SOL Scores, Adjusted for 2010 Math SOL Scores, by Subgroup .................................................................135

Table 10: Type III Tests of Significance for Individual Factors from the Three-Way ANCOVA .................................................................142
List of Figures

Figure 1: Bar Plot of Means and Standard Error Bars Per Whole Group ……………134
Figure 2: Bar Plot of Means and Standard Error Bars Per Subgroup………………136
Figure 3: Histogram of 2010 Virginia Mathematics SOL Test Scores for All Participants………………………………………………………137
Figure 4: Histogram of 2011 Virginia Mathematics SOL Test Scores for All Participants ………………………………………………………137
Figure 5: Histogram of the Residuals Showing Normal Distribution………………138
Figure 6: Scatterplot of Departmentalized and Non-Departmentalized Whole Groups.140
Figure 7: Scatterplot of Departmentalized and Non-Departmentalized Subgroups ……141
List of Abbreviations

Annual Measurable Objectives (AMO)
Analysis of Covariance (ANCOVA)
Analysis of Variance (ANOVA)
Adequate Yearly Progress (AYP)
Common Core State Standards (CCSS)
Data Collection and Opinion Instrument (DCO)
U.S. Department of Education (ED)
English Language Arts (ELA)
English as a Second Language (ESL)
Educational Testing Service (ETS)
Elementary and Secondary Education Act of 1965 (ESEA)
Georgia Criterion Reference Competency Test (CRCT)
Institutional Review Board (IRB)
National Assessment of Educational Progress (NAEP)
National Board for Professional Teaching Standards (NBPTS)
No Child Left Behind (NCLB)
National Council of Teachers of Mathematics (NCTM)
Statistical Analysis Software (SAS)
Standards of Learning (SOLs)
Virginia Department of Education (VDOE)
Zone of Proximal Development (ZPD)
CHAPTER ONE: INTRODUCTION

Traditional, general elementary education teachers working in traditional, self-contained (non-departmentalized) settings are expected to meet a tremendous number of instructional, behavioral, and administrative demands effectively, while covering all aspects of the elementary school curriculum. The non-departmentalized instructional setting presents a great challenge to these teachers, given that they are expected to be extremely knowledgeable about, and proficient in, all areas of the elementary curriculum.

Given today’s academic environmental pressure to document higher student achievement, along with the gap in the literature involving the evaluation of the effectiveness of different classroom organizational structures at the upper elementary level upon student achievement (Baker, 2011; Chang, Munoz, & Koshewa, 2008; Hood, 2010; Kent, 2010; McGrath & Rust, 2002; Moore, 2008; Patton, 2003; Ponder, 2008; Slavin, Lake, Chambers, Cheung, & Davis, 2009; Williams, 2009; Yearwood, 2011), it is essential that a study of the effectiveness of classroom organizational structures at the elementary level be conducted to address the empirical gap in the literature, adding to the field of knowledge in this area. This causal-comparative study will examine the two key classroom organizational structures typically implemented at the elementary level, namely, departmentalized and non-departmentalized settings, by investigating possible cause-and-effect relationships between the two different organizational structures and student achievement. The results of this study could provide essential information that may influence school districts, school administrators, and teachers as they make decisions about classroom organizational structure at the elementary level, which will support student learning and will contribute to closing the achievement gap between whole
groups and targeted subgroups.

In addition to the existence of an overall gap in the literature with regard to which classroom organizational structure is most effective at the elementary level, in terms of documented student achievement, even fewer studies have focused on the impact of classroom organizational structure on the achievement of subgroups, and the results of these studies have been mixed (Kent, 2010). Chapter 1 provides background information about departmentalized and non-departmentalized classroom organizational structures, presenting the reasoning behind opposing viewpoints with regard to which classroom organizational structure better meets the needs of the upper elementary student.

The background information provided in Chapter 1 is followed by clearly defined problem and purpose statements, which explain the objective of this study. The significance of this study is also outlined, along with a description of the research questions, hypotheses, identification of the independent and dependent variables, assumptions, limitations, and definitions of core terms.

**Background**

Since the historical passage of the No Child Left Behind Act (NCLB) in 2001, the ability to document higher student achievement has entered a politically charged, high-pressure stage of accountability (Mathis, 2004). Teachers have been under increasing pressure since 2001 to ensure that their students meet academic achievement goals established by their school districts, as well as by the state and federal governments, so that Annual Yearly Progress (AYP) goals were met and school and district accreditation standards were maintained in accordance with NCLB guidelines (Baker, 2011; Harris, 2012; Lauen & Gaddis, 2012).
In fact, elementary teachers and students in grades 3 through 8 have borne the brunt of the pressure of the accountability movement in education, as all states test their students in English language arts (ELA) and mathematics at these grade levels (Anderson, 2009). Teachers have also reported that accountability pressures have led them to emphasize specific information that will be tested, focusing on memorization of facts due to the nature of multiple-choice tests, thereby neglecting material that would require the students to apply their higher-order thinking and problem solving skills (Anderson, 2009).

Despite these accountability pressures and efforts put forth by teachers and students, there were substantial doubts about whether teachers could truly help all of their students reach NCLB’s goal of 100% proficiency in reading and mathematics on standardized tests developed by the state departments of education by the 2013-2014 school year (Cavanagh & Hoff, 2008). Therefore, as a result of these doubts and general concern about the future lack of attainment of NCLB goals, President Obama officially outlined his Administration’s comprehensive Elementary and Secondary Education Act of 1965 (ESEA) flexibility package on September 23, 2011. The flexibility package can grant states waivers from specific provisions of NCLB, in return for their implementation of certain reform measures, as reported by the Center for Education Policy (n.d.) on Federal Education Programs NCLB/ESEA Waivers.

As a result, the Commonwealth of Virginia applied for and was approved for its request for ESEA Flexibility from the U.S. Department of Education (ED) on June 29, 2012, upon receipt of an ESEA Flexibility Approval Letter from the U.S. Secretary of Education, Arne Duncan. Under ED flexibility guidelines, Virginia was granted waivers
from provisions of ESEA Section 1111(b)(2)(E)-(H), which included a waiver for
determining AYP under NCLB, where the establishment of annual measurable objectives
(AMOs) in reading and mathematics were allowed to replace the AYP goals under the
federal education law.

The Virginia Department of Education (VDOE) published a news release on June
29, 2012, entitled NCLB Waiver Approved by U.S. Department of Education Flexibility
Plan Does Away with Complex & Unrealistic ‘AYP’ Objectives, which explained that in
accordance with the waiver, annual benchmark goals would need to be established for
student learning, with the objective to reduce the failure rate by 50% in reading and
mathematics for students overall, and for each student subgroup, within a six-year period.
In addition, the waiver required that the amount of student progress attained had to
account for 40% of a teacher’s or principal’s rating on his or her performance evaluation,
further adding pressure to students, teachers, and administrators to continue to document
improvement in student achievement.

The ED issued a follow-up letter regarding ESEA flexibility, outlining
expectations for states that wished to apply for, or had applied for, flexibility regarding
NCLB requirements, stating that states were expected to set rigorous and comprehensive
plans that were “designed to improve educational outcomes for all students, close
achievement gaps, increase equity, and improve the quality of instruction” (Delisle, D. S.,
Delisle to P. I. Wright, August 29, 2012, p. 2). As evidenced by the requirements of
ESEA flexibility comprehensive plans, going forward, closing the achievement gap
between subgroups will continue to be a significant educational focus, from both a
national and state perspective.
Hence, high expectations are being established for academic performance, which will increase the pressure on all teachers and students to perform, as student achievement will continue to be measured based upon the results of annual student assessments. Therefore, ever-growing demands have been placed upon teachers to raise the performance bar in their classrooms in order to help their students to meet changing achievement requirements in reading and mathematics. The need to continue to document higher student achievement, representing greater student learning, often inspires educators to review the effectiveness of the classroom organizational structures already in place at the elementary level, particularly in the upper elementary grades. Rising expectations are particularly difficult to meet at the fifth grade level in the typical non-departmentalized setting because of the level of competency that fifth grade elementary education teachers must possess when teaching students more intricate content in all subject areas (reading, mathematics, social studies, and science).

Departmentalized instructors, also known as platooned instructors (Hood, 2010), at the elementary level typically possess an affinity for their particular subject area, supported by a greater level of knowledge and successful experience in that subject area, which provides a solid foundation for providing comprehensive instruction to students (Abbati, 2012; Baker, 2011; Chang et al., 2008; Hood, 2010; Kent, 2010; Marsh 2008; Moore, 2008; Patton, 2003; Ponder, 2008; Slavin et al., 2009; Williams, 2009; Yearwood, 2011). Lederman and Flick (2003) noted that subject matter knowledge was critical to the success of the teacher and the students, and the only question was how much subject matter expertise was needed in order for them to be successful at different levels.
As noted by Hood (2010), Jeffrey Hernandez departmentalized forty elementary schools when he served as a regional administrator in Dade County, Florida, and he reported that student performance improved dramatically on the state standardized test. Hernandez attributed this dramatic improvement in achievement to instruction provided in a departmentalized setting. As a result, Hernandez moved on to serve as Chief Academic Officer in Palm Beach County, Florida, and he departmentalized third through fifth grades in most of the 107 elementary schools there, given his experience observing the positive impact that departmentalized settings could have upon student achievement.

It is also important to note that most states, including Virginia, only require a general certification at the elementary level to teach in the elementary grades, as opposed to a subject area specialty certification. This can leave teachers lacking in the specialized type of knowledge and training needed to teach at the upper elementary grade levels, particularly in the area of mathematics. For instance, Irving Hamer, Deputy Superintendent of Academic Operations, Technology, and Innovation for the Memphis City Schools, highlighted the fact that not one of their 351 fifth grade teachers majored in math (Hood, 2010). Irving stated that their administration was trying to address this problem by considering alternative instructional solutions in math, including departmentalization, adding that “one way to get higher-order math in the fifth grade would be to departmentalize the fifth grade and make sure math is being taught by the most able math teachers” (Hood, para. 2).

With regard to the teaching of mathematics, Hill, Rowan, and Ball (2005) noted that part of the original NCLB focus had been to ensure that there was a highly qualified teacher in every classroom because there was evidence that American teachers were
lacking in essential subject matter-knowledge, particularly in mathematics. According to Hill et al., despite this increased level of interest and concern about the level of teachers’ expertise in terms of subject-matter knowledge, there is a gap in the research with regard to the study of its correlation with student achievement.

Content knowledge concerns still exist at the pre-service teacher stage, even when teachers have contemporary preparation. Rieg, Paquette, and Chen noted in their 2007 study that pre-service teachers had several concerns regarding their approach to instruction in the classroom that revolved around four themes, which included content knowledge, pedagogy, workload, and relationships. Pre-service teachers reported in the Rieg et al. study that, even though they had passed the required examinations for licensure, they were still concerned about the level of their content knowledge and about whether students would actually know more than they did about certain subjects. The width and breadth of content knowledge needed by one individual is of particular concern when all content-level instruction is provided in a non-departmentalized setting by one teacher.

This concern that teachers have about their lack of sufficient content knowledge in all subjects is a consistent theme shared at the upper elementary level, as noted by Chan and Jarman (2004), who pointed out that providing the most effective instruction in all subject areas is often difficult, if not impossible, for the upper elementary teacher to master. Chan and Jarman also noted that often these teachers just focus on the subject areas in which they are the most knowledgeable and/or the most comfortable, which can greatly impact instruction and student learning in the non-departmentalized classroom setting. This approach to instruction often deprives students of receiving the most
effective instruction in certain subject areas, which differs by teacher and adds to variability in student learning. These deficiencies in instruction are reflected in the students’ lack of mastery in certain subject area material, which may be documented by lower standardized test score performance.

Departmentalized instructors, on the other hand, usually receive specialized instruction in their subject area, either at the graduate level or at educational conferences by choice, or through ongoing, district-provided professional development.

“In no area do we have solid research that would tell us that the use of something called a ‘specialist’ improves kids’ learning – at least in part because the notion of what a specialist is can vary so much,” says Deborah Ball, Dean of the School of Education at the University of Michigan and a member of the National Mathematics Advisory panel. Nevertheless, Ball calls the idea “promising.” In 2008, the panel recommended that researchers look into the effectiveness of using specialists, or departmentalized instruction, to teach math, she notes. “We have a large-scale teacher education problem in this country,” says Ball. When standards are raised, it’s not just the students who are affected; teachers must also acquire new skills in order to teach to those standards, she says. (Hood, 2010, “Breaking from Tradition,” para. 4-5)

Therefore, the utilization of a departmentalized classroom organizational structure at the upper elementary level has the potential to have a significant, positive impact upon student achievement, given that the departmentalized instructor needs to be, and usually is, better prepared to meet the instructional challenge, particularly in the subject area of mathematics. In addition, as highlighted by Deborah Ball (Hood, 2010),
the implementation of departmentalization can be a cost-effective way to have a positive impact upon student achievement by effectively utilizing the teachers already in place, supported by the ability to target their professional development by subject area. The importance of teacher competence is also a foundational component of social constructivist theory, which serves as the theoretical framework for this study.

Social constructivist theory was developed almost entirely based upon the work of Lev Vygotsky, a Russian psychologist, who believed that children’s cognitive and language development occurred and progressed through social interactions with others, as noted by Pritchard and Woollard (2010). According to Vygotsky (1978), children learn from their experiences interacting with more knowledgeable adults and peers, internalizing this knowledge, as theorized in Piaget’s (1954) constructivist theory. Social constructivist theory combines Vygotsky’s (1978) sociocultural learning theory and Piaget’s (1954) constructivist learning theory, by explaining how children learn best in social settings.

Departmentalized settings provide the opportunity for teachers to serve as facilitators, fostering cooperative learning in their designated subject areas, encouraging collaboration among students, as knowledgeable teachers know how to step back and allow students to interact and construct their own learning (Abbati, 2012; Baker, 2011; Henderson, 2011; Hood, 2010; Kent, 2010; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011). The departmentalized setting, with a knowledgeable teacher-facilitator, may provide a more beneficial learning environment for students, much as Vygotsky had envisioned and Piaget had described in his book *The Construction of Reality in the Child* (1954).
However, there have been concerns that the departmentalized classroom organizational structure does not provide the type of support system that young children need. The traditional classroom model is viewed more positively by many researchers and educators because they believe this model allows for the development of deeper interpersonal teacher-student relationships, providing a more comprehensive support system in which young children can learn and grow (Bezeau, 1989; Canady & Rettig, 2008; Garcia, 2007). In fact, as noted by Williams in 2009, the traditional, self-contained, non-departmentalized classroom structure was considered to be the norm at the elementary level for most school systems, given the belief that the self-contained classroom organizational structure better met the needs of the “whole child” at that age.

It is also interesting to note that Williams (2009) described one of the earliest attempts to strengthen instruction at the elementary level, made decades ago, which was to provide specialized instructors in the areas of physical education, music, and art, in order to address the content-level instructional needs of the students in those subject areas. Therefore, specialists in their fields were introduced into the traditional classroom setting at that time in order to better meet the overall educational needs of young students as part of a partially departmentalized approach to providing effective instruction in particular subject areas.

Hence, there are contradictory viewpoints about which classroom organizational structure at the elementary level, non-departmentalized or departmentalized, is in the best interest of the child and his or her learning. Understandably, departmentalized instructors need to be sure to take a more comprehensive approach, with regard to meeting students’ needs. Garrett (2006) highlighted the need for departmentalized instructors to recognize
and meet the multifaceted developmental needs of the “whole child.” While subject area specialists, or departmentalized teachers, are typically very focused on their content areas (McPartland, Coldiron, & Braddock, 1987), teachers at the elementary level, in particular, also take courses and receive training in the area of child development, as required by elementary teacher preparation programs in connection with state certification guidelines. Consequently, it is expected that all elementary instructors should be aware of, and be especially sensitive to, elementary children’s needs and are trained to work with students at these ages.

Therefore, the implementation of the departmentalized structure at the upper elementary levels area warrants further empirical study (Abbati, 2012; Baker, 2011; Henderson, 2011; Hood, 2010; Kent, 2010; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011) because of the academic challenges presented at the upper elementary level and because of the gap in the literature on this topic. Recent studies comparing student achievement in departmentalized and non-departmentalized settings were reviewed (Kent, 2010; Moore, 2008; Ponder, 2008; Williams, 2009; Yearwood, 2011) and will be specifically critiqued in Chapter 2. As such, this quantitative, causal-comparative study will evaluate the effectiveness of the departmentalized versus non-departmentalized classroom organizational structure at the fifth grade level, with teachers utilizing identical VDOE mathematics curriculum guidelines, as measured by student achievement on the Virginia Standards of Learning (SOL) Mathematics Test.
Problem Statement

The problem is that there are contradictory research results and gaps in the literature with regard to whether upper elementary students receiving mathematics instruction following identical curriculum in a departmentalized setting will attain higher levels of achievement when compared with the achievement results obtained from a non-departmentalized setting (Baker, 2011; Chang et al., 2008; Hood, 2010; Kent, 2010; McGrath & Rust, 2002; Moore, 2008; Patton, 2003; Ponder, 2008; Slavin et al., 2009; Williams, 2009; Yearwood, 2011). This quantitative study investigated whether fifth grade, heterogeneously grouped, regular elementary students attending non-Title 1, Pre-K through 5 elementary schools in an urban public school district in eastern Virginia, who received mathematics instruction following identical VDOE curriculum guidelines, had higher achievement in mathematics in a departmentalized setting when compared to a non-departmentalized setting.

The results of this study addressed the gap in the literature with regard to which classroom organizational structure may be most effective, departmentalized or non-departmentalized, in terms of documented student achievement at the elementary level, as noted in recent studies by Kent (2010), Moore (2008), Ponder (2008), Williams (2009), and Yearwood (2011). Williams (2009) and Yearwood (2011) found achievement results that favored departmentalized settings, while Moore (2008) and Ponder (2008) had mixed results. Kent (2010) found no difference in student achievement when reading and mathematics instruction was provided at the fourth and fifth grade levels in departmentalized or non-departmentalized settings. These studies will be critiqued in detail in Chapter 2; however, the mixed and contradictory results of research on this topic
provide the foundation for further study on the possible relationship between the
departmentalized classroom organizational structure and higher student achievement in
mathematics.

**Purpose Statement**

The purpose of this causal-comparative study was to examine the application of the teaching and learning theory of social constructivism in order to determine if instruction provided in a departmentalized setting in the key content area of mathematics resulted in a statistically significant difference in student achievement compared with the impact upon student achievement when mathematics instruction was provided in a non-departmentalized setting. A quantitative, causal-comparative design was chosen for this study for purposes of investigating a possible cause-and-effect relationship between classroom organizational structure, departmentalized versus non-departmentalized settings (the independent variable) and the measured mathematics achievement (the dependent variable) of heterogeneously grouped, regular fifth grade elementary students by whole group and gender and racial minority/non-minority subgroup performance.

As applied to this study, the fundamentals of social constructivist theory suggest that the departmentalized classroom organizational structure may have a greater positive impact on student achievement in mathematics because the context of the departmentalized setting allows students to reap the benefits of their social learning experiences (Vygotsky, 1978). In addition, social constructivist theory would indicate that in this social learning environment, students are able to construct their own learning by internalizing mental and thinking processes (Piaget, 1954), with guidance from knowledgeable teachers in their field.
Participants received mathematics instruction following identical curriculum guidelines and attended non-Title 1, Pre-K through 5 elementary schools in an eastern Virginia urban public school district. Students’ achievement scores on their Virginia 2011 Grade 5 Mathematics SOL Tests from departmentalized and non-departmentalized settings were compared, using the students’ 2010 Grade 4 Mathematics SOL Test scores as a covariate to control for previous achievement. A three-way ANCOVA was conducted to evaluate whether there was a statistically significant difference in mathematics achievement between the two classroom organizational structures.

Student mathematics achievement results were evaluated by whole group and gender and racial minority/non-minority subgroup, in order to assess the possible cause-and-effect relationship between the classroom organizational settings and student achievement in mathematics. Hence, this investigation also addressed another gap in the literature with respect to the achievement of targeted gender and racial minority subgroups who receive instruction in departmentalized and non-departmentalized settings.

**Significance of the Study**

The results of this causal-comparative study will contribute to the field of education as a result of the investigation of the possible cause-and-effect relationship between two key classroom organizational structures and the achievement of regular fifth grade elementary students in mathematics. The results of this study could provide empirical evidence to school districts, school administrators, and teachers about which instructional setting, departmentalized or non-departmentalized, may make a statistically significant difference in student learning and achievement. Going forward, the
information provided by this study could be critical, given the increasing levels of accountability that will continue to be imposed upon school districts, schools, teachers, and students, as a result of comprehensive ESEA flexibility plans that are being implemented in Virginia.

This study also addresses a gap in the literature with regard to which classroom organizational structure, departmentalized or non-departmentalized, may be more effective in terms of documented student achievement at the elementary level (Abbati, 2012; Baker, 2011; Chang, et al., 2008; Henderson, 2011; Hood, 2010; Kent, 2010; McGrath & Rust, 2002; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011). Given that few studies have been conducted comparing departmentalized and non-departmentalized instruction at the elementary level, and that the results of these studies have been contradictory (Van Houten, 2012), more evidence is needed in order to evaluate the impact of these classroom organizational structures on student learning.

The results of this study will add to the field of knowledge obtained from similar studies in the area of classroom organizational structures (Abbati, 2012; Henderson, 2011; Kent, 2010; Marsh, 2008; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011). Most of the studies reviewed on classroom organizational structures that specified a conceptual framework for their studies chose sociocultural (Eddy, 2008; Marsh, 2008), constructivist (Abbati, 2012; Moore, 2008), or organizational (Lee, 2010) theories as the foundation for their work. Yearwood (2011) framed her study around sociocultural, constructivist, and social constructivist theories, and social constructivist learning theory was the theoretical framework established for this study.
The inability of NCLB to effectively close the achievement gap in the past several years between racial minority and racial non-minority children underscored the need for this study because, if it could be inferred that the departmentalized educational structure had a particularly positive impact upon racial minority subgroup performance, in addition to whole group performance, then implementing this classroom organizational structure at the upper elementary level could make a significant contribution to closing the achievement gap. Also, male/female subgroup mathematics testing results will add to the body of knowledge in upper elementary education with regard to what is learned about student performance by gender, which was evaluated as an independent variable, along with classroom organizational structure and racial status, in the three-way ANCOVA.

The non-Title 1, Pre-K through 5 elementary schools participating in this study were located within an 11-mile radius, and therefore, students were from a similar geographic, economic urban area. Departmentalized and non-departmentalized fifth grade classes were available for potential selection with a total population of 273 students, from which the comparison groups were formed. There was a total sample size of 90 students in the departmentalized group and 149 students in the non-departmentalized group who had 2011 Grade 5 Mathematics SOL Test results that could be compared, together with 2010 Mathematics SOL Test results that could be used as a covariate, based upon the application of the Common Support Approach (Martin & Bridgmon, 2012; Pohl, Steiner, Eisermann, Soellner, & Cook, 2009) for matching subjects, resulting in a total of 239 participants in the study.

Data regarding local area racial minority and racial non-minority percentages were provided through data sets obtained in 2010 by the U.S. Census Bureau (2012), and
the school district’s accountability office provided the students’ Virginia 2010 and 2011 Mathematics SOL Test data, together with each student’s gender and racial minority and racial non-minority status, for the departmentalized and non-departmentalized classes participating in the study. Descriptive and inferential statistics were applied using the testing data obtained from the school division for purposes of data analysis and interpretation, including calculating the mean and standard deviation of the comparison whole groups and subgroups. A three-way ANCOVA analysis was run for purposes of evaluating whether a statistically significant difference in variances existed in student achievement between the two different classroom organizational structures. The statistical analyses were conducted using Statistical Analysis Software (SAS) 9.3.

This study’s research plan supports the overall purpose of this study, as the statistical analyses applied to the data resulted in a credible evaluation and informative comparison of the effect of departmentalized and non-departmentalized instructional settings on heterogeneous whole group and homogeneous subgroup mathematics achievement in a regular fifth grade elementary school class. If higher achievement can possibly be attained by students as a result of a particular classroom organizational setting, this research effort may help schools and their school districts make choices that will help them meet ESEA flexibility requirements established by the state in order to maintain full accreditation status (Cavanagh & Hoff, 2008; Slavin et al., 2009, Slavin & Lake, 2008; National Center for Education Statistics, 2011; VanTassel-Baska et al., 2008).

The results of the studies by Cavanagh and Hoff (2008), Connell (2009), Gulpinar, (2005), Slavin et al. (2009), Slavin and Lake (2008), and VanTassel-Baska et
al. (2008) also support the need for having qualified teachers who serve as content area specialists in the regular classroom. These studies suggest that content area specialists are more capable of creating the type of differentiated, social constructivist learning environment in a departmentalized setting, which will promote student engagement, learning, and achievement at all ability levels. Therefore, with a departmentalized approach at the upper elementary level, schools could have highly qualified teachers working in their areas of expertise, helping students meet the increasing ESEA flexibility and state achievement expectations, by using teaching resources already at their fingertips.

School systems are responsible for providing effective instruction in key content areas for all students, resulting in steady progress and documented achievement, as measured by standardized test scores as set forth by the federal and state governments (Cavanagh & Hoff, 2008). This study could be replicated in other school districts or regions in order to determine whether a statistically significant difference exists in student achievement based upon the classroom organizational structure implemented, thereby impacting decisions that school districts and schools make with regard to choosing a classroom structure for the benefit of their students.

**Research Questions**

A causal-comparative research design and an ANCOVA were used to address the following research questions:

Research Question #1: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, gender, racial minority/racial
Research Question #2: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Research Question #3: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Research Question #4: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Research Question #5: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, as measured by students’
scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Research Question #6: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Research Question #7: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Hypotheses

A causal-comparative research design and an ANCOVA were used to address the following hypotheses:

Null Hypothesis 1 - \( H_{01} \): There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, gender, racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Null Hypothesis 2 - \( H_{02} \): There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics
achievement based upon classroom organizational structure and gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Null Hypothesis 3 - H_{03}: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Null Hypothesis 4 - H_{04}: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Null Hypothesis 5 - H_{05}: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Null Hypothesis 6 - H_{06}: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender, as measured by students’ scores earned on the Virginia
2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Null Hypothesis 7 - \( H_07 \): There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

**Identification of Variables**

The three independent variables in this study were the classroom organizational structure, consisting of departmentalized and non-departmentalized settings, as well as the gender and the racial minority/non-minority status of the students who were tested.

An independent variable is “a variable that the researcher thinks occurred prior in time to, and had an influence on, another variable (called the dependent variable). In a hypothesized cause-and-effect relationship, the independent variable is the cause” (Gall, Gall, & Borg, 2007, p. 642.) For purposes of this study, a departmentalized setting is identified as such when a teacher teaches two or more classes of students in a particular subject area during the school day. In fact, many departmentalized teachers have the opportunity to focus on a particular subject area all day with multiple classes. This level of experience in one subject area, along with concentrated professional development provided in that subject area “allows teachers to be an expert in the field they are teaching” (Hood, 2010, para. 4). In the non-departmentalized setting, the teacher is responsible for teaching all of the subjects during the school day, which includes the subject area of mathematics.
There are two other independent variables that are being taken into consideration for this study, which fall into the form of categories, namely, gender (male or female) and racial minority or racial non-minority status. Gender and racial minority/non-minority subgroups were evaluated on a nominal scale. Students were classified as having either a racial non-minority status or racial minority status as reported by the school system providing the testing data for the study. Racial minorities were evaluated as one group consisting of American Indian/Native Alaskan, Asian, Black/African American, Native Hawaiian/Pacific Islander and children of two or more races, in addition to the one ethnic category identified by the U.S. Census Bureau, Hispanic or Latino. These designations are the official race and ethnic classifications specified by the U.S. Census Bureau (2012), which must act in accordance with the Office of Management and Budget (OMB) standards that were set in 2010.

The dependent variable is “a variable that the researcher thinks occurred after, and as a result of, another variable (called the independent variable). In a hypothesized cause-and-effect relationship, the dependent variable is the effect” (Gall et al., 2007, p. 637). In this study, the dependent variable is the mathematics score that fifth grade students obtained on the Virginia 2011 Grade 5 Mathematics SOL Test after they received instruction that followed the identical VDOE fifth grade mathematics curriculum, which was presented in a either a departmentalized or non-departmentalized setting.
Definitions

Achievement gap – A consistent difference in scores on student achievement tests between certain whole groups or subgroups of students, typically measured by subject areas, such as mathematics and reading (Eddy, 2008).

Adequate Yearly Progress (AYP) – “All school districts will be measured against the concept of adequate yearly progress (AYP), which creates a benchmark for continuous improvement” (Hanson, Burton, & Guam, 2006, p. 17), as established by the Elementary and Secondary Education Act (ESEA), which was reauthorized in 2001 and is also known as the No Child Left Behind (NCLB) Act.

Analysis of covariance (ANCOVA) calculation – A statistical technique “used to control for initial differences between groups before a comparison of the within-groups variance and between groups variance is made. The effect of ANCOVA is to make the two groups equal with respect to one or more control variables” (Gall et al., 2007, p. 320).

Annual measurable objectives (AMOs) – As noted in the Virginia public schools accountability guide for the 2013-2014 school year, “The federal Elementary and Secondary Education Act (ESEA) requires states to establish Annual Measurable Objectives (AMOs) for raising overall reading and mathematics achievement and the achievement of student subgroups” (VDOE, n.d.-a, p. 1).

Causal-comparative research design – This quantitative research design is a “nonexperimental investigation in which researchers seek to identify cause-and-effect relationships by forming groups of individuals in whom the independent variable is
present or absent—or present at several levels—and then determining whether the groups differ on the dependent variable” (Gall et al., 2007, p. 306).

Departmentalized settings – Classroom organizational structures, with a team of teachers serving as subject area specialists, where the students or the teachers change classrooms in order to receive instruction in all content areas. The number of departmentalized teachers on a team can vary, with a minimum of two teachers serving as a team, with as many as four teachers working together to teach content to multiple classes of students (McGrath & Rust, 2002).

Effective instruction – Instruction which will result in steady progress and documented achievement, as measured by standardized test scores as set forth by the federal and state governments (Cavanagh & Hoff, 2008).

No Child Left Behind (NCLB) – Established by the Elementary and Secondary Education Act (ESEA) legislation passed in 2001, consisting of approximately 1400 pages. “The overall goal of the No Child Left Behind (NCLB) Act is to have all students – 100 percent – achieving at proficient levels by 2014” (Hanson et al., 2006, p. 17).

Non-Departmentalized settings – Classroom organizational structures, where one regular education teacher teaches all required subject area content (other than perhaps music, art, and physical education) to a class of students all day for the entire school year (McGrath & Rust, 2002).

Racial minorities – Students will be evaluated as one group for purposes of this study, consisting of American Indian/Native Alaskan, Asian, Black/African American, Native Hawaiian/Pacific Islander and children of two or more races, in addition to the
one ethnic category identified in 2010 by the U.S. Census Bureau, Hispanic or Latino (U.S. Census Bureau, 2012).

Racial non-minorities – Students will be classified for purposes of this study as racial non-minority if they have been reported as White by the school system providing the testing data for the study (U.S. Census Bureau, 2012).

Social constructivist theory – A learning theory based upon the work of Vygotsky, Piaget, Bruner, Bandura, and Dewey, which purports that children construct their own individual, internal understanding when learning in classroom environments, supported by social and collaborative activities, as part of their learning and development (Pritchard & Woollard, 2010).

Title 1, Improving The Academic Achievement of The Disadvantaged, ESEA Act of 1965 (20 U.S.C. 6301 et seq.) - The purpose of this Act is to “ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging State academic achievement standards and state academic assessments” (ED, 2004, p. 1).

U.S. Department of Education (ED) Flexibility Guidelines - Virginia was granted waivers from provisions of ESEA Section 1111(b)(2)(E)-(H), which included a waiver for determining AYP under NCLB, where the establishment of annual measurable objectives (AMOs) in reading and mathematics were allowed to replace the AYP goals under the federal education law (Delisle, D. S., Delisle to P. I. Wright, March 5, 2013).

Virginia Standards of Learning (SOL) Mathematics Test – “The Standards of Learning (SOL) for Virginia Public Schools establish minimum expectations for what students should know and be able to do at the end of each grade or course” (VDOE,
2012a, p. 1), and students are assessed at that time or as specified by the VDOE by subject and grade level. Students are tested in reading and mathematics in grades 3 through 8 at the end of each school year.
CHAPTER TWO: LITERATURE REVIEW

The goal of this study was to evaluate whether fifth grade regular elementary students who receive instruction in departmentalized settings from departmentalized teachers in mathematics demonstrate higher levels of achievement when compared with the control groups of fifth grade students who receive instruction following identical curriculum in non-departmentalized settings from non-departmentalized teachers. The need for fifth grade teachers who teach mathematics to possess high levels of competency in order for their students to be successful in this critical subject area, where the content is more complex and demanding than that required of teachers working in the lower grades, formed the basis for this study.

It is important to clarify the meaning of departmentalization versus non-departmentalization, which was applied during this study for discussion, data collection, and evaluation purposes, given that there is a great deal of confusion with regard to the definition of each type of instructional model (Baker, 2011; Lobdell & van Ness, 1963; Welch, 2000; Welch, Brownell, & Sheridan, 1999). Departmentalized mathematics teachers at the elementary level, for the purposes of this study, are those teachers who teach mathematics to two or more different classes of students during the regular school day. Departmentalized mathematics teachers at the elementary level may be either fully departmentalized, where they teach mathematics to different classes of students all day, or they may be partially departmentalized, where they teach mathematics to different classes of students for two or more periods, or part of the elementary school day.

Departmentalized or semi-departmentalized instruction can occur as a result of team teaching, which includes a multitude of instructional delivery structures, including
collaborative teaching, cooperative teaching, parallel teaching, station teaching, or co-teaching. Welch, Brownell, and Sheridan (1999), in their literature review on team teaching and school-based problem solving teams, highlighted the fact that there has been a problem in arriving at conclusions from the literature regarding teaching team structure because the terms “team” and “teaming” have different meanings for teachers, administrators, and researchers.

Welch (2000) noted that “co-teaching (Cook & Friend, 1996; Dieker & Barnett, 1996; Nowacek, 1992; Walther-Thomas, Bryant & Land, 1996), cooperative teaching (Bauwens & Hourcade, 1995), and team teaching (Welch & Sheridan, 1995) all refer to a similar instructional delivery system” (p. 366). For instance, in just looking at one example of an explanation of what it means to take a cooperative instructional approach, Bauwens and Hourcade (1995) defined cooperative teaching as a structure where two or more instructors, who are particularly skilled in certain subject areas, work in cooperation to serve heterogeneously grouped students in regular, general education classroom settings. However, no matter which approach or combination of approaches achieves a level of either full or semi-departmentalized instructional delivery of mathematics in the regular fifth grade classes for the school district participating in this study, the classes were considered departmentalized and were evaluated accordingly.

Self-contained, non-departmentalized classes have one classroom teacher who is responsible for teaching the four key subject areas within the elementary curriculum, namely, ELA, mathematics, science, and history/social science. It is possible that the classroom teacher may be responsible for some or all of the additional instructional areas (art, music, and physical education) as well, depending upon the school or the school
district, making their classes purely or totally self-contained and non-departmentalized. However, self-contained classes are usually served by specialists in the areas of art, music, and physical education, and these classes may be considered to be following a modified, self-contained model (Lobdell & van Ness 1963). For the purposes of this study, purely self-contained, non-departmentalized classes and modified self-contained, non-departmentalized classes were considered non-departmentalized and were evaluated accordingly.

There is a great need for further research evaluating the effectiveness of instruction in departmentalized and non-departmentalized settings, along with the evaluation of the performance of racial minority and gender subgroups in these settings. Patton noted in 2003 that contradictory results have been obtained from past studies that evaluated student achievement when instruction was provided in different classroom organizational structures. Kent (2010), Moore (2008), Ponder (2008), Williams (2009), and Yearwood (2011) also noted in their studies that previous research findings regarding the effectiveness of departmentalized and non-departmentalized classroom organizational structures were mixed, thereby warranting further study.

**Theoretical Framework**

Sociocultural learning theory and constructivism scientific theory served as the foundation for a majority of the research studies reviewed that evaluated the possible relationship between the instructional setting and student performance. The theoretical framework chosen for this study was social constructivism learning theory, a combination of sociocultural and constructivist learning theories. Sociocultural learning theory is based primarily upon the work of the Russian psychologist, Lev Vygotsky (1935, 1978,

To understand social constructivism, one needs to understand aspects of both sociocultural learning theory (Vygotsky, 1978) and constructivist theory (Piaget, 1954). Vygotsky (1935, 1986) theorized, in accordance with sociocultural theory, that children relied upon their social experiences in order to gain understanding, build their internal conceptual knowledge, and develop as individuals, which serves as the foundation for child development and may occur spontaneously and sporadically. Piaget (1952, 1954) believed that children developed by constructing their own individual learning, internalizing mental and thinking processes, which served as the foundation for child development in progressive stages. Piaget (1952) held that

What we must translate into terms of adaptation are not the particular goals pursued by the practical intelligence in its beginnings . . . but it is the fundamental relationship peculiar to consciousness itself: the relationship of thought to things. The organism adapts itself by materially constructing new forms to fit them into those of the universe, whereas intelligence extends this creation by constructing, mentally, structures which can be applied to those of the environment. (p. 4)

Vygotsky (1935), on the other hand, believed that the relationship between the child and their social environment and their social communication with others (speech and verbal meaning) were the keys that unlocked the door to constructing internal understanding.

Vygotsky theorized that it was the relationship between the social environment and the child that led to true learning, as the child gained the ability to generalize and internalize meaning through their social experiences, which served as the true foundation
for child development. Vygotsky’s research and observations showed that the cycle of interactions between the child and their social environment allowed children to achieve higher level thinking processes and reach their full potential as individuals. Hence, while Vygotsky and Piaget never met, the premises of their learning theories revolved around how children develop and construct their own learning and thinking processes internally while interacting with the external environment.

Vygotsky (1935) believed that children developed through this relationship with their environment rather than believing that children must develop their own internal processes first. Piaget (1954) believed that children developed by constructing their own learning internally, as constructivists believe that individuals do not perceive objective reality as it is, but rather, that sensory input should be viewed as an interaction with pre-existing knowledge. Vygotsky theorized that children could only do this by interacting with their social environment, from which the child would internalize and develop their own mental processes. Therefore, both Vygotsky and Piaget theorized that children had to construct their own meaning in order to gain understanding, but Vygotsky’s research studies demonstrated that children accomplished this by taking advantage of their relationship with their environment, which he did not view as a static relationship, but one which changed as the child changed.

Based upon his research, Vygotsky (1935) concluded that there was an important relationship between the child and his or her environment, and that the environment was not “peripheral in relation to development” (p. 1), but rather a dynamic entity that influenced and directed the child’s development. Vygotsky found through research and observation that, as the child changed, the relationship between the child and the
environment changed, and the same environment would then proceed to have a different impact upon the child, further impacting the child’s development. Vygotsky noted that the relationship between the environment and the child was the key to the child constructing learning internally, as we could show many more instances which would demonstrate that absolutely every aspect of development will determine which way the environment will influence development, i.e. the relationship between the environment and the child and not just the environment in its own right, or just the child in its own right, will always be central. (p. 5)

Vygotsky (1935) believed that as the child changed, he or she would gain something different from the same environment, such as by looking at the same picture from a different perspective. The child would learn how to generalize and categorize new information, given his or her new paradigm, which would lead to more advanced thinking processes as the child internalized new knowledge and gained a new level of understanding. This sociocultural approach highlights the importance of the necessity for providing a stimulating, dynamic, social learning environment, such as that provided in a departmentalized setting, from which children can reap the rewards by gaining new knowledge and constructing their own understanding.

Therefore, Vygotsky (1935) discovered through his research that children developed “under particular conditions of interaction with the environment” (p. 6) and that, where one would expect the child to be at the final stage of development, actually exists in a rudimentary form in the child at the first stage, where the environment exerts a
real influence. Vygotsky stated that the “environment was a source of development, not just a setting” (p. 7).

Vygotsky’s (1935, 1978, 1986, and 1998) work revolved around three areas which fall into the social constructivist domain: individuals in the learner’s environment who play a key role in learning, the people who affect the learner’s view or perspective, and the tools implemented that affect the way in which the learner constructs his or her own knowledge. All three of these factors affect the learner and how he or she will progress in terms of intellectual development. While the constructivist believes that learners construct their own individual knowledge, the social constructivist believes that this learning can only truly take place through the use of language and social interaction.

In terms of sociocultural learning, Vygotsky (1935) theorized that the child proceeded to develop through the cyclical process of interacting with his or her own environment, building upon their external communication skills in speech. Vygotsky saw speech as a means of social interaction as well as a form of expression and a means of understanding. Vygotsky believed that external speaking skills led to internal speech and brought meaning to the child’s vocabulary, which affected their internal thinking processes and their level of understanding, as words and their meanings were considered to be units of thought. Therefore, Vygotsky held that children furthered their own development and learned how to take in information by generalizing and categorizing material by being able to interact with others in a social setting or environment, thereby bringing further meaning to their own learning.

Vygotsky (1986) found that when children used external speech as the primary form of communication in social settings as part of the social function in their
environment, this process served as a foundation for children to learn how to speak to themselves, or use internal speech. As noted by Vygotsky,

In our conception, egocentric speech is a phenomenon of the transition from interpsychic to intrapsychic functioning, i.e. from the social, collective activity of the child to his more individualized activity--a pattern of development common to all the higher psychological functions. (p. 228)

Vygotsky (1986) explained that social interaction allowed children to experience their environment by interacting with the experiences and thoughts of other persons, and he found that children who did not possess the ability to generalize were unable to communicate effectively or conceptualize, making understanding impossible for them. Vygotsky believed that children converted their use of external speech to internal speech, constructing their own internal thinking processes and furthering their own development, much as Piaget (1954) had theorized. Therefore, Vygotsky highlighted the importance of the social role of the child’s environment, as well as the importance of the inter-connected relationship between the environment and the child’s development, and hence, his or her learning.

It is interesting to note that Bruner (1971) and Dewey (1916) also highlighted the importance of social interaction to the construction of learning. For instance, Bruner pointed out that “those who are acquainted with cross-age tutoring will know, as I discovered, the extent to which those who helped are helped, that being a teacher makes one a better learner” (p. 21). Dewey highlighted the importance of social interaction by stating that “the other point is the necessity of a social environment to give meaning to habits formed” (p. 212), in terms of students being able to construct meaning from, and
learning through, social interaction. Bandura (2001) also reconfirmed his belief in the importance of the social interaction connection to learning and cognitive development, noting that “it is not just exposure to stimulation, but agentic action in exploring, manipulating, and influencing the environment that counts . . . an agentic perspective fosters lines of research that provides new insights into the social construction of the functional structure of the human brain (Eisenberg, 1995)” (p. 4).

Vygotsky (1998) also theorized that there was a learning zone, defined as the zone of proximal development (ZPD) which he identified as the range, in terms of mental age, of what the child could do himself, independently, without help, successfully, and what the child could accomplish while working with knowledgeable others. The ZPD range establishes both the child’s level of mental development and mature capabilities at that point in time and also predicts what the child could do with the help of knowledgeable peers or adults cooperatively, identified as the area of future development. Therefore, the lower end of the ZPD range reflects the child independent capability, and the upper end of the range reflects what the child could accomplish by extending himself/herself and his/her capabilities by working to learn with the help of more advanced peers or adults.

Vygotsky (1998) believed that all students worked in their ZPD ranges as they learned and that “the optimum time for teaching both the group and each individual child is established at each age by the ZPD” (p. 204). Consequently, the social learning context of the departmentalized setting should provide a platform for students to mature mentally and achieve, given the ZPD learning concept proposed by Vygotsky, resulting in higher achievement. Also, as students work to learn, given their ZPD, and considering the anxiety that many students experience when learning, the social interaction provided
through cooperative learning opportunities can be the key to student success by reducing student stress (Daniels & Cole, 2007). Nasir and Hand (2006) also highlighted the importance of the social, interpersonal learning process, known as scaffolding, in which assistance provided by others in a social setting can help to improve a student’s level of performance and increase their level of understanding, which would go hand-in-hand in support of students working to extend their capabilities and learning within their ZPDs.

Vygotsky (1978) did not believe that children’s mental capabilities developed in a linear fashion, but rather, he thought it was a complex progression, marked by periodic growth, uneven functional development, and the mixture of external and internal factors. Therefore, teachers can make a real difference in children’s lives as they grow, develop, and become more independent thinkers, because teachers can create those periodic moments that result in leaps in a child’s development that result from construction of his or her own knowledge, again connecting to the constructivist approach taken by Piaget (1954), Borenstein and Bruner (1989), Bruner (1971, 2008), and Dewey (1910, 1916). Therefore, a social learning setting, like one that is more likely to be found in a departmentalized classroom organizational environment, would facilitate greater child development and increased learning. The departmentalized setting is more likely to provide cooperative learning and sharing experiences, and as Vygotsky theorized (1935, 1978, 1986, and 1998), learning is enabled when students have the opportunity to work with competent adults and with higher-achieving peers in environments that are conducive to providing these types of learning experiences.

Vygotsky (1935, 1978) believed effective education was conducted through social interaction, which allowed students to think and learn about how to construct their own
knowledge, rather than to just be receivers of factual content. Vygotsky (1978) was concerned about what types of cooperative activities would lead to the intellectual development of the child. Vygotsky was also concerned that the student learn to understand concepts that would promote higher-level thinking and application, rather than just learning rote knowledge, which are consistent with Piaget’s (1954) constructivist theory.

Students who are taught in departmentalized settings have the opportunity to interact socially with multiple teachers across several content areas. Departmentalized settings provide opportunities for students to communicate with a number of highly competent teachers who possess a vast array of knowledge, exposing them to a variety of personalities and teaching styles, which will enhance their own learning experiences and help build their social skills (Page, 2009; Yearwood, 2011).

Teachers who are subject matter experts and who are secure in their field also know how to differentiate instruction to meet the diverse needs of each student so that he or she can internalize what they have learned and move on to a higher level ZPD, furthering his or her own intellectual development. Vygotsky (1978, 1986) recommended that individualized education goals for each student be recognized by responding to their diversity, rather than taking an approach that everyone learns the same way, supporting current efforts towards providing differentiated learning opportunities in the regular classroom (VanTassel-Baska et al., 2008), which can be further supported in departmentalized instructional settings.

Samuelson (2012) highlighted the fact that the cognitive development of children has been stagnated due to the efforts to pursue greater proficiency on standardized tests.
Samuelson also pointed out that there has been a loss of opportunity to pursue dynamic and diverse learning opportunities as a result of this standardization. Hence, the engaging, differentiated, and cooperative learning that can take place in the departmentalized setting could help to offset the move toward extreme standardization in this era of numerous assessments and increased accountability.

The departmentalized setting is rich, in terms of providing opportunities for authentic teaching and learning experiences, social interaction, and the construction of individual knowledge by each learner. Social constructivist learning theory forms the foundation for evaluating the effectiveness of the departmentalized setting in this study by evaluating the potential effectiveness of this learning environment, based upon achievement attained by students. Dewey noted back in 1902 that what inspires the interest and passion in children is what propels them towards a higher level of learning. It is possible, even in this era of standardization and increased pressures to perform, that the departmentalized setting may provide more opportunities for the types of diverse, social activities that inspire students to learn, furthering their own cognitive development, as envisioned by Vygotsky (1935, 1986), Piaget (1954) and Bandura (2001).

**Social Interaction, Cognitive Development, and Learning**

Numerous studies (Slavin & Lake, 2008; Slavin et al., 2009; Quatroche, Bean, & Hamilton, 2001; Walshaw & Anthony, 2008; Yearwood, 2011) described the relationship between social interaction and cognitive development and learning, highlighting the need for teachers to provide cooperative learning opportunities and emphasizing the importance of learning through the use of language. These studies concluded that students need to be able to explore their ideas with others in a social setting for learning
to take place, specifically describing the benefits of encouraging students to explain their thinking process to others. In addition, several studies (Baker, 2011; Kent, 2010; Patton, 2003; Ponder, 2010; Slavin & Lake, 2008; Slavin et al., 2009; Quatroche et al., 2001; Walshaw & Anthony, 2008; Williams, 2009; Yearwood, 2011) emphasized the importance of the teachers’ level of content knowledge and expertise in the teaching of mathematics and the use of language, in order to be able to competently plan and deliver effective lessons and implement changes in daily teaching practices, which have been shown to make the difference in student learning and achievement.

Departmentalized teachers, who focus on a particular content area and often receive additional specialized training in that area through professional development provided by the school or school district (Gerretson, Boxnick, & Schofield, 2008), are more likely to possess a greater, in-depth understanding of the subjects that they teach (Quatroche et al., 2001). Departmentalized teachers are then more fully prepared to utilize this knowledge to prepare and present lessons and structure cooperative learning activities that facilitate socialization and the use of language to positively impact student learning and achievement in a particular subject area in a departmentalized setting (Walshaw & Anthony, 2008). Therefore, at the upper elementary grade levels, where there is a particular need for highly competent teachers, particularly in the area of mathematics, content area specialists who serve students in departmentalized settings are more likely to have a positive impact on student achievement, and thereby, more effectively prepare the students for the eventual transition into middle school (Disseler, 2010).
On the other hand, the non-departmentalized teacher is unable to focus on any one subject area, and he or she is less likely to possess an in-depth knowledge of all of the content material in all of the subject areas, which would have allowed him/her to help students achieve at the same levels as those students who received instruction from a departmentalized teacher (Chan & Jarman, 2008). Therefore, the continuation of a non-departmentalized approach at the fifth grade level may inhibit what students can truly achieve, particularly in the more complex area of mathematics.

There are proponents of self-contained instruction at the upper elementary level, as some of the studies reviewed either favored the non-departmentalized setting or found no difference between the departmentalized and non-departmentalized settings (Chang et al., 2008; Harris, 1990; Kent, 2010; McGrath & Rust, 2000; Patton, 2003), or the results were mixed (Baker, 2011; Moore, 2008; Ponder, 2008). Therefore, it is a combination of the mixed results of previous studies and the continuing need to attain and document increased student achievement, which forms the basis for this study.

**Facilitation of Cooperative Learning**

The positive impact of cooperative learning through peer interaction, supported by instruction and guidance provided by a teacher who is knowledgeable in a content area, was found to be particularly true for those studies that investigated the impact of the role of the teacher on student responsiveness and their achievement in the classroom (Esmonde, 2009).

Slavin et al. (2009) highlighted the consistent positive impact of incorporating increased student participation and engagement in learning across all grade levels.
Consequently, it may be more important to focus on the classroom organizational structure, which often dictates how instruction is provided. The departmentalized classroom structural approach is more likely to provide the platform for the development of engaging, cooperative lessons and activities by knowledgeable teachers, who may be able to provide more opportunities for social interaction and learning. By evaluating the effectiveness of departmentalized versus non-departmentalized settings, in terms of student achievement, the researcher may demonstrate which one of these paths may positively impact student learning, rather than depending upon changes in curriculum or reliance on computer technology instruction to reach students more effectively (Slavin et al.). In fact, highly knowledgeable content area teachers, who are more likely to be chosen as departmentalized instructors in departmentalized settings at the upper elementary level, are more apt to effectively integrate technology into classroom activities as well as identify and address the needs of multiple intelligences, by incorporating differentiation into instruction, in order to meet the diverse needs and abilities of their students (VanTassel-Baska et al., 2008).

The differentiated approach to instruction meets Vygotsky’s (1978) recommendation that the individual needs and goals of each student be met, which may be more achievable in the departmentalized setting, rather than by focusing on providing “sameness” in instruction (Samuelson, 2012). A departmentalized setting may also provide appropriate social opportunities for students to construct their own learning internally, as Piaget (1954) and Vygotsky (1978) envisioned, in accordance with social constructivist theory.
Therefore, social constructivist theory postulates that it is erroneous to think of the attainment of knowledge as an isolated entity, but rather, teaching and learning should be approached as a social process. Social constructivist theory focuses on the social nature of individuals and the fact that learning in a social environment brings further meaning to the attainment of knowledge and positively impacts the subsequent development of the learner. Hence, it is critical that teachers have an in-depth understanding of their subject area, particularly in the more complex area of mathematics, in order to be able to design and coordinate effective cooperative learning activities, because knowledge is best learned in a socially interactive way.

**Review of the Literature**

This study will investigate the effectiveness of mathematics instruction provided in a fifth grade departmentalized setting by fifth grade departmentalized teachers, as measured by the implied impact upon student achievement, when compared with the effectiveness of the instruction provided in a non-departmentalized setting by a non-departmentalized teacher, who is responsible for covering all areas of the upper elementary curriculum. A number of the reviewed studies (Slavin & Lake, 2008; Slavin et al., 2009; Quatroche et al., 2001; Walshaw & Anthony, 2008; Yearwood, 2011), which investigated the impact of the role of the teacher on student responsiveness and their achievement in the classroom, demonstrated that social constructivist theory would serve as a valid foundation for the theoretical framework and research design chosen for this study.

Based upon a review of the literature, previous studies on departmentalized and non-departmentalized mathematics instruction have shown mixed results with regard to
which classroom organizational structure is more effective, as measured by higher levels of student achievement. Walker (1996), Williams (2009), and Yearwood (2011) all found that fifth graders receiving instruction in departmentalized classes scored higher on mathematics achievement tests than students who received instruction in the same curriculum in non-departmentalized classes. Van Houten (2012) found no statistically significant difference between fifth grade students’ achievement in mathematics based upon departmentalized or non-departmentalized classroom structures. Harris (1990), McGrath and Rust (2002), and Mitchell (2013) found that students in sixth grade, who received instruction from departmentalized and non-departmentalized instructors, performed equally well on mathematics achievement tests, showing no difference or greater benefit from either classroom organizational structure.

Johnson’s (2013) findings showed that students at the upper elementary level, especially males, experienced more benefit from the self-contained classroom. Lambert (2008) found that self-contained fifth grade mathematics students scored significantly higher than departmentalized students, but that the data supported that students from higher socioeconomic environments may benefit from receiving instruction from multiple teachers, like in a teaming configuration. Ponder (2008) had mixed results, analyzing third and fourth grade class test data, which included results based upon gender, raciality, and special program subgroup information. Ponder discovered that fourth grade students and third grade bilingual students benefited more from departmentalized instruction in mathematics, while fourth grade female English as-a-second-language (ESL) and bilingual students performed better with non-departmentalized mathematics instruction.
The following is an evaluation of the pertinent details of five relevant studies (Kent, 2010; Moore, 2008; Ponder, 2008; Williams, 2009; Yearwood, 2011) related to the effectiveness of instruction provided in departmentalized versus non-departmentalized settings in the elementary school context.

Yearwood (2011) conducted a quantitative, causal-comparative study comparing students’ reading and mathematics achievement scores, as measured by the Georgia Criterion Referenced Competency Test (CRCT), in fifth grade departmentalized and non-departmentalized settings. There were 2,152 fifth grade participants who participated in Yearwood’s study from 29 elementary schools in rural Georgia, and departmentalized and non-departmentalized groups were formed on a non-randomized basis for this ex post facto study. The ANCOVA calculation was applied to the 2010 data collected to determine whether or not the mean achievement scores differed, using students’ 2008 CRCT scores as a covariate, and statistical significance was determined based on an alpha of ≤ .05.

The racial makeup of Yearwood’s (2011) participants in the study was somewhat diverse, but a large percentage (72.8%) of the participants were White. The departmentalized setting group was made up of 16 schools with a population of 1,186, and the non-departmentalized group was made up of 13 schools with a population of 966. Each group consisted of participants who had a disability, were economically disadvantaged, or were limited English proficient. The sample size was large, which helped to ensure a normal distribution of test score data.

For the measurement of reading achievement, Yearwood (2011) found that 49.8% of the variance in 2010 reading scores was explained by the 2008 scores. There
was a statistically significant difference attributed to the setting, with the null hypothesis being rejected 66.4% of the time. The estimated effect size was small at 0.3%. A student would be expected to score 1.89 points higher on the reading CRCT in a departmentalized setting than a student taught in a non-departmentalized setting, with a 95% confidence interval. Yearwood did note that when large sample sizes are used, like in her study, even small differences could become statistically significant, even if the differences between the two groups were really of little practical importance.

For the measurement of mathematics achievement, Yearwood (2011) found that 54.3% of the variance in the 2010 scores was explained by the 2008 scores. Yearwood found that the difference between the departmentalized and non-departmentalized groups was statistically significant, with the null hypothesis being rejected 99.6% of the time. The effect size was very small at 0.2%. A student would be expected to score 5.63 points higher on the mathematics CRCT in a departmentalized setting than a student taught in a non-departmentalized setting, with a 95% confidence interval.

While on the surface, the size of the effect of departmentalized instruction was small, every point increase in student achievement matters, as noted by Yearwood (2011), when it comes to achieving established goals for meeting ESEA flexibility requirements and for documenting progress in closing the achievement gap. Therefore, in some cases, a 5.63-point difference, on average, could make the difference between passing and failing the state mathematics test for a student, or accreditation or lack of accreditation for a school or school district.

In Yearwood’s 2011 study, students needed to score between 800 and 849 to pass the Georgia CRCT Mathematics Test, and therefore a 5 point difference, or a score
of 795 versus 800, would have made the difference between passing and failing. If students scored above 849, they would have exceeded the standard, and therefore, a 5-point difference could have made the difference between meeting the standard at a score of 845 and exceeding the standard with a score of 850. However, due to the statistically measured small size of the effect, it must be noted that these results demonstrate that it could be assumed that other variables had affected student achievement to a greater extent than the organizational structure.

Yearwood’s (2011) results were consistent with the results of studies conducted by Williams (2009) and Moore (2008), both of which suggested that fifth grade students achieved at higher levels when receiving mathematics instruction in departmentalized settings. Williams conducted a causal-comparative study that investigated the possible effects of departmentalized and non-departmentalized classroom organizational structures on fifth grade student achievement on the Georgia CRCT utilizing data from 2007 and 2008. Williams also collected data from an electronic teacher Data Collection and Opinion instrument (DCO), which was administered to all fifth grade teachers in 57 of the 59 schools participating in the study. Teachers were asked to report on which classroom organizational structure they preferred, along with whether or not they felt they had a voice in decisions regarding classroom organizational structure for fifth grade teachers and how they felt about their level of preparation to teach all subjects to fifth grade students.

Williams’ 2009 study included 2,487 participants from 31 schools with a non-departmentalized structure and 2,162 students from 26 schools with a departmentalized structure in 2007. Williams’ study also included 2,282 students from 26 schools with a
non-departmentalized structure and 2,455 students from 31 schools with a
departmentalized structure in 2008, where the balance between schools that used
departmentalized and non-departmentalized classes was reversed from 2007. Williams’
study utilized an alpha level of .05 for statistical significance on t tests and .005 for z
scores. While Williams did not find a statistically significant difference between student
achievement for students taught in departmentalized or non-departmentalized settings in
2007 and 2008, she did find that there was a significant difference in the percentage of
students who passed with a performance level of 2 (meets expectations) or 3 (exceeds
expectations) by students who received instruction in the departmentalized settings.

Interesting teacher feedback was also reported in Williams’ 2009 study, which
was obtained from teachers who completed the DCOs. Out of 189 responses regarding
teachers’ preferences for classroom organizational structures, 136 teachers preferred the
departmentalized setting; out of 200 responses regarding having a voice in decision
making at their school regarding organizational structure choice, 112 responses were
affirmative. Out of 180 DCO responses regarding initial college training preparation for
teaching, only 89 respondents felt that their initial college training prepared them to teach
all subjects at the fifth grade level. It was also interesting to note that out of 180
respondents who reported their teaching certifications, more than half of the teachers had
an additional endorsement in various areas, but only 15 (8.3%) were certified to teach
mathematics.

Moore (2008) conducted a quantitative study comparing student achievement in
20 schools having departmentalized and non-departmentalized settings, which utilized the
Criterion Reference Test/Tennessee Comprehensive Assessment Program (CRT/TCAP)
scores. Students’ fourth and fifth grade scores were reported by category as below proficient, proficient, and above proficient, similar in nature to the Georgia CRCT scale evaluated by Williams (2009) and Yearwood (2011). Moore found no difference in fourth and fifth grade student achievement between departmentalized and non-departmentalized settings in language arts, science, and social studies, along with no difference in fourth grade mathematics achievement.

Moore (2008) did find that fifth grade departmentalized mathematics classes had achievement scores that were statistically significant at a 95% confidence level, which is worthy of note. However, the eta square index was .06, again suggesting a weak association between mathematics achievement scores by classroom organizational structure. Moore had also distributed a demographic and teacher’s perception survey to gather information about teacher preparation, qualifications, and experience. A majority of the respondents to Moore’s survey reported that they preferred to teach in a departmentalized setting, particularly at the fifth grade level (fourth grade teachers - 56% and fifth grade teachers - 72%).

Ponder (2008) investigated the effects of classroom organizational structure, grade level, and gender on the student achievement of subgroups consisting of African American, Asian, Hispanic, White, ESL/bilingual, economically disadvantaged, and the Gifted and Talented, using a factorial multivariate of analysis of variance (MANOVA) calculation. The review of the literature conducted by Ponder, which was also supported by Patton’s review in 2003, found that, despite the pressure to close the achievement gap between gender and racial minority/non-minority subgroups, few studies have been
conducted that investigate the effect of classroom organizational structures on the achievement of these student subgroups.

Ponder (2008) utilized one mathematics test, the Texas Assessment of Academic Skills (TAKS) and two science tests, District Common Assessments (DCA2, DCA3) to evaluate student achievement of third and fourth grade students. Ponder discovered that third grade bilingual students and all regular fourth grade students participating in the study scored higher when receiving mathematics instruction in departmentalized settings. However, Ponder found that fourth grade female ESL and bilingual students scored higher in mathematics, and fourth grade bilingual students scored higher in science, when instruction was provided in a non-departmentalized setting, thereby arriving at mixed results based upon the grade levels and group variables involved.

Kent (2010) conducted a causal-comparative study utilizing fourth and fifth grade test data from the 2009 Kentucky Core Content Test (KCCT) from eight schools in one school district in Kentucky, which had a demographic representation of 49% White and 51% racial minority. Kent utilized the multilevel analysis, Hierarchical Linear Modeling (HLM) and analysis of variance (ANOVA) calculations based on data collected according to a specific classroom, school, classroom organizational structure, gender, ethnicity, and socioeconomic status. Kent found that there was not a statistically significant difference in student achievement when reading and mathematics instruction was provided at the fourth and fifth grade levels in either departmentalized or non-departmentalized settings. Kent also found that based upon the classroom-level variable, which measured the contrast between departmentalized and non-departmentalized
settings, that the classroom organizational structure was not a significant predictor for student achievement in either reading or mathematics.

Kent (2010) did find that higher mathematics scores were based upon a student’s ethnicity (White), socioeconomic status (relatively high), and grade (fourth grade), but not based upon classroom organizational structure. Kent noted as part of her analysis that part of the reason for the variability in results of studies on classroom organizational structure might relate to variability in instructional practices from teacher to teacher as well as to differences among the students. Factors such as the number of students placed in a class that belonged to each socioeconomic or racial group could have played a role in contributing to the mixed results of studies on classroom organizational structure. Kent also mentioned that the differences might also be related to the location of the schools involved in past studies, such as rural or urban locations.

While these contradictory results may have been due to a variety of other factors, such as weaknesses in the research design, methods of measurement, sample size, and/or problems with internal validity, there is a great need for conducting further research to evaluate the potential effectiveness of different classroom organizational structures on student achievement at the upper elementary level. It is interesting to note that of the aforementioned studies that showed statistically significant differences, which implied a possible cause-and-effect relationship between departmentalized settings and higher student achievement, those positive results were specifically related to achievement in mathematics, primarily at the fifth grade level (Moore, 2008; Yearwood, 2011), which is the premise of this study.
In addition, based upon the teacher surveys collected as part of the studies conducted by Moore (2008) and Williams (2009), the departmentalized setting was the preferred classroom organizational structure selected by a majority of the respondents who completed the surveys, which was substantiated in a later study on departmentalized and self-contained structures by Johnson (2013). Robertson (2012) found in her study that administrators and teachers acknowledged in their interviews that they believed the departmentalized approach was a best practice that could be implemented at the elementary level, but the results of the study did not produce sufficient evidence to provide support for transitioning from the self-contained to the departmentalized model.

This study of the impact of the utilization of departmentalized versus non-departmentalized settings in the area of mathematics at the fifth grade level will add to the empirical evidence that may help administrators, teachers, and parents choose the most appropriate and effective educational structure for children at this stage of learning. Data was evaluated based upon whole group performance, as well as by gender and racial minority/non-minority status, in order to comprehensively evaluate the effectiveness of each classroom organizational structure. Results of this study may also provide empirical evidence regarding which classroom organizational structure will help close existing achievement gaps in mathematics, providing administrators, teachers, and parents with critical information in order to make data-driven educational decisions (Henderson, 2011).

Kowalski and Lasley (2008) confirmed that the use of “evidence-based practice (EBP)” is becoming the foundation for making classroom organizational structuring decisions and is becoming the norm, as large amounts of student achievement data are
collected and evaluated in this new age of technology due to increased pressures to prove that students are achieving, as part of the accountability movement. It is important to note, however, that while data can assist with decision-making, data should not stand alone as the foundation for making educational decisions. Kowalski and Lasley also noted that when evaluating educational data, professionals should view data in context and from the perspective of effectiveness, always keeping the best interest of students in mind, with the ultimate goal being to improve instructional practice, which may include making informed decisions about classroom organizational structure, and thereby, positively impacting the overall effectiveness of the school.

It should be recognized that in this high-pressure era of accountability, teachers are under ever-increasing pressure to demonstrate their students’ levels of subject area proficiency through a regular evaluation of their students’ test data (Baker, 2011; Harris, 2012; Lauen & Gaddis, 2012; Mathis, 2004), despite the fact that research data can be fallible (Anderson, 2009). For instance, students are assessed every nine weeks by local school districts contained within the geographical area of this study. Teachers in the local school districts are required to administer district-created subject area benchmark tests every nine weeks for purposes of identifying skill areas that require re-teaching, remediation, or reinforcement.

However, these benchmark tests are not just utilized to judge student performance or to measure student progress. These benchmark tests are also utilized to evaluate teacher performance throughout the school year, and teachers have frequent individual and group meetings with school administrators for the purpose of reviewing benchmark test results. Year-end Virginia SOL tests results are also analyzed by school district test
coordinators, elementary educational directors, subject area directors, administrators, and teachers extensively, with student and teacher performance evaluated by educational strand and/or by test question and by overall student achievement on the assessment.

Elmore, Peterson, and McCarthey (1996) put forth the idea that one way to improve teaching and learning would be to make changes in a school’s classroom organizational structure. Elmore et al. identified three areas of concern within the traditional classroom structure, including teacher isolation from each other with reduced opportunities for collaboration, limited grouping of students for targeted instruction, and a lack of balance in terms of how curriculum is presented at the classroom level.

More recently, Baker (2011) pointed out that the results of studies on departmentalized versus non-departmentalized structures tend to lean in favor of the non-departmentalized model, stating that there were notable inconsistencies and a lack of explanations for the questions that remain about the effectiveness of these classroom organizational structures. However, Baker also noted that as far back as 1967, other researchers, such as Anderson and Tanner, put forth arguments in favor of the departmentalized structure, stating that it was unreasonable to expect teachers to have high levels of expertise in all content areas, particularly at the upper elementary level.

Despite the limited number of studies conducted at the elementary level, or perhaps because of that fact, it is still unclear which classroom organizational structure is most effective, in terms of measured student achievement, particularly in the upper elementary grade levels and specifically in the subject area of mathematics. Therefore, as noted by numerous educators and researchers (Elmore et al., 1996), additional studies in the area of departmentalization are warranted in order to help identify which classroom
organizational structure will best meet the needs of elementary students as developing individuals and as academic learners. This need is particularly crucial for students in the area of mathematics in the upper elementary grades, which usually poses the greatest challenge for elementary teachers.

**Elementary Instruction in Virginia**

Teachers in Virginia are expected to provide content area instruction by following state-defined subject-area SOLs, curriculum frameworks, and enhanced scope and sequence lesson plan guidelines (VDOE, 2012b) for purposes of ensuring that all students receive instruction covering the identical content. Students are expected to learn grade level, state-specified SOL content, and they are assessed at the end of each school year on their knowledge and understanding of this content, when prescribed by the state, in order to determine their level of proficiency.

Students in Virginia are tested in reading and mathematics on Virginia’s SOLs at the end of every school year from grades three through eight, and therefore, students who have been attending school in Virginia become accustomed to taking these tests from an early age. Students who have relocated to Virginia from other states have typically been exposed to other types of standardized state tests since approximately third grade due to requirements of NCLB. Students in this study will have had experience taking their fourth and fifth grade SOL Mathematics tests, with fifth grade results being compared and analyzed for purposes of this study. The VDOE provides SOL Test Blueprints to inform the public (school districts, teachers, parents, and students) about how the SOL tests are structured.
Elementary students in Virginia receive content area instruction during four major periods of time of the school day covering mathematics, language arts, science, and social studies, with additional time allotted for resource classes, recess, and lunch. The Virginia Board of Education regulations require “school divisions to provide instruction for a minimum of 180 days or 990 hours each school year” (Wright, 2010, p. 1).

Therefore these regulations specify a minimum requirement of at least 5.5 contact hours of instruction per day (990 hours divided by 180 days) at the elementary level, spread across the disciplines of English, mathematics, science, and history/social science (Virginia Board of Education, 2000). While the Commonwealth of Virginia has established a minimum number of hours for annual instruction at the elementary level, along with a specified number of days, it is possible for local school boards to set requirements for student attendance that exceed the minimum number of hours required.

Based upon Virginia’s established regulations, however, the typical elementary instructional day is comprised of 5.5 hours of instructional time, or a total of 330 minutes, less 40 minutes for resource class (art, physical education, music, guidance, etc.), or 290 instructional minutes of content instruction per day. It is important to note that at the elementary level, more instructional time is usually allotted by school divisions on a daily basis to the area of English (also commonly referred to as English language arts, or ELA) than to the other three subject areas (mathematics, science, and history/social science). The decision to dedicate more instructional time to ELA is usually made by school divisions (and even noted on division websites) due to the demands of the material that needs to be covered in this subject area, which requires instruction in the areas of reading, English, and writing.
For instance, the school division involved in this study required that students at the elementary level received 105 minutes of ELA instruction daily, while another local school division surveyed required 120 minutes of ELA instruction daily. The remaining amount of daily instructional time available was allotted for instruction in the areas of mathematics, science, and history/social science. For the Virginia school division involved in this study, by taking 290 minutes required for total content instruction and subtracting 105 minutes for ELA instruction, there are 185 minutes remaining, which must be divided among the remaining subject areas of mathematics, science, and history/social science. Therefore, the three remaining content areas are allotted approximately 60 minutes each.

While, on occasion, some of the local Virginia school divisions reduce the time allotted for science and/or history/social science instruction from 60 minutes to 50 minutes daily, thereby increasing time allotted for mathematics or reading instruction by 10 or 20 minutes, there is far less instructional time devoted to the teaching of mathematics than to the teaching of ELA. Therefore, there are approximately 60 to 70 minutes typically allotted for mathematics instruction daily, compared with the 105 to 130 minutes allotted for ELA instruction, in some of the local Virginia school districts near the school district participating in the study.

This discrepancy between the amount of time spent on elementary instruction in ELA and mathematics was noted by Phelps, Corey, DeMonte, Harrison, and Lowenberg Ball (2011) in their analysis entitled “How Much English Language Arts and Mathematics Instruction Do Students Receive? Investigating Variation in Instructional Time.” These researchers noted, “What stands out are not the averages but the large
variations across classrooms” (p. 632). The Phelps et al. analysis showed that when evaluating school days when ELA and mathematics were actually taught, the grand mean was 101.5 minutes of instruction in ELA and 63.1 minutes in mathematics, with a 38% variance in the amount of ELA instruction and a 42% variance in the amount of mathematics instruction between classrooms within a school.

Phelps et al. (2011) noted that “depending on the classroom they attend, students can expect to receive remarkably different amounts of instruction” (p. 632). Therefore, the Phelps et al. analysis highlighted the detrimental impact of the variation in the use of the prescribed instructional time between classrooms upon student learning in addition to the effects of the limits imposed by the discrepancy in the time allocated to ELA versus mathematics instruction. Students who typically received more instruction in ELA also received more instruction in mathematics from the teacher in that classroom, perhaps as a result of NCLB and the need to focus on core subjects for testing purposes. However, Phelps et al. expressed serious concerns about the impact of these variations in instructional time, stating that “the large variation demonstrated by these results represent substantial inequity in students’ opportunity to learn ELA and mathematics” (p. 631).

While there is certainly an established need for a greater number of minutes of instruction in ELA, given the number of skills which need to be taught and learned, students are receiving far fewer minutes of instruction in mathematics than ELA (an average of between 43% to 53% less, based upon Virginia’s daily total for instructional time requirements and the local school district ELA instructional time requirements noted earlier). The effective use of that allocated instructional time, which requires concentrated high quality instruction, including the application of best practices and the
development of engaging, objective-based student activities, can greatly impact the amount of student learning that can take place.

Wood (2005) wrote an editorial called “Understanding Mathematics Teaching: Where We Began and Where We Are Going,” explaining that expectations for teaching mathematics now require a deeper conceptual understanding of how mathematics works in order for effective instruction to take place. Therefore, the instructional time in mathematics must be utilized in a way that is particularly effective by knowledgeable teachers in order to positively impact student performance in this discipline.

Departmentalized instruction reduces instructional time variations and thereby levels the playing field for students, providing equal opportunities for them to learn.

Non-departmentalized teachers, who are responsible for the instruction in all four content areas, can also adjust instructional time limits for teaching the subjects, given that they have their students for almost the entire school day for instruction, which can lead to the types of variations in instructional time reported in the Phelps et al. (2011) analysis. As a result, non-departmentalized classes are at a much higher risk for having larger variations in the use of instructional time. Therefore, it appears that the non-departmentalized instructors, who are responsible for teaching all of the content areas every day, tend to spend more time teaching the subjects in which they are the most knowledgeable and the most comfortable, which helps explain the variations in instructional time observed between classrooms (Phelps et al., 2011).

Addressing these concerns and ensuring equity in terms of allotted instructional time for ELA and mathematics may be the first step in providing equitable opportunities for all students to gain an in-depth understanding of both subjects, while improving
efforts to close the achievement gap as well. The implementation of the departmentalized classroom organizational structure at the upper elementary level would help to ensure equitable instructional time in mathematics for the benefit of all students.

Gerretson et al. (2008) noted that, as most elementary schools continue to utilize the traditional, non-departmentalized model at the elementary level, the teacher, who serves as a generalist, is still expected to serve as the expert. However, the quality of traditional classroom instruction is not as it was envisioned, and the structure of the traditional classroom with the single teacher serving as the expert may limit opportunities to facilitate true conceptual understanding among students across all subject areas.

Reys and Fennell (2003) pointed out that teachers of mathematics in the elementary school need to know and understand the mathematics content they teach, know how students learn mathematics, and be able to apply content-based instructional strategies that support student learning in mathematics, in accordance with The Principles and Standards for School Mathematics established by the National Council of Teachers of Mathematics (NCTM) in 2000. This concept is further supported by Tabernik and Williams (2010) as part of their study, which investigated the relationship between sustained, targeted professional development in mathematics and student performance in the United States and other high-achieving countries. Tabernik and Williams noted that “It is not enough for teachers to develop strong pedagogical skills; they must also know their subject area well enough to understand how to teach it to students” (p. 46).

Therefore, non-departmentalized teachers may be struggling as they are being asked to serve as subject matter experts in four key subject areas, which includes even more demanding and complex material that needs to be taught in the upper elementary
grades, particularly in the area of mathematics. On the other hand, departmentalized instructors have to maintain a strict schedule, as they have to begin and end classes at prescribed times, leading to naturally more regulated instruction. As students move into the upper elementary levels, teachers need to be particularly knowledgeable about the subject area of mathematics, having a greater understanding of its applications, in order to make the most of the limited instructional time available in this subject area and in order to make a difference in the lives of their students. Students who fail to gain a solid understanding of how mathematics works often carry these weaknesses in mathematics with them as they move into the upper grades in middle and high school.

Mathematics instruction at the upper elementary grade levels is particularly important, as emphasized by the results of a 2012 study entitled “College Bound in Middle & High School? How Math Course Sequences Matter,” which was commissioned by The Center for the Future of Teaching and Learning at WestEd, a non-profit organization that focuses on policies and practices for improving teaching in California. The study revealed the inability of students to be successful when repeating algebra, as approximately 80% of the students who repeated Algebra I failed to score proficient on the California Standards Test (Finkelstein, Fong, Tiffany-Morales, Shields, Huang, 2012). Finkelstein, the lead researcher conducting the study, noted, “These results provide powerful evidence that school systems are struggling to successfully teach, or reteach, mathematics to students who are not already performing well in math by the time they reach middle school” (as cited by Tucker, 2012, p. 1).

Hence, the key to success in mathematics in higher grades may depend upon the level of student proficiency in mathematics in the upper elementary grades. Another
factor noted in the study was that teachers often present algebraic instruction in the same manner every time, failing to help their students learn the material by using other methods (Finkelstein et al., 2012). This is where departmentalized elementary mathematics instructors, who essentially serve as subject matter experts, can step in and work to bring students to the required levels of proficiency in mathematics that they will need to be successful in middle and high school, starting at the elementary level.

Fully departmentalized elementary teachers in mathematics in Virginia typically spend at least four hours (240 minutes) of their 290-minute instructional day focused on the teaching of mathematics. Partially departmentalized mathematics teachers may teach mathematics for between 40% and 62% of their instructional day (two to three classes or 120 to 180 minutes of the 290 minutes available). While partially departmentalized mathematics teachers may have responsibility for another subject area or two for their homeroom class, such as writing, science, or social studies, they naturally remain more heavily invested in their favored area of departmentalization. The power of the departmentalized setting is that the content material is more likely to be presented by a subject matter expert, who can present the material in a more effective way to students and positively impact student achievement.

**Teacher Preparation and Expertise**

Quatroche et al. (2001) highlighted the need to ensure that teachers are not only properly prepared in their content area, but also that they have opportunities to receive professional development with a focus on specific teaching methods, including follow-up training on best teaching practices (Slavin et al., 2009). As Quatroche et al. noted, “The literature seems clear that instruction, to be effective, must be delivered by well-prepared
professionals” (p. 289). It is also important to note that, because of the more demanding curriculum requirements of the upper elementary grades, there is a critical need for teachers at the fifth grade level to be content knowledgeable and proficient in practice in order to positively impact student achievement so that students can attain mastery prior to moving on to higher grade levels (Slavin et al.).

Unfortunately, elementary school teachers are not known to have strong backgrounds in mathematics, since they come from the 75% of the high school population that stop taking mathematics courses after only having two or three courses in mathematics (National Research Council, 1989). Another concern noted by the National Research Council in their 1989 report, Everybody Counts: A Report to the Nation on the Future of Mathematics Education, revolved around the lack of an organized approach towards the establishment of programs of mathematics curriculum and instruction across the nation.

This massive system of mathematics education has had no national standards, no global management, and no planned structure—despite the fact that each step in the mathematics curriculum depends in vital ways on what has been accomplished at all earlier stages and that scores of professions depend on skills acquired by students during their study of mathematics. (p. 39)

Given these concerns about the lack of a consistent, structured approach to curriculum and instruction, the Common Core State Standards (CCSS) Initiative was begun as a state-led effort, which established standards in 2010 for all of the nation’s students in kindergarten through 12th grade in ELA and mathematics (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2012).
The CCSS were created for purposes of establishing clear, concise educational goals and learning objectives for better preparing students to enter either college or the workforce, encouraging voluntary adoption by the states. The whole idea was to promote equity and consistency for students in learning key components in ELA and mathematics to ensure that students were exposed to the content and skills that they would need, wherever they lived.

The federal government was not involved in the creation of the CCSS. However, this state-led effort addresses concerns about having a unified effort for the development of a structured curriculum or program of learning in reading and mathematics for all students in the nation, a need that was highlighted by the National Research Council back in 1989. Forty-five states adopted the CCSS, and with Indiana recently opting out of the following CCSS, there are now forty-four states working to develop common assessments that are aligned with the standards, which will replace their existing end-of-year state assessments beginning in the 2014-2015 school year (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2012).

Virginia is now one of six states that are not following the CCSS, but Virginia utilized their own existing process for review and adoption of existing standards and curriculum in order to incorporate content from the CCSS into the SOLs. The VDOE’s position is that “Virginia’s SOL are equal to or in some instances more rigorous in content and scope than the CCSS” (VDOE, 2011, p. 3). The VDOE adopted updated Mathematics SOLs in 2009, which were aligned with testing and assessed for the first time in 2012. While the SOLs are somewhat aligned with the CCSS, there is a difference in that the SOLs do not dictate methodology, while the CCSS, in fact, do dictate
methodology, applications, and extensions of content that the teachers should utilize, based upon their students’ learning needs.

In general, both the CCSS and the Virginia Mathematics SOLs are considered to be rigorous, and each set of standards provides a detailed explanation of the expectations for student learning and understanding in mathematics. “By the time students have progressed into high school mathematics content through the CCSS or SOL, they have received at least the same mathematical content delivered through different learning progressions” (VDOE, 2011, p. 3). Therefore, Virginia’s teachers will still have students who are facing a different learning progression in mathematics by following the SOLs, compared with the CCSS. In addition, students who enter classes in Virginia from other states have a variety of mathematical backgrounds, which happens quite often due to the large numbers of military families who relocate into and out of the state on a regular basis.

While these recent efforts to develop consistent, structured standards for all students in the nation is commendable, there is still a lack of elementary school teachers who are knowledgeable in the area of mathematics, and these teachers bear a heavy burden when trying to help students construct their own levels of in-depth mathematical understandings in order to be successful. Walshaw and Anthony (2008) highlighted the importance of the role of teachers in developing sociocultural classroom communities in mathematics that encourage an exchange of ideas, assertions, predictions, and alternative solutions. These types of collaborative classroom communities in mathematics promote active engagement, resulting in an improved understanding of underlying mathematical concepts that are applicable outside of the school environment.
In their review of the research on mathematics instruction, Slavin and Lake (2008) noted that their findings suggest that researchers and educators should focus more on how mathematics is actually taught, along with what approach will move their students forward. This type of subject-area focus is also what will be needed to close the achievement gap between racial minority and racial non-minority students, as well as between students in the lower and middle socioeconomic classes.

Fully and/or partially departmentalized mathematics instructors who work in departmentalized settings spend the majority of their planning time in mathematics lesson preparation, along with being involved in targeted professional development in the area of mathematics, in addition to gaining a substantial amount of regular instructional experience in mathematics. The departmentalized or specialized approach for the teaching of mathematics is supported by Gerretson et al. (2008), who conducted a study entitled “A Case for Content Specialists as the Elementary Classroom Teacher” in order to identify factors that explained the increased use of content area specialists in elementary schools, particularly in the area of mathematics. Gerretson et al. reported that the specialist, content area approach permits each instructional professional to take advantage of the opportunity to have a “laser-like focus” (p. 302) on their particular subject area of interest.

Departmentalized mathematics instructors serve as specialists in their area, whether they are technically identified as specialists or not. Departmentalized mathematics instructors coach other teachers, make professional development presentations to the faculty in the area of mathematics, and serve as mentors for teachers who are new to the school division (Gerretson et al., 2008). Mentoring can be critical to
the success of the new teacher and can help veteran teachers maintain and update their skills while reducing attrition from the profession. Zientek and Thompson (2008) studied the effectiveness of teacher preparation and mentoring programs, noting that mentoring has been recommended for mathematics teachers since the 1894 *Report of the Committee of Ten on Secondary School Studies with the Reports of the Conferences Arranged by the Committee*, which was prepared for the National Educational Association. Zientek and Thompson also reported that the National Commission on Teaching and America’s Future noted back in 1996 that mentoring can be critical to supporting new teachers, helping them to become successful, and thereby, increasing teacher retention rates, which was also noted by Stevens (2009).

Departmentalized mathematics instructors who teach in departmentalized settings are in the best position to provide mentoring to other teachers who need to fortify their knowledge base, application skills, and use of teaching strategies in the area of mathematics. Departmentalized mathematics instructors are also in the best position to provide effective mathematics instruction to elementary students, particularly at the upper elementary level. Gerretson et al. (2008) noted that elementary classroom teachers often lack a deep, conceptual understanding of mathematics, which makes it difficult to teach essential mathematical concepts to young children. Reys and Fennell (2003) noted in their article entitled “Who Should Lead Mathematics Instruction at the Elementary Level” that the way to improve mathematics instruction at the elementary level will depend to some extent on teachers who have specialized knowledge in facilitating mathematics instruction.

However, elementary educators have been, and are, viewed as generalists
Elementary educators usually have state-issued general elementary education certification, ranging from Pre-K to Grade 6, depending upon the particular state’s guidelines, rather than possessing a specific subject-area certification, which would be required at the middle or high school instructional level. The National Research Council noted in their report, *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* back in 1989 that the United States was one of the few countries that still expected its elementary teachers to teach all of the content area subjects well, despite evidence to the contrary, particularly in mathematics and science.

The National Research Council (1989) also noted that there are qualified teachers who already have the interest and experience to pursue departmentalized or specialist positions in mathematics and science, while other teachers could qualify with additional coursework or professional development. The National Research Council suggested that states consider modifying their certification requirements to include specialist or subject area elementary certification in order to encourage the formation of additional specialized classroom organizational structures at the elementary level. Specialized instruction, particularly in the area of mathematics and science, could have a significant effect upon student achievement and better prepare America’s students for careers in the global marketplace of the future.

In terms of student support, departmentalized mathematics instructors at the elementary level often volunteer to offer free tutoring sessions for students—before, during, and after school—in an effort to utilize their expertise for the purpose of helping those students who are struggling the most in mathematics. The study conducted by Tabernik and Williams (2010) entitled “Addressing Low U.S. Student Achievement in
Mathematics and Science Through Changes in Professional Development and Learning” reported that

Teacher participation in professional development and teacher certification in mathematics were associated with a narrowing of the gap between male and female students with regard to level of improvement in student performance on the OATM [Ohio Achievement Test for Mathematics] from 2006 to 2007.

Finally, teacher background in mathematics was associated with a narrowing of the minority achievement gap with regard to level of improvement in scores over the 2-year period. (p. 39)

The extra effort put forth by departmentalized mathematics instructors, who feel secure in their subject area and who are willing to share their expertise and invest additional time in order to help struggling teachers and students, can make a big difference in students’ lives and have a positive impact upon closing the achievement gap between males and females and racial minority and racial non-minority students.

**Departmentalized Instruction**

The concept of departmentalizing at the elementary level is a contentious topic, often debated by school district leaders, educational administrators, instructors, and parents. Baker (2011) noted in her study on departmentalization at the elementary level that, upon a review of the literature, the issue of whether to departmentalize or not at the elementary level is still unresolved. Baker pointed out that limited empirical research exists on this topic going back to the 1960s and 1970s, with the results of most of the studies being either inconclusive or contradictory.
Since the mid-1800s, the norm for elementary school classroom structures has revolved around the traditional, self-contained, non-departmentalized, graded class, with students grouped by grade level and served by one teacher. The Quincy Grammar School of Boston, which was the first city graded school in the country, was started by J. D. Philbrick in 1848 (Otto, 1954). Schooling in the United States initially began in the colonists’ individual homes, followed by efforts to have groups of children taught by one woman in one home or other location, in what became known as the “dame schools” (Otto, p. 1). Dame schools ran from approximately 1650 until the early 1800s, but they were not serving a large enough proportion of students who needed to be educated (Cubberley, 1902; Otto, 1954; Rury, 2002). After the conclusion of the War of 1812, a democratic system of public schools was formed in the New England area, while outside of New England, schooling was left to churches, individuals, societies, and institutions for serving the poor (Cubberley, 1902).

Otto (1954) effectively summarized this shift towards graded schools by quoting a U.S. Bureau of Education Bulletin from 1916, stating that by 1860, there was a unified system of graded schools in every city and town, with a specified course of study, time limits, and legislative protection. As noted by Otto, “this unifying movement . . . resulted in better articulation and government of the entire period of elementary education. . . another stage in the evolutionary process which had been going on for half a century” (p. 11).

Interest in departmentalizing at the elementary level began to grow between 1910 and 1929, followed by the addition of specialized teachers in the areas of art, music, and physical education (Lobdell & van Ness, 1963). Departmentalization fell into and out of
favor about every ten years, up through the 1950s, with constant arguments being put forth about the benefits of each structure, departmentalized versus non-departmentalized (Lobdell & van Ness).

Non-departmentalized instruction has its advantages, including the development of stronger teacher-student interpersonal relationships and increased opportunities for integrated instruction across disciplines. However, it is important to highlight the fact that many elementary teachers do not feel knowledgeable enough to teach their students in certain subject areas and even dislike certain subject areas (Liu, 2011). Liu noted that many elementary teachers experience high anxiety related to the teaching of mathematics due to their own lack of confidence in mathematical subject matter knowledge. On the other hand, departmentalization allows teachers to work from their subject area of strength and in areas in which they are interested, allowing them to make the most of the instructional time they have with their students.

A review of the literature highlights the specific benefits of choosing departmentalized instruction, particularly at the upper elementary level, including having enthusiastic subject matter experts in the classroom, along with more lesson planning time, resulting in in-depth, engaging lesson preparation (Hood, 2010; McPartland, 1987; MecPartland, Coldiron, et al., 1987). Students in departmentalized classes can become eager learners who benefit from being exposed to active, engaging lessons, different teaching personalities, and various teaching styles, while their teachers benefit from having increased opportunities for collaboration. In a departmentalized setting, teachers are usually provided with additional opportunities to participate in targeted professional development in their preferred subject areas. Another benefit for students is that, at the
conclusion of fifth grade, they are far more prepared to make the transition to a departmentalized middle school.

While there are several benefits to be gained from the implementation of departmentalized instruction, there are some significant limitations that also must be considered. These concerns revolve around teachers having trouble developing the necessary interpersonal relationships with students, given the number of students that they are serving in multiple classes, along with being too self-involved with a primary subject, making it difficult for them to relate to other teachers (Hood, 2010; Lobdell & van Ness, 1963; McGrath & Rust, 2002; McPartland, 1987; McPartland, Coldiron, et al., 1987). There are also strict time schedule requirements due to changing classes, which pose organizational issues for students who need to gather all the necessary materials to move from class to class, unless the teachers move. In addition, some students may have issues adjusting to having different teachers, along with meeting the different requirements those teachers may have (i.e. for headings on papers, class rules, classwork and/or homework requirements, etc.). There are also issues with lost instructional time due to transition time between classes and student settling-in time in preparation for lessons.

Baker (2011) conducted a case study that focused on the decision of whether to departmentalize elementary schools, and she recommended that researchers touch base with middle schools in order to see how those schools have been dealing with departmentalization issues, which could prove helpful to any elementary schools considering the implementation of departmentalization. Additional studies evaluating student-testing results by comparing departmentalized with non-departmentalized student
achievement, as was completed in this study, provide evidence-based data for decision-making purposes (Henderson, 2011) that will help schools and school divisions make appropriate decisions about the best choice for a classroom organizational structure at the elementary level for their students.

**Implementation of Departmentalization**

Departmentalization at the elementary level is sometimes implemented to prepare students for the transition to a departmentalized middle school or to provide specialized instruction by teachers who have extensive knowledge in certain subjects (Baker, 2011). For many years, few studies were conducted on this topic; however, new research has emerged. Chan and Jarman (2004) noted, “Innovative measures, including grade-level teams, cross-grade teams, non-graded structure, and partial departmentalization (Wiles & Bondi, 2001) have been practiced with varying degrees of success and laid the groundwork for the successful implementation of full departmentalization of elementary education” (p. 70).

Chan and Jarman (2004) noted that, historically, there have been problems with collaboration and integration when implementing departmentalization at the elementary level and that the emotional needs of the students may not always have been met. Also, some students perform better in a non-departmentalized setting, as noted by McGrath and Rust (2002), who found that a self-contained group gained significantly more on total battery, language, and science subtests and lost less time to transition between participants than did the departmentalized class. However, McGrath and Rust noted that some studies found that departmentalized organizational approaches can be advantageous for the student. Departmentalization offers advantages in the areas of content
specialization (Abbati, 2012), collaboration across grade levels (Marsh, 2010), increased teacher retention due to higher job satisfaction (Stevens, 2009), the preparation of students for transition to middle school (Disseler, 2010), and ability grouping by discipline within each grade level (Chan & Jarman, 2004).

Baker (2011) highlighted several factors that schools or school districts should consider to help ensure student success before making the decision to implement departmentalization. Baker’s recommendations included reviewing the existing institutional norms, interests, and knowledge of the individuals involved, along with ensuring that the appropriate structures are in place in order to ensure successful implementation. Baker also emphasized that teachers need to be in favor of departmentalization and be committed to ongoing collaboration, including keeping lines of communication open, which would lay the foundation for success for any new instructional plans. Teacher surveys could be conducted, similar to those conducted by Moore (2008) and Williams (2009) to determine teachers’ preferences regarding their preferred classroom organizational structure.

The National Mathematics Advisory Panel (ED, 2008) reported that many schools across the country were turning to mathematics specialists (who work directly with students) or mathematics coaches (who work directly with teachers) in an attempt to improve instruction and achievement. The National Mathematics Advisory Panel also noted that there was virtually no research available on the effect of mathematics specialists on student achievement. Therefore, it follows that a study comparing the impact of departmentalized instruction in mathematics is both needed and fundamental to discovering whether instruction provided in a departmentalized setting is more effective.
than when instruction is provided in the non-departmentalized setting.

While there are different definitions for the roles and responsibilities for mathematics specialists by state or school district, departmentalized instructors (being viewed as specialists, using their expertise to work with students in a particular content area) are usually more knowledgeable and are provided with more professional development and training in their content area (McGatha, 2009). In addition, given that departmentalized instructors are more focused on a given subject area (Abbati, 2012)—or fewer subject areas if there is partial departmentalization—they have more time to plan engaging, differentiated lessons, experience greater job satisfaction (Johnson, 2013), and have higher retention rates (Chan & Jarman, 2004; Stevens, 2009). Departmentalized teachers are more likely to differentiate their lessons in order to meet the diverse needs and learning styles of their students, effectively utilizing their content area expertise (Abbati, 2012; VanTassel-Baska et al., 2008) in addition to planning cooperative learning activities.

When teachers feel knowledgeable and confident in the subject area material they are presenting, they feel empowered and are more satisfied with the contributions they are making to their students’ learning. This increased level of satisfaction leads to higher levels of morale among individual teachers and teaching teams, positively impacting the school as a whole. This departmentalized classroom organizational structure approach, relying on the foundational beliefs associated with social constructivist theory, would also help to empower students and build their morale by actively engaging them in their own learning, resulting in greater success for both students and teachers.
Non-departmentalized Instruction

Despite trial-and-error efforts at the implementation of departmentalization over the past century and the introduction of specialists in the areas of art, music, and physical education, the traditional, self-contained model or the modified self-contained model has remained in favor at the elementary level over the departmentalized model. Today’s self-contained classroom teacher is still held responsible for instruction in the four key content areas of ELA, mathematics, science, and history/social studies. In fact, the elementary classroom teacher has historically been viewed as possessing the necessary subject matter knowledge expertise to effectively instruct students in the self-contained setting (Ackerlund, 1959; Anderson, 1962; Chan & Jarman, 2004; Culyer, 1984; Patton 2003), while having a superior ability to address the developmental needs of the child.

The reasons that proponents of the self-contained, non-departmentalized model believe in its effectiveness, even to this day, were probably articulated best by Ackerlund in 1959 when he noted that the self-contained classroom “provides for greater teacher acquaintance with each child, more flexibility in time allotments, and better correlation and integration of subject matter. Moreover, it avoids the necessity of the child having to adjust to more than one teacher” (p. 283). As it now stands, numerous educators and several researchers have supported the non-departmentalized content area model over the years, despite the fact that upon a review of the literature, there have been few studies actually conducted at the elementary level comparing the effectiveness of the departmentalized versus the non-departmentalized settings.

The overriding goal of quarterly benchmark testing administered by several local Virginia school divisions is supposed to be for the purpose of effectively preparing
students to perform well on the annual, year-end Virginia subject area SOL tests. However, teachers who are insecure in their level of content knowledge face even greater stress, given their inability to effectively instruct students in subject areas where their own knowledge is lacking, in addition to being under increasing pressure to have their students produce higher test scores.

In the self-contained, non-departmentalized classroom, where the teacher is expected to essentially serve as the expert across all subject areas (Baker, 2011; Lederman & Flick, 2003), this pressure can grow to the point where the teacher is unable to perform or to where he or she just focuses on a few subject areas. Teachers face even greater content knowledge pressure at the upper elementary grade levels, particularly in the area of mathematics, due to increasing content complexity and more demanding expectations, such as those put forth by the VDOE. Students are expected to evaluate word problems and interpret pictures and graphs, along with conducting calculations involving algebraic approaches and multi-step solutions.

However, as noted earlier, there are several benefits that can be reaped from the self-contained, non-departmentalized model, including increased opportunities for developing closer teacher-student relationships through the provision of emotional and psychological support, along with flexibility with regard to instruction (Hood, 2010; Lobdell & van Ness, 1963; McPartland, 1987; McPartland, Coldiron, et al., 1987). While a review of the literature regarding instructional effectiveness reveals that the non-departmentalized model for elementary schools is still the favored instructional model at the elementary level, data does not exist to support this stance. There is currently a lack of empirical evidence to properly evaluate departmentalized versus non-departmentalized
instruction at the elementary level, and the results of the studies conducted have been inconsistent. Much of the research available was conducted years ago, and limited research has been conducted at the elementary level. In the meantime, the curriculum demands, particularly in mathematics, have grown more complex with ESEA flexibility requirements (Delisle, D. S., Delisle to P. I. Wright, August 29, 2012), followed by increases in state expectations for student performance.

Therefore, additional studies involving collecting data from departmentalized and non-departmentalized classes for comparison at the elementary level will provide much needed empirical evidence regarding the effectiveness of these classroom organizational structures. Kowalski and Lasley (2008) advised, however, that researchers and educators should review the data with a critical eye for purposes of decision-making, in order to support making the right choices that will result in improved student achievement.

Mathematics Instruction and Closing the Achievement Gap

It is widely understood that mathematical knowledge and skill can be the key to success, both academically and professionally. As noted by Esmonde (2009), knowledge and skill in mathematics can be critical for a student’s success, in terms of achieving high school graduation and entry into college, followed by the ability to have choices for pursuing a number of professional career paths. Given that mathematical knowledge can serve as the gatekeeper for college and careers, it is important that research studies be conducted to identify instructional settings that may level the playing field for all students so that they will have the option to pursue academic and professional opportunities in the future. However, Slavin and Madden noted in 2006, several years after NCLB had been enacted, that
The gap in academic achievement between African American (as well as Latino) children and their White peers is arguably the most important of all educational problems in the U.S. This gap, which appears early in elementary school, develops into differences in high school graduation rates, college attendance and completion, and ultimately, the differences in income and socioeconomic status (SES) that underlie the most critical social inequities. (p. 54)

This achievement gap continues to be a challenge, which has not been overcome, after years of efforts to close these gaps. The 2011 Annual Report on Condition and Needs of Public Schools in Virginia (VDOE, 2011) reported that the National Assessment of Educational Progress (NAEP) found there are still disparities in achievement among subgroups in Virginia, despite high achievement by students in reading and mathematics overall. For instance, it was noted in the report that results from the 2011 NAEP show that “Virginia public school students continue to rank among the nation’s highest achievers in reading and mathematics and outperform their peers nationwide, and Virginia now ranks among the top on Advanced Placement Results” (p. 11). Yet, based upon testing conducted by the NAEP in 2011, fourth grade results showed a 22 test-score point gap in mathematics achievement between Black and White students, and eighth grade results showed a 29 test-score point gap. The average mathematics score results were based on a NAEP Mathematics Scale that ranged from 0 - 500 for grades 4 and 8 (National Center for Educational Statistics, 2013). Reading assessments showed a 22 test-score point difference between Blacks/Hispanics and Whites in both fourth and eighth grades, based on the NAEP Reading Scale that ranged from 0 - 500 (National Center for Educational Statistics, 2013).
According to the National Center for Education Statistics, as reported in *The Nation’s Report Card: Mathematics 2011*, the NAEP found that, while average mathematics scores have risen 28 points from 1990 to 2011 for fourth graders nationwide, there were not any significant changes in the White/Black or White/Hispanic score gaps between 2009 and 2011. A large gap in achievement between these subgroups remained, with an average of a 25-point scaled score difference between Blacks and Whites, down from a 32-point scaled score difference in 1990. The scaled score gap between males and females remained stable at a one-point difference.

In Virginia, these achievement gaps in reading and mathematics often result in lower achievement in high school, along with higher dropout rates for subgroups. While the state dropout rate fell from 7.8% in 2010 to 7.2% in 2011, as reported in the 2011 *Annual Report on the Condition and Needs of Public Schools in Virginia*, the dropout rate for Blacks was more than twice that of White students, and Hispanics dropped out at three times the rate of Whites. In addition, while 71% of Virginia’s Asian students and 55% of White students earned an Advanced Studies diploma, only 37% of Hispanics and 29% of Black students earned the advanced diplomas by comparison.

Esmonde (2009) discussed mathematical reform efforts and the need to ensure that students have “positive mathematical identities as knowers and doers of mathematics” (p. 1019) in order for them to perceive themselves as being successful in mathematics, which may be a key in helping to close the achievement gap. In fact, Bandura (1993) noted that “positive attitudes toward mathematics were better predicted by perceived self-efficacy than by actual ability” (p. 119). Teachers of mathematics need to provide their students with equal opportunities to learn mathematics (Eddy, 2008;
Marsh, 2008; Ponder, 2008). Esmonde (2009) summarized these thoughts best, noting that what teachers do in the classroom matters. How teachers view and treat their students can make a real difference in terms of whether or not the students are persistent in their efforts, and thereby, achieve success. These concentrated efforts must be kept in mind in order to progress towards achieving equity in the classroom and in the workplace.

The NEA Foundation (n.d.) has recognized the need to assist low income and minority student subgroups who are underachieving by supporting a “Closing the Achievement Gaps Initiative” to help these subgroups accelerate their rate of achievement in reading and mathematics. School districts in Virginia will be required to demonstrate progress towards closing these achievement gaps under new state AMO requirements listed on the VDOE website according to ESEA flexibility guidelines received from the ED (Delisle, D. S., Delisle to P. I. Wright, August 29, 2012). In a further effort to make progress towards closing the achievement gap, instruction provided in a departmentalized setting has the potential to increase student achievement, given the results of a recent study by VanTassel-Baska et al. (2008) that evaluated the impact of changes in teachers’ instructional behavior on student achievement, demonstrating that teachers who possess content specific expertise engage their students at a higher level. VanTassel-Baska et al.’s results are further supported by a study by Boyd, Lankford, Loeb, Rockoff, and Wyckoff, (2008), which analyzed individual student and teacher data for grades three through eight from 2000-2005, suggesting that the selection and retention of teachers with stronger qualifications made a significant difference in New York City public schools by leading to improved student learning.
If teachers are to make progress towards closing the achievement gap in mathematics between subgroups, including racial minority and non-minority students and between boys and girls, then not only do they need to continue to work towards understanding their students’ levels of mathematical understanding, but they need to provide opportunities for students to construct their own deeper levels of conceptual knowledge and establish positive visions of themselves as mathematicians (Esmonde, 2009). Forming a positive vision of oneself being successful in mathematics can be a challenge for some members of gender and racial minority subgroups, which can greatly impact their mathematical performance. Based on the research, developing goal-directed activities that integrate cultural norms and integrate the use of tools and artifacts can prove to be effective and provide equal opportunities for learning (Eddy, 2008; Marsh, 2008).

It is important that educators gain a better understanding of how race and culture interact with the reality of a child’s school experience. “Findings have shown that when students behave and interact in ways that differ from the norms and expectations of their schooling institutions, both learning and school achievement suffer (Cummins, 1986; Foleu, 1991; Rist, 1973)” (Nasir & Hand, 2006, p. 452). Therefore, it is paramount that teachers be secure enough in their own content knowledge to be able to recognize and adapt to the different methods of learning, communication, and social interaction on the part of subgroup members, which may differ from what a teacher may view as the norm (Eddy, 2008; Marsh, 2008; Ponder, 2008).

Nasir and Hand (2006) analyzed research studies on race, culture, and learning from a sociocultural theoretical perspective, encouraging other researchers to pursue
additional research in this area. While it is understood that there are integrated relationships between race, culture, and gender, which greatly impact the achievement of minority or gender subgroups, the body of research available has failed to provide an organized framework from which to fully understand or explain the findings from existing studies.

Nasir and Hand (2006) did note in their analysis of the literature that “Steel [1997] and colleagues argue that one inhibitor of school performance is stereotype threat; the perceived threat of racial stereotypes being imposed can depress academic performance, through their anxiety-inducing effects on thought and problem solving” (p. 457). Therefore, teachers need to be sensitive to the their own internalized bias, if any, against poor or minority groups or against a particular gender, or a combination of all or some of these factors (i.e. a poor, minority male), recognizing that outward bias may impact student learning and achievement, as this bias may impact how the students see themselves and their levels of capability.

The impact of this stereotype threat has been shown to be particularly true in the area of mathematics, as students tend to have more anxiety about learning and performing well in mathematics in general. In fact, “[Hancock, 2004, 2005] argues that the presence of multiple marginalized communities creates a compound effect that is more than the sum of the parts. For instance, being simultaneously Black, female and poor creates a multiplicity of obstacles” (Nasir & Hand, 2006, p. 454).

Gender and racial minority stereotypes can serve as obstacles, acting like roadblocks, in terms of students seeing themselves as being successful in school. There are other theories which suggest that societal and cultural conflict inside and outside of
school jointly affect the achievement of minority children (Nasir & Hand, 2006). These societal and cultural factors can lead to resistance on the part of minority students in school because minority students may not have the structure at home to support them or because schooling is not valued at home, and these students may not have the relationships with teachers and/or students at school that encourage learning.

Lee (2005) studied how prospective teachers facilitated mathematical problem solving using a technology tool, discovering that teachers need to learn from the student’s perspective how their students from different backgrounds learn using these tools. It was determined from Lee’s study that prospective teachers learned how to teach mathematics more effectively when they focused on their students’ work rather than their own actions, following a “planning-experience-reflection” (p. 250) cycle. When teachers reflect on their own practice and modify their instructional approach, they are more likely to have a positive impact upon student learning, the major premise behind the standards established by the National Board for Professional Teaching Standards (NBPTS, 2012). Wood (2005) emphasized the connection between subject matter knowledge and pedagogical content knowledge, noting that the strength of the connection between the two results in a more effective application of knowledge resources by teachers, which impacts the quality of their teaching.

Teachers are responsible for helping their students overcome the temptation to resist taking on new challenges and help them make sense out of learning, so that they learn to value learning. Teachers can accomplish this by creating learning activities that appeal to student subgroups, whereby they can learn in social contexts that make sense in their world, where they can construct their own learning, which holds meaning for them.
For instance, teachers should develop cooperative learning activities that pull from real-world situations for the students, such as problem solving activities that involve budgeting for spending, such as calculating possible options for purchases of iTunes music, iPod apps, eBooks, video games, etc. More studies are needed with regard to race, culture, gender, and learning, as was the case under NCLB, and is now the case with AMO requirements, in order to help teachers understand what they can do in the classroom with their students in order to help close the achievement gap (Harris, 2012; Lauen & Gaddis, 2012).

There are constraints at home and at school on students that are related to specific stereotypical ideas about gender, which can be restrictive on students and limit their performance in certain subjects or limit their participation in certain school or sport activities. This is particularly true for girls and learning in mathematics (Perry, 2011). As girls and boys progress through the mathematics curriculum, there is little difference in their levels of ability, effort, and interest in the early years. However, as girls reach the teenage years, their level of effort drops, perhaps due to social pressures and their ultimate career goals. Girls’ experiences in school, home, and society may have a stereotypical effect by steering them towards academic and career paths that do not require higher-level mathematics (National Research Council, 1989).

Ponder (2008) highlighted that there are known genetic and social differences between boys and girls that greatly impact how they learn and that a one-size-fits-all approach to instruction, particularly in mathematics, may not be the most effective approach. Also, in addition to gender specific genetic differences, and social differences, students from different cultures may have different learning styles, and in order for them
to be successful, the students need to be taught in the way that they learn (Eddy, 2008; Marsh, 2008; Ponder, 2008).

Esmonde (2009) noted that certain students, including girls, students of color, and working-class students, may need significant assistance from teachers in order to be willing to be successful academically, while working to still feel accepted in their social community. Given that mathematical skill is often viewed as the gatekeeper for entrance into higher education and the pursuit of a wide range of technical professions (i.e. computer science, engineering, medicine, etc.), more work needs to be done to encourage positive mathematical identities in girls, while encouraging them to follow more challenging paths, in terms of mathematical course work, in high school and college.

Marsh (2008) pointed out in her study on organizational systems and effective classroom instruction that changing structural and systemic practice has been shown to make a difference, facilitating higher student performance for students of color and for those living in poverty. Therefore, implementing effective classroom organizational structures could positively impact the achievement of student subgroups and help to close the achievement gap, if teachers take gender and cultural norms into account as part of their daily instructional practice.

More studies are needed which evaluate the effectiveness of different types of classroom organizational structures at the elementary level by comparing departmentalized and non-departmentalized achievement of whole groups, as well as racial minority/non-minority and gender subgroups (Baker, 2011; Chang et al., 2008; Hood, 2010; Kent, 2010; McGrath & Rust, 2002; Moore, 2008; Patton, 2003; Ponder, 2008; Slavin et al., 2009; Williams, 2009; Yearwood, 2011). Additional studies on
classroom organizational structures at the elementary level need to be conducted in order to identify which instructional setting will contribute the most to closing the achievement gap, particularly in mathematics. These efforts will be essential for the U.S. to be able to successfully compete in the global marketplace of the future. Students from all backgrounds must be able to make learning connections and see the value of what they are learning and doing in order to internalize what they have learned and further their own development.

Therefore, teachers need to ensure that all of their students actively participate in engaging learning activities by helping students create positive visions of themselves as individuals and as learners. However, as noted in Everybody Counts: A Report to the Nation on the Future of Mathematics Education published by the National Research Council (1989), “In reality, no one can teach mathematics. Effective teachers are those who can stimulate students to learn mathematics. Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding” (p. 58).

**Summary**

If educational leaders are to make a difference in the overall mathematics achievement of students, along with potentially helping to close the achievement gap between racial non-minority and racial minority students and between boys and girls, they are going to need make decisions about choosing classroom organizational structures that will positively impact what happens in the classroom every day. Departmentalized mathematics instructors who work in departmentalized settings are typically more knowledgeable and comfortable working with and teaching mathematics,
and they are more likely to be able to incorporate updated mathematics curriculum effectively and develop engaging lesson activities that will positively impact students and improve student achievement.

It is theorized in this study that the level of learning achieved by students is dependent upon their social interactions with their teachers and other students in the classroom, as they construct their own learning in accordance with social constructivist theory. Students internalize learning as new knowledge as they develop proficiency and test their critical thinking skills by working with knowledgeable teachers and other students who are more advanced in the content area. Given the gap in the literature with regard to studies conducted on effective classroom organizational structures at the elementary level, the results of this study will provide educators and educational leaders with more information about making structural choices that align with social constructivist theory and result in higher student achievement.

Classroom organizational structures may also have a greater or lesser effect on the certain subgroup performance. Hence, this investigation also addresses another gap in the literature with respect to the achievement of targeted gender and racial minority/non-minority subgroups who are receiving instruction in departmentalized and non-departmentalized settings.
CHAPTER THREE: METHODOLOGY

Departmentalized or partially departmentalized instruction at the elementary level is provided by teachers who focus on teaching one subject area for all or part of the school day in a departmentalized setting, similar to a middle school or high school model (Hood, 2010). Non-departmentalized instruction at the elementary level is provided by teachers who are responsible for all of the major content area subject matter (ELA, mathematics, science, and social science) instruction in a traditional, virtually self-contained or non-departmentalized setting (Canady & Rettig, 2008). The purpose of this study was to determine whether fifth grade students achieved higher levels of mathematics proficiency, by whole group and by subgroup, based upon the receipt of mathematics instruction in departmentalized or non-departmentalized settings, which may suggest which classroom organizational structure was most effective.

School administrators are strongly motivated to select the most effective teachers by subject area to teach in departmentalized settings, particularly in the more challenging area of mathematics, because of the increasing pressures administrators feel to have their students demonstrate subject area proficiency, as measured by annual testing results. Therefore, the selection of departmentalized instructors by the school administrator is viewed as critically important to the school and the school division because these teachers will impact the learning and achievement of more than one class of students for the entire school year.

Administrators as well as teachers are held accountable for the test scores of the students at their schools, as overall passing rates by subject area are published in the newspaper and on school and school district web sites, for review by parents and the
public at large. In addition, accreditation for the school and the school district depends upon the levels of proficiency achieved by students, by whole group and by subgroup, based upon reading and mathematics test scores. Schools must now meet increasingly stringent goals, known as AMOs, in reading and mathematics, which were allowed to replace the AYP goals under the federal education law. AMOs were set for all students, as well as for three proficiency gap groups, and for other subgroups, as part of VDOE’s ESEA amended flexibility request to ED (VDOE, 2013), which was subsequently approved by ED (Delisle, D. D., Delisle to P. I. Wright, March 5, 2013, p. 1), whereby Virginia’s schools would maintain their full accreditation status by meeting AMO accountability requirements as agreed to by the state and federal governments.

Proficiency gaps are the differences in performance of traditional underperforming student subgroups, which are compared with established AMOs that have been set. The three proficiency gap groups are comprised of: group 1, which includes students who have disabilities, are limited-English proficient, and who are economically disadvantaged students, regardless of race or ethnicity; group 2, African American students, not of Hispanic origin, including those students already counted in group 1; and group 3, Hispanic students, including those students already counted in group 1 (VDOE, 2013). Therefore, these new AMO guidelines highlight the need for administrators and teachers to continue their efforts to help students achieve, including the need to concentrate their efforts in working effectively with student subgroups in order to help close the achievement gap.

It is also true that administrators, teachers, and district school leaders will continue to be under increasing pressure to have their students perform well in reading
and mathematics, by whole group and by subgroup, as measured by student achievement in these subjects each year. Hence, the logic is that administrators have been selecting and will continue to select the best mathematics teachers to teach their students mathematics in a departmentalized setting at the elementary level, as student performance, school and district accreditation, and jobs have been, and are, on the line. In Virginia, student achievement in mathematics at the elementary level is measured by student performance on the grade-appropriate mathematics SOL test, which is administered annually. The Grade 5 Mathematics SOL Test was used as the instrument of measurement for this study to analyze whether or not a possible cause-and-effect relationship existed between the departmentalized classroom organizational structure and higher student achievement in mathematics.

Design

A causal-comparative quantitative design was chosen for this study because a key feature of this design is the comparison and evaluation of a presumed cause, identified as the independent variable, and a presumed effect, the dependent variable, in order to determine if it is viable to suggest a cause-and-effect relationship between the two (Gall et al., 2007). The independent variables in this case were the classroom organizational structure, gender, and racial status, and the dependent variable was student achievement.

The nature of the causal-comparative design dictates that the researcher cannot manipulate the variables, as “Causal-comparative researchers attempt to determine the cause or consequences of differences that already exist among groups of individuals” (Wallen & Fraenkel, 2001, p. 330). The causal-comparative design is also the appropriate choice when categorical variables are being studied (Gall et al., 2007; Wallen
& Fraenkel). Bornstein (1980) recognized that conducting laboratory experiments to study causation was not always possible, given the challenge of studying living organisms and the impossibility of directly controlling relevant characteristics, which therefore requires researchers to infer causality by utilizing statistical tests of variance utilizing the independent variables and the dependent variable, based upon data taken from samples of participants considered to be representative of a larger population of interest.

In this study, the participants were not randomly selected to be part of the sample groups for comparison, but rather, they were selected because they belonged to departmentalized or non-departmentalized population groups that were already established for instruction in mathematics. The participants’ archived mathematics test data was then utilized to analyze the possible cause-and-effect relationship between the independent variables of classroom organizational structure, gender, and racial status, which could not be manipulated, and the dependent variable of student achievement in mathematics that was observed and which had already occurred. Therefore, the causal-comparative research design was the most appropriate choice for this study, as the possible cause-and-effect relationship between the independent variables and the dependent variable was evaluated in retrospect, a distinguishing factor for this type of research design (Gall et al., 2007; Wallen & Fraenkel, 2001).

The fifth grade schools selected to participate in this study were based upon their type of elementary school (non-Title 1), classroom composition (regular education students), and classroom organizational structure (departmentalized and non-departmentalized). The essence of the research questions addressed in this study
revolved around whether fifth grade regular elementary students who received instruction in departmentalized settings in mathematics demonstrated higher levels of achievement when compared with the achievement of comparable groups of fifth grade students who received instruction in the identical curriculum in non-departmentalized settings. Students’ scores on their Virginia 2011 Grade 5 Mathematics SOL Test were compared and analyzed in order to identify whether or not there was a possible cause-and-effect relationship between a classroom organizational structure and student achievement in mathematics.

While the interpretation of results from causal-comparative studies requires caution, in terms of observing possible cause-and-effect relationships, results of such studies (Kent, 2010; Ponder, 2008; Yearwood, 2011; Williams, 2009) can add to the knowledge base in the field of education and provide a foundation for further study (Cohen, Manion, & Morrison, 2007). The remainder of this chapter will highlight details regarding the research questions and hypotheses, participants, setting, instrumentation, procedures, and data analysis for this study.

Questions and Hypotheses

A causal-comparative research design and an ANCOVA were used to address the following research questions and hypotheses:

Research Question #1: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, gender, racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5
Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 1 - $H_{01}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, gender, racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #2: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 2 - $H_{02}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #3: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?
Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 3 - $H_{03}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #4: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 4 - $H_{04}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #5: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, as measured by students’
scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 5 - $H_{05}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #6: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 6 - $H_{06}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #7: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?
Null Hypothesis 7 - H₀₇: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Participants

The participants in this study were selected from a population that included, and was representative of, regular fifth grade elementary students attending departmentalized and non-departmentalized mathematics classes that were already established in non-Title 1, Pre-K to Grade 5 elementary schools, who were not cluster grouped for receipt of special education or gifted services, in an urban school district of between 10,000 and 30,000 students in eastern Virginia. Students attending Title 1 schools were not included as part of the school selection process, as the purpose of this study did not include an evaluation of student achievement of the economically disadvantaged, who may have received additional special classroom instruction or assistance in mathematics.

Demographic information regarding the race and gender percentages in the school district’s local area from the 2010-2011 school year are provided with the results of the study. The student population was from the non-Title 1, Pre-K to Grade 5 elementary schools, which were within an 11-mile radius of each other, demonstrating that the samples were taken from a population of students attending schools in a similar demographic and geographic area.

The sample was chosen on a convenience basis based upon their assignment to either a regular departmentalized or regular non-departmentalized fifth grade classroom
for mathematics instruction in non-Title 1 elementary schools, which were made accessible to the researcher by the school division participating in this study. “Convenience sampling is a non-probability sampling technique where participants are selected because of their convenient accessibility and proximity to the researcher” (Castillo, 2009, p. 1). The school division served 14 grade levels from Pre-K through grade 12, and the percentage of the school district’s population that attended fifth grade in 2010-2011 was 7.32%, showing a relatively even distribution of the number of students across all 14 grade levels. There were many more Title 1 Pre-K through Grade 5 schools than non-Title schools in the district and, therefore, the elementary population attending non-Title schools was smaller in comparison to that of the Title 1 schools in the district.

The sampling frame for this study included regular fifth grade elementary students attending non-Title 1, Pre-K to Grade 5 elementary schools in the participating eastern Virginia urban school district who attended departmentalized and non-departmentalized classes during the 2010-2011 school year and who were not cluster grouped for receipt of special education or gifted services. Student demographic data, including gender and racial minority/non-minority status, together with their Grade 4 2010 Mathematics SOL Test data and their Grade 5 2011 Mathematics SOL Test data, was collected on a de-identified basis, based upon student enrollment in departmentalized and non-departmentalized classes in non-Title 1, Pre-K through Grade 5 elementary schools for 2010-2011.

The common support method of matching participants (Martin & Bridgmon, 2012; Pohl, et al., 2009) was used to select participants from the departmentalized and
non-departmentalized classes to form whole groups for comparison, and from which
subgroups were formed for comparison, based upon students’ scaled scores on their 2010
Grade 4 Mathematics SOL Test. Therefore, participants selected for study only included
students who had Mathematics SOL scores for 2010 and 2011. In addition, in accordance
with the common support method for matching, the sample selected did not include
students from the non-departmentalized group with scores lower than all of those in the
departmentalized group or students from the departmentalized group with scores higher
than all of those in the non-departmentalized group.

There was a student population of 273 students who had been placed in
departmentalized or non-departmentalized fifth grade classes during the 2010-2011
school year. Of the 273 students, there were 99 departmentalized students, with 90
having scores for 2010 and 2011 that could be compared. Of the 273 students, there were
174 non-departmentalized students, with 20 who did not have scores for 2010, in addition
to five non-departmentalized students who were not selected because they had scores
below those of the departmentalized group. This left 149 non-departmentalized students
who had mathematics test scores that could be compared. Both groups had students with
perfect scores of 600 for comparison.

Therefore, from the population of 273 students, a total of 34 students (nine
departmentalized and 25 non-departmentalized) were not selected from the population as
part of the sample to be compared and analyzed, resulting in a sample of 239 participants
selected for study. The needed sample size for evaluation and analysis for a causal-
comparative study for a population of this size should be approximately 163 participants
at a confidence level of 95% (Israel, 2009). Therefore, the greater sample size of 239
chosen for this study produced results with greater statistical power. The power analysis is critical in the context of the ANCOVA because statistical power is inversely related to the probability of making a Type II error, or arriving at a false negative, the failure to reject a false null hypothesis (Boslaugh, 2013; Israel, 2009). The higher the statistical power, the more likely one will reject the null hypothesis when the alternative hypothesis is true, taking the effect size, sample size, and significance level into consideration.

In addition to forming departmentalized and non-departmentalized whole groups for statistical comparison and to further control for extraneous variables, homogeneous subgroups were formed for comparison from the matched departmentalized and non-departmentalized whole groups, based upon gender, racial minority/non-minority status, and the combination of gender/racial status (Boslaugh, 2013). For example, the mathematics achievement of departmentalized minority males was compared with mathematics achievement of non-departmentalized minority males, and the mathematics achievement of departmentalized minority females was compared with mathematics achievement of non-departmentalized minority females. Statistical calculations were applied to the mathematics test score data in order to evaluate whether the independent variable of classroom organizational structure may have interacted with the independent variables of gender, racial status, and the combination of gender/racial status, to affect the dependent variable of mathematics achievement differently for each subgroup.

**Setting**

The school district chosen for this study was in an urban area in eastern Virginia, where fifth grade students were assigned by elementary school administration to either a departmentalized class or to a non-departmentalized class in regular education classrooms
in non-Title 1, Pre-K through Grade 5 schools throughout the district. Several school
districts in Virginia already utilize departmentalized and non-departmentalized
instruction at these grade levels, but the decision to use either of these instructional
models is inconsistent from year to year, from school district to school district, and from
school to school, based upon my own experience and information gathered from
conversations with numerous teachers, administrators, and accountability representatives
from other school districts.

The five non-Title 1, Pre-K through Grade 5 elementary schools chosen to
participate in this study from the participating school district were within an 11-mile
radius of one another and served grades Pre-K through Grade 5 in a regular elementary
school setting. Hence, the students attending the departmentalized and non-
departmentalized mathematics classes participating in this study were from the same
demographic and geographic area. The schools were also similar in size in terms of the
total number of students enrolled, with less than 500 students attending each school.

The fact that the elementary schools participating in this study were similar in
nature with regard to demographics, geographic location, and student enrollment
established a similar foundation for students who participated in this study, reducing
extraneous variables that may have impacted student performance from school to school.
Treatment groups (departmentalized) and control groups (non-departmentalized) were
compared in this study, and it was important that members of the nonrandomized groups
selected were from schools that were similar because bias was reduced. However, the
use of a control group does not guarantee a sufficient standard of comparison because the
groups may differ in factors other than the treatment, which may also affect the outcome.
Therefore, these other factors may introduce bias into the estimation of the treatment effect (Bornstein, 1980; Boslaugh, 2013; Johnson & Christensen, 2010).

In this study, by selecting comparison groups who attended schools with similar environmental factors (demographics, geographic location, and school size), the treatment group resembled members of the control group as closely as possible with regard to these factors. If students in the comparison groups had attended schools with different demographics, were from different geographic areas, or had attended larger or smaller schools in terms of student enrollment, other extraneous factors could have impacted the students’ performance on the mathematics test and affected the results obtained in this study.

Departmentalized settings had been utilized for instruction for a minimum of five years at the elementary level in the school district participating in the study. All schools participating in this study were fully accredited during the 2010-2011 school year. The classes from the schools chosen to participate in this study had students who were heterogeneously grouped, and the average student/teacher ratio among fifth grade classes for the schools participating in this study was 18 to 1. The fifth grade students selected for participation attended regular education classes without inclusion clusters or gifted clusters as part of their population, as reported by the school district participating in the study.

Teachers were required and expected to follow the identical fifth grade mathematics curriculum guidelines put forth by the VDOE in the Grade 5 Mathematics Standards of Learning (VDOE, 2001a), curriculum framework, and test blueprints, supported by numerous teacher resources and helpful videos, as adopted in 2001 and
posted on the VDOE website (VDOE, 2001b). These efforts have been made for purposes of ensuring equality in education by setting forth identical curriculum and instruction expectations for every fifth grade teacher of mathematics in Virginia so that students learn and can demonstrate proficiency on the annual Grade 5 Mathematics SOL Test. Therefore, the content covered by the mathematics instruction provided and the rate at which this instruction is provided is heavily regulated and ensures similarity in instructional content across all fifth grade classes in Virginia and within the departmentalized and non-departmentalized classes of students participating in this study.

In addition, school administrators monitor instruction in all of their classrooms closely to ensure that the state curriculum is being followed, as the end-of-year SOL tests administered in mathematics, reading, and other content areas are aligned with the curriculum frameworks and blueprints, as posted on the VDOE website. Administrators and teachers were evaluated in 2011 in general based upon the performance of their students on the annual SOLs. Under new ESEA flexibility guidelines that became effective during the 2012-2013 school year, student progress will officially comprise 40% of the administrators’ and teachers’ annual performance rating.

School administrators were strongly motivated to select the most effective teachers by subject area to teach in departmentalized settings, particularly in mathematics, because of the increasing pressure they are under to have their students produce higher SOL test scores (Baker, 2011; Harris, 2012; Lauen & Gaddis, 2012; Mathis, 2004). Therefore, administrators mostly likely chose the strongest teachers to serve as departmentalized teachers in mathematics for the 2010-2011 school year, based upon (a) the observed teachers’ knowledge and understanding of mathematics, (b) their
observed ability to implement effective instructional strategies in mathematics, and (c) their past success in the teaching of mathematics as demonstrated by student performance.

The teachers of both departmentalized and non-departmentalized student groups in this study exhibited a degree of similarity, in terms of official teaching qualifications, because they all held a minimum of a bachelor’s degree and were professionally certified, as verified by the school division, possessing a Commonwealth of Virginia teaching license in elementary education, a requirement for teaching in a public elementary school in Virginia. The departmentalized and non-departmentalized teachers participating in this study also had a minimum average of 4 years of teaching experience, as reported by the school division. It is important to note that the non-departmentalized teachers were more experienced, as they had an average of 14 years of teaching experience, compared with an average of 4 years of teaching experience for the departmentalized teachers, and 44% of the non-departmentalized teachers had master’s degrees, while none of the departmentalized instructors had master’s degrees.

A high degree of standardization for expectations for instruction have been set by the VDOE, with results measured by the annual SOL tests as required by subject area. These expectations were clearly communicated and supported by ongoing professional development for all teachers, as reported by the school division, to level the playing field and increase similarity in instruction so that all students received the same high quality instruction by subject and grade level. Teachers were also observed and evaluated regularly by school administrators, which included a review of their students’ SOL test
results, to ensure competency of instruction, which was expected to result in subject area proficiency and satisfactory testing performance by students.

Students receiving mathematics instruction in both the treatment (departmentalized) and comparison (non-departmentalized) settings received instruction following the identical curriculum and instructional pacing guide, in addition to periodically demonstrating their performance on the nine weeks’ benchmark SOL practice tests, in an effort to provide each child with the exact same elements of instruction by grade level and subject area. Therefore, the difference between the departmentalized and non-departmentalized setting, in terms of instruction and its potential impact upon student learning, would be the nature of the departmentalized setting itself due to the fact that instruction was being provided by a departmentalized instructor, who was fundamentally more knowledgeable and experienced in their field and who was not responsible for teaching all areas of the elementary subject area curriculum to their students. The average classroom teacher-student ratio, time allotted for instruction, and district-provided instructional materials were approximately the same, and each teacher was held responsible for instruction and the level of achievement attained by their students in the areas taught.

Therefore, this study focused on the difference between the two settings being compared based upon the guidance of a knowledgeable instructor who could design and implement lessons that were cooperative and which encouraged greater social communication, language development, critical thinking, and conceptual development and learning on the part of the student, which is in agreement with the social constructivist theory of learning and child development as devised by Vygotsky (1935,
1978, 1986) and Piaget (1954). Through peer interaction and sharing, children may also have more opportunities to experience learning from more knowledgeable peers in the departmentalized environment, as opposed to the non-departmentalized environment, enabling them to advance to a higher level within their ZPD, which can be demonstrated by greater student achievement.

**Instrumentation**

In this *ex post facto*, causal-comparative study, fifth grade students’ Virginia 2011 Grade 5 Mathematics SOL Test results were compared after the receipt of mathematics instruction in either departmentalized or non-departmentalized settings (the independent variable) in fifth grade, in order to evaluate the possible cause-and-effect relationship between the departmentalized classroom organizational structure and student achievement in mathematics (the dependent variable).

As noted in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle*, provided by the VDOE (D. Keeling, personal communication, March 1, 2013), the VDOE established updated Standards of Accreditation (SOA), which outlined the requirements for student testing, graduation, and accreditation for schools in Virginia. SOL tests were first developed in 1996, and the first SOL tests were administered in the spring of 1997. The passage of NCLB reinforced efforts already in place in Virginia that focused on establishing instructional standards, student testing, and the reporting of results. As noted in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle*, the SOL assessment program “is the cornerstone of Virginia’s system of accountability for the public schools and is authorized in Virginia law and administrative rules (see Article 1,
Section 15 of the Constitution of Virginia and Section 22.1-253.13:3C, Code of Virginia” (p. 2). Students are expected to learn grade level, state-specified SOL content, and they are assessed at the end of each school year on their knowledge and understanding of this content, when prescribed by the state, in order to determine their level of proficiency.

The SOL assessments are standards-based and are designed to measure student achievement in multiple content areas, such as reading, writing, mathematics, science, and history/social science. The format of the assessments are primarily multiple choice (MC), except for the portion of the writing test which includes writing prompts for students. In 2000, there was a statewide Web-Based SOL Technology Initiative legislated and funded by the General Assembly for the purpose of implementing testing online. These online tests were intended to mirror the paper/pencil SOL tests, as noted in the Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle. As of 2011, all SOL tests were available online, except for part of the writing test. It is expected that the administration of online tests will continue to grow, as the administration of paper/pencil tests decreases.

The SOL tests are constructed in accordance with the SOL testing blueprint, which outlines the categories for testing that are related to required content or skills for each subject area. The actual number of items that will be tested in each content category by subject area is listed on the relevant testing blueprint, which is available on the VDOE website for teachers, parents, and students. According to the VDOE, approximately 300 MC questions are developed by the Educational Testing Service (ETS) content specialists annually for the SOL tests, and about 220 are field tested each year for every grade level.
and subject. ETS content specialists are also responsible for “developing MC items that adhere to principles for quality item construction, universal design, and fairness (bias and sensitivity issues),” as noted in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle* (VDOE, n.d.-b, p. 7).

The SOL tests are also reviewed yearly by the SOL Assessment Committee to ensure that the test items are fair and accurate (VDOE, 2012c). The SOL Assessment Committee, which is comprised of “Virginia teachers, school administrators and content specialists [who], participate in the development of SOL assessments by serving on committees that review test items and forms to ensure that they measure student knowledge accurately and fairly” (VDOE, 2012c). The VDOE also provides Test Blueprints to inform the public (school districts, teachers, parents, and students) about how the SOL tests are structured. As noted in the *Virginia Standards of Learning Assessments Technical Report, 2010-2011 Administration Cycle*, “This blueprint is used in each administration so that there is consistency from year-to-year in what is being assessed in relation to the content standards” (p. 40). The VDOE also releases selected SOL practice test items from the tests administered during the previous spring, which are available to the public (VDOE, 2012d).

The SOL established in 2001 for mathematics were designed to “provide a framework for instructional programs designed to raise the academic achievement of all students in Virginia . . . [setting] reasonable targets and expectations for what teachers need to teach and students need to learn” (Commonwealth of Virginia Board of Education, 2001). The overall goal of the standards is to identify specific mathematical learning objectives for students, which will prepare them to pursue higher education, so
that they can compete in the technological workforce of the future in order to become successful, contributing members of society.

The five broad goals of the SOLs in mathematics revolve around problem solving, mathematical communication, mathematical reasoning, mathematical connections, and mathematical representations as outlined in the Grade 5 Mathematics SOL Test Blueprint (VDOE, 2005). The intention of the SOLs is to provide time for mathematical learning to take place, allowing students to progress through the content by providing opportunities for students to apply skills as they move through the grade levels. Students then have the opportunity to demonstrate their proficiency in mathematics, as they are tested annually on SOL tests, in accordance with the level of skill expected at each grade level.

The Virginia 2011 Grade 5 Mathematics SOL Test was aligned with the Virginia’s Mathematics SOLs adopted in 2001 (2001a), as documented on the Grade 5 Mathematics SOL Test Blueprint (VDOE, 2005), which specified the exact SOL being tested, each reporting topic category or content strand, and the number of test items presented by strand. The content strands covered by the SOLs are consistent across the grade levels of Kindergarten through Grade 8, which include Number and Number Sense, Computation and Estimation, Measurement, Geometry, Probability and Statistics, and Patterns, Functions and Algebra (Commonwealth of Virginia Board of Education, 2001).

The 2011 Grade 5 Mathematics SOL Test Blueprint (VDOE, 2005) provided a list of specific areas or skills covered within each content strand, together with a detailed breakdown of the number of test items that would be presented on the Grade 5 Mathematics SOL Test for administrators, teachers, parents, and students. The 2011
Grade 5 Mathematics SOL Test included eight questions each for Numbers/Number Sense and Probability/Statistics, 12 questions each for Computation/Estimation and Measurement/Geometry, and 10 questions for Patterns, Functions and Algebra, for a total of 50 questions that were counted towards the students’ scaled scores representations (VDOE, 2005). There were also ten field-tested items presented on the test, which were not utilized to compute the students’ scaled scores on the test.

Therefore, as noted above, teachers were fully informed ahead of time in the SOL Test Blueprint regarding exactly how many questions would be presented, by strand, on the 2011 Grade 5 Mathematics SOL Test. All fifth grade teachers were provided with clear and specific SOL objectives from which to prepare and conduct their mathematics instruction, following the identical Virginia SOL Grade 5 Standards (VDOE, 2001a), Curriculum Framework (VDOE, 2002), and Enhanced Scope and Sequence (VDOE, 2004) in preparation for the annual SOL test in mathematics in 2011.

Teachers followed the same Virginia 2001 Grade 5 Mathematics Standards and Curriculum until 2011. Updated SOLs for mathematics were adopted in 2009, and teachers started to incorporate some of these changes into their instruction during the 2010-2011 school year. While some of these new curricula items were field tested on the 2011 Mathematics SOL Tests, students were not officially tested on the updated SOLs until 2012.

In terms of scoring on the SOL, the SOL assessment raw scores are reported as a scaled score, as noted in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle*, “Because Virginia uses multiple versions of a test within a grade and subject, the scale is used to control slight variations from one
version of a test to the next” (VDOE, n.d.-b, p. 21). The scaled scores allow for comparison of test scores between individual students or groups of students by content area. Scaled scores on the SOLs can range from 0 to 600, with a 0 scaled score equivalent to a 0 raw score and a 600 scaled score equivalent to a perfect raw score. The 2011 Grade 5 Mathematics SOL Test has not yet been officially released; however, per the VDOE, for the content area of mathematics, there are four proficiency levels which the students could have attained, including Fail/Below Basic (310 and below), Fail/Basic (311-399), Pass/Proficient (400-499), and Pass/Advanced (500-600) (D. Keeling, personal communication, March 1, 2013).

There were two versions of the same test administered in 2011 provided by the VDOE, identified as Core 1 and Core 2. The two different cores, or different versions of the test, covered the same strands and were equated to ensure equality in difficulty, even though they did not have the exact same test questions. School divisions were able to choose to use one version of the test as the main form or core for their school division, while using the other form or core as the alternate test. The use of the different versions or cores of the same test can vary from division to division, per information provided by the VDOE (D. Keeling, personal communication, March 1, 2013).

There were specific guidelines for test administration in accordance with the Grade 5 Mathematics SOL Test Blueprint adopted in 2001. The 2011 Grade 5 Mathematics SOL Test was untimed, and there was no penalty for students who made guesses on the test. Students were permitted to use a protractor or angle ruler, standard and metric rulers, and scratch paper during the entire test, along with a four-function calculator for the second section of the test.
In terms of the instrument’s validity, the VDOE (n.d.-b) reported in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle* that the “SOL tests exhibit evidence of face validity due to the rigor with which the SOL Test Blueprint specifications match the emphasis in the SOL Curriculum Frameworks” (p. 39). In addition to possessing face validity, the relationship between each SOL Curriculum Framework and the SOL Test Blueprint lays the foundation for content validity of SOL tests because each Virginia SOL test is constructed according to a specified test blueprint that is designed to make sure that each assessment is aligned with and addresses each content area’s standards. The VDOE asserted in their *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle* that the SOL testing instrument is intrinsically valid, as evidenced by the process used to develop and design the SOL program it has implemented (D. Keeling, personal communication, March 1, 2013).

For construct validity, the VDOE (n.d.-b) noted in their *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle* that the VDOE has been conducting ongoing research to determine if the results of the SOL tests “behave in ways that are consistent with expectations, underlying theory, or in a similar fashion as other measures of this construct” (p. 41). For instance, in comparing the Grade 5 Mathematics SOL Test previously with the national percentile ranks, as detailed in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle*, “there was a .76 correlation with the Stanford 9 Grade 5 Math test” (p. 41).
In addition to the Virginia 2011 Grade 5 Mathematics SOL Test being a valid measure of student achievement, the Virginia SOL content area tests are deemed to be reliable. The Cronbach’s alphas for the Virginia 2011 Grade 5 Mathematics SOL Test as reported by the VDOE (n.d.-b) in the *Virginia Standards of Learning Assessments Technical Report: 2010-2011 Administration Cycle* by gender (p. 61) and ethnicity (p. 65) are presented in Table 1.

Table 1

*Cronbach’s Alphas for the 2011 Grade 5 Virginia Mathematics SOL Test*

<table>
<thead>
<tr>
<th>Version of Test</th>
<th>Total 5th Grade Population</th>
<th>Gender</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core 1 – Online</td>
<td>0.87</td>
<td></td>
<td>0.87</td>
</tr>
<tr>
<td>Core 1 – Paper</td>
<td>0.89</td>
<td>0.88</td>
<td>0.90</td>
</tr>
<tr>
<td>Core 2 – Online</td>
<td>0.88</td>
<td>0.87</td>
<td>0.89</td>
</tr>
<tr>
<td>Core 2 – Paper</td>
<td>0.89</td>
<td>0.89</td>
<td>0.90</td>
</tr>
</tbody>
</table>

In terms of credibility, the teachers and students from the departmentalized and non-departmentalized classroom organizational structures within the school district participating in this study were not aware that a study would be taking place comparing their Virginia 2011 Grade 5 Mathematics SOL achievement results, supporting credibility of the data obtained for the study.

Previous studies by Johnson (2013), Kent (2010), Mitchell (2013), and Ponder (2008) also utilized nominal measurements based upon gender and/or race in order to
assess student performance by subject area and grade level in departmentalized and non-
departmentalized settings. The identification of the independent variables of gender and
racial status for participants in this study helped the researcher determine if the
interaction of these variables with the independent variable of classroom organizational
structure inferred a possible cause-and-effect relationship with student achievement in
mathematics. This was important because the VDOE and local school districts report
student performance based upon SOL test results obtained by grade level and subject
area, categorized by gender and race (Black and Caucasian), in order to help identify
specific groups that have visible areas of need. These subgroups are then targeted for
remediation for purposes of creating individual and/or subgroup instructional plans in
order to help these students improve their achievement in subject areas where they have
not yet attained proficiency.

Therefore, one of the goals of this study was to evaluate if there was a possible
interaction between some or all of the independent variables of classroom organizational
structure, gender, and racial status, because the VDOE, local school districts, school
administrators, and teachers typically evaluate, and are evaluated on, student achievement
on SOL tests by gender and race for purposes of improving instruction and achievement.
Consequently, the Virginia 2011 Grade 5 Mathematics SOL Test instrument was an
appropriate choice for measuring fifth grade student achievement in mathematics in
either a departmentalized or non-departmentalized setting for purposes of this study. The
validity, reliability, and credibility of the SOL instrument provided valuable data for
evaluating classroom organizational structure effectiveness, adding to existing knowledge
in the field of elementary education.
Procedures

The school district participating in the study was contacted about submitting a request to conduct a research study comparing the academic achievement in reading and mathematics for departmentalized and non-departmentalized regular elementary classes at non-Title 1 schools in their school district. An official “Request for Approval, Research Projects” was submitted and approved, with data collection to occur once IRB approval was obtained from Liberty University.

It is important to note that the school division’s Instructional Accountability Director acted as a liaison between the researcher and the school administrators, who had already identified teachers to provide mathematics instruction in departmentalized and non-departmentalized settings for the 2010 to 2011 school year in fifth grade mathematics. The school division’s Instructional Accountability Department provided the students’ demographic information and their 2010 and 2011 Mathematics SOL Test data that had identifying information removed for each participant. The data included gender and racial minority/non-minority status designations for enrolled students who attended regular education fifth grade departmentalized or non-departmentalized classes in the non-Title 1, Pre-K through Grade 5 elementary schools in the school district. The school division’s Instructional Accountability Department also acted as liaison between the researcher and the administrators regarding any questions related to the data.

Subsequent general information provided by the school division’s Instructional Accountability Department demonstrated that all of the teachers at the elementary level were responsible for teaching their own reading classes, and, therefore, data could not be obtained from any departmentalized reading classes. In addition, there were only two
departmentalized fourth grade mathematics classes, which would have provided limited data for a valid evaluation. However, there were five fifth grade departmentalized mathematics classes and a number of non-departmentalized fifth grade classes available, per reports submitted by the school principals to the Instructional Accountability Department. Therefore, this study evaluated fifth grade mathematics achievement, based upon mathematics instruction provided in departmentalized and non-departmentalized settings at the fifth grade level, upon receipt of IRB approval.

A moderately-sized urban public school district in Eastern Virginia with between 10,000 and 30,000 students participated in this study. There were five non-Title 1, Pre-K through Grade 5 elementary schools located in the public school district. All of the non-Title 1, Pre-K through Grade 5 schools participated in this study, which were in close proximity to one another for demographic purposes. Students attending these schools were administered the Virginia 2011 Grade 5 Mathematics SOL Test as required by the VDOE. There were five departmentalized classes and nine non-departmentalized classes in mathematics at the fifth grade level at the five non-Title 1, Pre-K through Grade 5 elementary schools, all of which followed the same state mathematics curriculum guidelines for instruction (with departmentalized instruction in mathematics being conducted in two of the five non-Title 1, Pre-K through Grade 5 elementary schools in the district).

The average class size for fifth grade departmentalized and non-departmentalized classes at the five non-Title 1 elementary schools participating in this study in 2010-2011 was 18 students. Therefore, the average student-teacher ratio was 18:1, which was considered to be an excellent class size ratio according to the Research Brief on Class
Size published in 2012 (Haimson) because it provided a solid foundation for teachers and students to work together to achieve their academic goals at this grade level. As noted by Haimson in one example from 2012, the Icahn Charter Schools in New York City, which had capped their class sizes at 18 for all students in grade K-8, outscoresd all other New York City charter schools in the state. Haimson also noted that in Florida in 2003, voters voted to cap class sizes at 18 in grades PreK-3, at 22 in grades 4-8, and at 25 in high school, which had to be achieved by the 2010-2011 school year. As a result, “Between 2003 and 2009 the state’s students experienced significant gains on the national assessments known as the NAEPs, as well as a narrowing of the achievement gap between white and black students” (Haimson, 2012, p. 4). Hence, the favorable average class size of 18 for the departmentalized and non-departmentalized regular education classes in this study provided an instructional environment where the teachers in both groups could work at an optimal level with all of their students in order to positively impact their learning and achievement, from which statistical comparisons could be made.

Upon a successful oral defense of the dissertation proposal and once IRB approval had been obtained from Liberty University, the researcher made an official request for a de-identified list of fifth grade regular elementary students attending non-Title 1, Pre-K through Grade 5 elementary schools in 2010-2011, who were not cluster grouped for receipt of special education or gifted services. The de-identified list of student data that was provided by the school district’s Instructional Accountability Department, listed the students’ gender and racial minority/non-minority status, along with their Virginia 2010 Grade 4 Mathematics SOL Test data and Virginia 2011 Grade 5 Mathematics SOL Test
data by departmentalized and non-departmentalized mathematics classes for purposes of sample selection.

The regular education students were already assigned to fifth grade classes across five non-Title 1 schools (with five departmentalized classes and nine non-departmentalized classes), with two of the non-Title 1, Pre-K through Grade 5 schools providing departmentalized instruction in mathematics. The classes chosen for this study from the non-Title 1, Pre-K through Grade 5 elementary schools were regular education classes (not self-contained or cluster grouped special education classes and not self-contained or cluster grouped gifted classes), as reported by the school district. The participants from the departmentalized and non-departmentalized classes were chosen from the sampling frame for comparison from among the fifth grade classes available at all five non-Title 1, Pre-K through Grade 5 elementary schools. Departmentalized and non-departmentalized comparison groups were formed by using the common support method of matching students, utilizing their scaled scores on the 2010 Grade 4 Mathematics SOL Test.

This comparison and evaluation of students’ mathematics achievement between the departmentalized and non-departmentalized groups utilized the de-identified, scaled student test score data and demographic information to determine if there was a statistically significant difference in the Virginia 2011 Grade 5 Mathematics SOL Test results (by whole group and subgroup) after students received instruction following the identical curriculum in both departmentalized and non-departmentalized settings. Conclusions were drawn from an evaluation of departmentalized and non-
departmentalized fifth grade mathematics achievement as measured by students’ scaled scores on their 2011 Grade 5 Mathematics SOL Test.

**Data Analysis**

The recommended statistical approach for evaluating the performance of whole groups and subgroups with different factors, such as gender and racial status, and the possible effects of an independent variable upon a dependent variable, is a statistical technique where the control variables are built into the calculation, known as a factorial analysis of variance (ANOVA) (Johnson & Christensen, 2010). A factorial analysis was used to evaluate the possible effect of the independent variables of classroom organizational setting (departmentalized and non-departmentalized), gender, and racial status on the dependent variable of student achievement in mathematics (Boslaugh, 2013).

Descriptive statistics were computed from the students’ 2011 Grade 5 Mathematics SOL Test scaled scores using SAS 9.3, including the mean and standard deviation of the data from the departmentalized and non-departmentalized whole groups and subgroups, for the purpose of determining the distribution, central tendency, and dispersion of the data being evaluated. Given that there will be initial differences when comparing groups, statisticians recommend that the application of an ANCOVA calculation be considered (Johnson & Christensen, 2010), where the scaled scores on the dependent variable, in this study, the 2011 Grade 5 Mathematics SOL Test, can be adjusted for the initial differences on a reliable covariate. The ANCOVA calculation, or covariate analysis, can remove the initial advantage from the students’ scaled scores, so
that the results can be compared fairly, as if the two groups had started equally (Gall et al., 2007). The use of a covariate increases statistical power and control, as long as a good covariate is used (Boslaugh, 2013; Cohen et al., 2007; Gall et al., 2007; Johnson & Christensen, 2010).

The assumptions for the ANOVA calculation must be met before considering whether or not to apply the ANCOVA calculation to the data (Boslaugh, 2013). For instance, the outcome variable or dependent variable, the students’ 2011 Grade 5 Mathematics Test scaled score should be continuous, measured at an interval or ratio level, being unbounded or covering a wide range (Boslaugh, 2013), which the dependent variable does in this study (scaled scores range from 0 to 600). Also, the factors or group variables should be dichotomous or categorical, as they are in this case, being based upon gender and/or racial status. In addition, the value of the dependent variable needs to be independent of the values of the other variables utilized in the study for the ANOVA calculation to be a valid measure. The students’ scaled scores on their 2011 Grade 5 Mathematics Tests (the dependent variable) were independent of the other variables of classroom organizational structure, gender, racial status, and their previous scaled scores on the 2010 Grade 4 Mathematics SOL Test.

The researcher established that the data met the assumptions of the procedures being used, which is an expected component of all quantitatively-based studies (Garson, 2010). “For instance, parametric statistics are those which assume a certain distribution of the data (usually the normal distribution), assume an interval level of measurement, and assume homogeneity of variances when two or more samples are being compared” (Garson, 2010, p. 1). The distribution of the data was verified by creating a histogram of
the data and by conducting a statistical test for normality, using the Kolmogorov-Smirnov test (Boslaugh, 2013) and the Shapiro-Wilk test. The variance of each of the groups should also be approximately equal, which was verified by use of the Levene statistic, a conservative test.

With the variances being significant, the next assumption that needed to be verified before proceeding with the ANCOVA calculation was for homogeneity of regression slopes. Failure to meet this assumption would have implied that there was an interaction between the covariate and the treatment, or in this case, the classroom organizational structure. Therefore, it was important to investigate the nature of the relationship between the dependent variable and the covariate to help determine linearity. A Type III test was conducted, which demonstrated that there were not any interactions between the outcome variable (the students’ 2011 Grade 5 Mathematics SOL scaled scores) and the covariate (the students’ Grade 4 Mathematics SOL scaled scores) and each factor, including classroom organizational structure, gender, and racial status.

With no significant interactions, the assumption of homogeneity of slopes was upheld, and a three-way ANCOVA calculation was deemed appropriate and was applied to compare and analyze the data collected. The students’ 2010 Grade 4 Mathematics SOL Test scores, which were deemed to be reliable, were used as a covariate, where the variance in the covariate explained a unique variance in the outcome variable, taking each of the factors (classroom organizational structure, gender, and racial status) into account. The Cronbach’s alphas for the 2010 Grade 4 Virginia Mathematics SOL Test were 0.89 (Core 2) for online tests (there was no online test for Core 1) and 0.89 (Core 1) and 0.88 (Core 2) for the paper tests, substantially higher than the accepted lower level of .70,

Therefore, the 2011 Grade 5 Mathematics SOL Test data collected for this study were analyzed using a three-way ANCOVA calculation in SAS 9.3, in order to investigate the effects of two different classroom organizational structures, gender, and racial minority/non-minority status on fifth grade regular elementary students’ mathematics achievement. The statistical analyses were performed at the \( \alpha = .05 \) level of significance using a two-tailed test. The comparisons were performed by testing the statistical significance of the differences of the students’ mean scaled scores, in order to assess the effectiveness of instruction provided in departmentalized and non-departmentalized settings by whole groups and their subgroups, based upon the main effects and interaction effects.

Cohen (1988) noted that effect size “is in practice a most important determinant of power or required sample size or both” (p. 10). Cohen also pointed out that the reliability of the sample results, depending upon the statistical model utilized, may or may not be dependent upon the unit of measurement, the population value, and the shape of the population distribution, but he stated that the reliability is always dependent upon the size of the sample utilized. Statistical power is the probability of rejecting a false null hypothesis, with a power of at least .80 accepted as the standard (Cohen).

The partial eta-squared calculation was reported in this study, following guidance by Pierce, Block, and Aguinis (2004), who issued an article cautioning researchers to clarify the distinction between classical and partial eta-squared calculations when utilizing multifactor ANOVA designs. Classical eta-squared is defined as “a descriptive
index of strength of association between an experimental factor (main effect or interaction effect) and a dependent variable” (Pierce et al., p. 918). As also noted by Pierce et al., “Although eta squared is frequently reported, it is an upwardly biased estimate of the population strength of association between an independent variable and a dependent variable, particularly when total sample size is small” (p. 917). However, the partial eta-squared measure was used in this study to compute the effect size because this calculation computes “the proportion of total variation attributable to the factor, partia)lling out (excluding) other factors from the total nonerror variation (Cohen, 1973; Haase, 1983; Kennedy 1970)” (Pierce et al., p. 918).

“Partial eta² values range from 0 to 1” (Pierce et al., 2004, p. 918), exactly like the classic eta-squared. As noted by Cohen (1988), in general, the magnitude of the effect for partial eta-squared values at approximately .01 are small, .059 are moderate, and .138 are considered to be large. The sums of the partial eta-squared are not additive, and it is possible for the sums of the eta-squared values to be greater than 1.0 (Pierce et al.).

Coe (2002) highlighted the fact that significance tests pose problems because the p-value depends upon the size of the effect and the size of the sample, which can lead to confusion. Coe recommended reporting the effect size together with an estimate for its confidence level, which he felt could clarify this confusion. Therefore, power will be reported post hoc using a retrospective power analysis, using the actual sample size and effect size, at a 95% confidence interval, in order to clearly report what the power was and size of the effect, based upon the results of this study. Coe also noted that “effect
size quantifies the size of the difference between two groups, and may therefore be said to be a true measure of the significance of the difference” (Ques. 4, para. 1).

It must be kept in mind that the generalizability of the results of this study will be limited to similar-sized school districts in the eastern Virginia or the mid-Atlantic area with similar demographics to those of the district participating in the study. In addition, due to the variability of the implementation of different types of departmentalization and also varying degrees of teacher preparation, generalizability of results to other school districts may be limited. However, the results of this study may prove valuable, as the results of the statistical analyses and evaluation allowed the researcher to determine if the differences obtained between the performance of the two groups and their subgroups were statistically significant. If the 2011 Grade 5 Mathematics SOL Test results of the departmentalized group showed higher levels of achievement significantly beyond those of the non-departmentalized group, one would have demonstrated that a possible cause-and-effect relationship existed between mathematics instruction provided in a departmentalized setting and greater student achievement in mathematics.
CHAPTER FOUR: FINDINGS

The purpose of this causal-comparative study was to examine the application of the teaching and learning theory of social constructivism in order to determine if instruction provided in a departmentalized setting in the key content area of mathematics resulted in a statistically significant difference in student achievement compared with the impact upon student achievement when mathematics instruction was provided in a non-departmentalized setting.

This chapter will present the results of the statistical analysis of the comparison of students’ achievement scores on their Virginia 2011 Grade 5 Mathematics SOL Test from departmentalized and non-departmentalized settings by whole group and by gender and racial subgroups, including the descriptive statistics, assumption testing, and statistical results by hypothesis.

Research Questions and Hypotheses

A causal-comparative research design and an ANCOVA were used to address the following research questions and hypotheses:

Research Question #1: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, gender, racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 1 - \( H_0: \) There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics
achievement based upon classroom organizational structure, gender, racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #2: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 2 - $H_{02}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #3: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 3 - $H_{03}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure and racial minority/racial
non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #4: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 4 - $H_{04}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender and racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #5: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 5 - $H_{05}$: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon classroom organizational structure, as measured by students’
scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #6: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 6 - H₀₆: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon gender, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.

Research Question #7: Was there a statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores?

Null Hypothesis 7 - H₀₇: There was no statistically significant difference between departmentalized and non-departmentalized fifth grade students’ mathematics achievement based upon racial minority/racial non-minority status, as measured by students’ scores earned on the Virginia 2011 Grade 5 Mathematics SOL Test, while controlling for students’ Virginia 2010 Grade 4 Mathematics SOL Test scores.
Descriptive Statistics

This quantitative study evaluated the possible cause-and-effect relationship between classroom organizational structure, departmentalized versus non-departmentalized settings (the independent variable), on the measured mathematics achievement (the dependent variable) of heterogeneously grouped, regular fifth grade elementary students by whole group and gender and racial minority/non-minority subgroup. Descriptive statistics were computed that summarized the sample, based upon whole group and subgroup subject participation.

The fifth grade regular student population attending non-Title 1, PreK-5 elementary schools was representative of the population of the school district, being close to a 50/50 ratio as of 2012 for gender and racial status, as measured by the U.S. Census Bureau from April 1, 2010, to July 1, 2012, which showed virtually no change in the population statistics from 2010-2011, the school year covered in this study (U.S. Census Bureau, 2013).

Participants were selected for the sampling frame by utilizing a common support method of matching of students, based upon upper and lower bounds of students’ 2010 Grade 4 Mathematics SOL Test scores for the formation of departmentalized and non-departmentalized comparison groups. Tables 2 and 3 provide the lower and upper bounds for the scores students obtained on the 2010 Mathematics SOL Test in departmentalized (Table 2) and non-departmentalized (Table 3) groups.
Table 2

*Departmentalized 2010 Mathematics SOL Test Score Extreme Observations*

<table>
<thead>
<tr>
<th>Score Number</th>
<th>Lowest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>320</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>366</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>378</td>
<td>600</td>
</tr>
<tr>
<td>4</td>
<td>391</td>
<td>600</td>
</tr>
<tr>
<td>5</td>
<td>391</td>
<td>600</td>
</tr>
</tbody>
</table>

Table 3

*Non-Departmentalized 2010 Mathematics SOL Test Score Extreme Observations*

<table>
<thead>
<tr>
<th>Score Number</th>
<th>Lowest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>289</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>296</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>303</td>
<td>600</td>
</tr>
<tr>
<td>4</td>
<td>303</td>
<td>600</td>
</tr>
<tr>
<td>5</td>
<td>316</td>
<td>600</td>
</tr>
</tbody>
</table>
The lowest departmentalized 2010 Mathematics SOL Test score was 320, which was higher than the lowest non-departmentalized scores. Both classroom structures had students with 600s on their 2010 Mathematics SOL Tests. Therefore, there were five non-departmentalized students who had scores lower than any of the departmentalized students, ranging from 289 to 316, and they were not selected for participation in the study.

Selecting a data set with common support removed only five non-departmentalized participants from selection, and 29 students were not selected for participation because they did not have Mathematics SOL Test scores for both 2010 and 2011 for comparison, leaving a sample size of 239 (273 - 34 = 239), with 149 non-departmentalized students and 90 departmentalized students.

Table 4 shows the mean, standard deviation, minimum, and maximum values of 2010 and 2011 Virginia Mathematics SOL Test scores, which are presented over all of the students in the data set using SAS 9.3.

Table 4

<table>
<thead>
<tr>
<th>Value</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 Math SOL Scaled Test Scores</td>
<td>473.14</td>
<td>68.80</td>
<td>320.00</td>
<td>600.00</td>
</tr>
<tr>
<td>2011 Math SOL Scaled Test Scores</td>
<td>496.77</td>
<td>81.02</td>
<td>274.00</td>
<td>600.00</td>
</tr>
</tbody>
</table>
Table 5 presents the mean, standard deviation, minimum, and maximum values of 2010 and 2011 Virginia Mathematics SOL Test scores of the 90 students in the data set for the departmentalized whole group.

Table 5

Mean and Standard Deviation of 2010 and 2011 Mathematics SOL Test Scores by Departmentalized Whole Group

<table>
<thead>
<tr>
<th>Value</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 Math SOL Scaled Test Scores</td>
<td>503.20</td>
<td>60.88</td>
<td>320.00</td>
<td>600.00</td>
</tr>
<tr>
<td>2011 Math SOL Scaled Test Scores</td>
<td>537.10</td>
<td>65.63</td>
<td>320.00</td>
<td>600.00</td>
</tr>
</tbody>
</table>

Table 6 presents the mean, standard deviation, minimum, and maximum values of 2010 and 2011 Virginia Mathematics SOL Test scores of the 149 students in the data set for the non-departmentalized whole group.

Table 6

Mean and Standard Deviation of 2010 and 2011 Mathematics SOL Test Scores by Non-Departmentalized Whole Group

<table>
<thead>
<tr>
<th>Value</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 Math SOL Scaled Test Scores</td>
<td>454.99</td>
<td>67.09</td>
<td>320.00</td>
<td>600.00</td>
</tr>
<tr>
<td>2011 Math SOL Scaled Test Scores</td>
<td>472.40</td>
<td>79.87</td>
<td>274.00</td>
<td>600.00</td>
</tr>
</tbody>
</table>
Tables 7 and 8 show the descriptive statistics for participants in this study, categorized by departmentalized and non-departmentalized comparison subgroups.

Table 7

*Descriptive Statistics for Departmentalized Comparison Subgroups*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F Minority</td>
<td>484.81</td>
<td>63.62</td>
<td>522.56</td>
<td>74.23</td>
<td>16</td>
<td>17.8</td>
</tr>
<tr>
<td>F Non-Minority</td>
<td>513.27</td>
<td>59.46</td>
<td>544.19</td>
<td>62.45</td>
<td>37</td>
<td>41.1</td>
</tr>
<tr>
<td>M Minority</td>
<td>492.57</td>
<td>75.46</td>
<td>532.36</td>
<td>77.34</td>
<td>14</td>
<td>15.6</td>
</tr>
<tr>
<td>M Non-Minority</td>
<td>506.26</td>
<td>50.86</td>
<td>538.70</td>
<td>59.16</td>
<td>23</td>
<td>25.5</td>
</tr>
</tbody>
</table>

Table 8

*Descriptive Statistics for Non-Departmentalized Comparison Subgroups*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F Minority</td>
<td>439.88</td>
<td>63.72</td>
<td>459.37</td>
<td>87.89</td>
<td>41</td>
<td>27.5</td>
</tr>
<tr>
<td>F Non-Minority</td>
<td>453.90</td>
<td>72.57</td>
<td>468.57</td>
<td>71.94</td>
<td>30</td>
<td>20.1</td>
</tr>
<tr>
<td>M Minority</td>
<td>456.61</td>
<td>62.35</td>
<td>482.00</td>
<td>76.96</td>
<td>46</td>
<td>30.9</td>
</tr>
<tr>
<td>M Non-Minority</td>
<td>473.03</td>
<td>70.98</td>
<td>478.91</td>
<td>81.42</td>
<td>32</td>
<td>21.5</td>
</tr>
</tbody>
</table>
Based upon the summary statistics shown in Tables 7 and 8, 51.88% of the entire sample were female while 48.12% were male, and 48.95% of the entire sample were minorities while 51.05% were non-minorities. Therefore, the female/male proportions and minority/non-minority proportions studied for the entire convenience sample were close to 50% each. A greater percentage of participants were female than male in the departmentalized group, while the proportions of female and male participants studied in the non-departmentalized group were closer to 50% each. A greater percentage of non-minority participants received instruction in the departmentalized setting compared to minority participants, while a greater percentage of minority participants received instruction in the non-departmentalized setting compared to non-minority participants.

Figure 1 shows the means and standard errors for departmentalized and non-departmentalized whole groups, based upon the students’ 2011 Mathematics SOL Test, adjusted for their 2010 Test, as 515.39 ($SE = 6.82$) and 484.84 ($SE = 4.99$), respectively.

*Figure 1.* Bar plot of means and standard error bars per whole group.
The 2010 Mathematics SOL Test scores were included primarily as an adjustment for testing other effects. Table 9 displays summary results from the statistical model for the subgroups by classroom organizational structure, which includes the average 2011 scores, adjusted to the average 2010 scores, showing what the students in each of these groups would have scored in 2011 after adjusting for differences in their 2010 scores.

Table 9

Mean 2011 Math SOL Scores, Adjusted for 2010 Math SOL Scores, by Subgroup

<table>
<thead>
<tr>
<th>Structure</th>
<th>Gender</th>
<th>Race</th>
<th>MathSOL2011 Mean</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departmentalized</td>
<td>F</td>
<td>Minority</td>
<td>514.04</td>
<td>14.70</td>
</tr>
<tr>
<td>Departmentalized</td>
<td>F</td>
<td>Non-Minority</td>
<td>514.87</td>
<td>9.95</td>
</tr>
<tr>
<td>Departmentalized</td>
<td>M</td>
<td>Minority</td>
<td>518.16</td>
<td>15.74</td>
</tr>
<tr>
<td>Departmentalized</td>
<td>M</td>
<td>Non-Minority</td>
<td>514.50</td>
<td>12.41</td>
</tr>
<tr>
<td>Non-Departmentalized</td>
<td>F</td>
<td>Minority</td>
<td>483.67</td>
<td>9.39</td>
</tr>
<tr>
<td>Non-Departmentalized</td>
<td>F</td>
<td>Non-Minority</td>
<td>482.63</td>
<td>10.79</td>
</tr>
<tr>
<td>Non-Departmentalized</td>
<td>M</td>
<td>Minority</td>
<td>494.08</td>
<td>8.72</td>
</tr>
<tr>
<td>Non-Departmentalized</td>
<td>M</td>
<td>Non-Minority</td>
<td>478.99</td>
<td>10.38</td>
</tr>
</tbody>
</table>

The means for each subgroup with accompanying standard error bars from Table 9 are displayed in Figure 2.
Assumption Testing

Assumptions had to be met to ensure that the ANCOVA calculation was appropriate. The ANCOVA was applied to evaluate student achievement on the 2011 Mathematics SOL Test, based upon three categorical factors, including classroom structure, gender, and race and one continuous covariate, the 2010 Mathematics SOL Test, which was included primarily as an adjustment for testing other effects. The assumption of normality was evaluated using histograms, as well as the Kolmogorov-Smirnov and Shapiro-Wilk tests.

Figure 2. Bar plot of means and standard error bars per subgroup.
Figure 3. Histogram of 2010 Virginia Mathematics SOL Test scores for all participants.

Figure 4. Histogram of 2011 Virginia Mathematics SOL Test scores for all participants.
Figure 3 shows how the participants scored in 2010. Scores between 400 and 500 were fairly common, and there is also a prominent group of participants who scored near 600, the highest possible score. Figure 4 shows how the participants scored in 2011. Scores improved in general from 2010 to 2011 when comparing the histograms from Figures 3 and 4, as the percentage of higher scores shifted to the right in Figure 4. This is not a formal test of whether there are differences, but the histograms may help to explain the statistical results obtained upon further analysis.

The results of the Kolmogrov-Smirnov tests established that the whole groups and all of the subgroups met the assumptions for normality with p-values greater than 0.15. Figure 5 shows the histogram of the residuals utilizing the 2011 SOL Test data.

Figure 5. Histogram of the residuals showing normal distribution.
The Shapiro-Wilk test results also showed that the residuals were normally distributed within each departmentalized and non-departmentalized subgroup, with the $W$ statistic ranging from 0.95 to 0.98 and $p$-values ranging from 0.12 to 0.69.

The assumption for homogeneity of variances was tested and upheld by running the Levene’s Test for equal variances across the residuals of the eight factor groups (all combinations of structure, gender, and race). The results of the Levene’s Test were $F(7, 231) = 1.04, p = .402$, indicating that the null hypotheses of equal variance across the eight factor groups should not be rejected. The assumption that there were no extreme outliers was established by checking scatterplots of the test scores and by using the common support method of matching, where the sample selected did not include students from the non-departmentalized group with scores lower than all of those in the departmentalized group or students from the departmentalized group with scores higher than all of those in the non-departmentalized group.

Type III tests of significance for homogeneity of slope were run for the factor groups. The MathSOL2010 factor was combined with structure ($p = 0.959$), gender ($p = 0.515$), structure and gender ($p = 0.98$), race ($p = 0.34$), structure and race ($p = 0.784$), gender and race ($p = 0.063$), and structure, gender, and race ($p = 0.714$), and no interactions were statistically significant at the 0.05 level. The interaction of the 2010 Mathematics SOL with all the other factors were also considered by measuring the linearity of the regression relationship between the variables, and none were statistically significant at the 0.05 level, and the assumption of linearity was upheld.

Therefore, it was determined that applying the ANCOVA calculation was appropriate, as shown by the ANOVA for the three-way ANCOVA, $F(8, 230) = 27.85, p$
= < .001, which referred to any part of the variability in 2011 Mathematics SOL Test scores that was directly related to the variability in the factors (structure, gender, race, or 2010 math scores). The $F$ value of 27.85 is considered to be quite high and indicates that a significant amount of variability in the 2011 Mathematics SOL Test scores was related to the factors in the model. In addition, with a $p$-value of < 0.001, it can be concluded that there was a significant relationship between some combination of the factors being evaluated and the 2011 Mathematics SOL Test scores that were earned.

**Statistical Results by Hypothesis**

Scatterplots for the ANCOVA calculation are displayed in Figures 6 and 7.

![Analysis of Covariance for MathSOL2011](image)

*Figure 6. Scatterplot of departmentalized and non-departmentalized whole groups.*
The scatterplots for the ANCOVA calculation for the departmentalized and non-departmentalized whole groups (Figure 6) and subgroups (Figure 7), are based upon the students’ 2011 Grade 5 Mathematics SOL Test scores, adjusted for the students’ 2010 Grade 4 Mathematics SOL Test scores.

The 2010 Mathematics Grade 4 SOL Test scores were controlled for because of their relationship to the dependent variable, the 2011 Grade 5 SOL Mathematics Test scores, and as expected, the Type III tests of significance showed that the 2010 Mathematics SOL Test scores were significant with an $F$ Value of 149.37 and a $p$-value of $< 0.001$. Table 10 shows the results of Type III tests of significance for each factor or combination of factors, measured individually, in two-way interactions and in a three-
way interaction. Each factor was tested assuming that all other factors were already accounted for in the calculations.

Table 10

*Type III Tests of Significance for Individual Factors from the Three-Way ANCOVA*

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>43111.16</td>
<td>43111.16</td>
<td>12.50</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Gender</td>
<td>349.82</td>
<td>349.82</td>
<td>.10</td>
<td>.751</td>
</tr>
<tr>
<td>Structure &amp; Gender</td>
<td>28.75</td>
<td>28.75</td>
<td>.01</td>
<td>.927</td>
</tr>
<tr>
<td>Race</td>
<td>1122.49</td>
<td>1122.49</td>
<td>.33</td>
<td>.569</td>
</tr>
<tr>
<td>Structure &amp; Race</td>
<td>561.63</td>
<td>561.63</td>
<td>.16</td>
<td>.687</td>
</tr>
<tr>
<td>Gender &amp; Race</td>
<td>1090.82</td>
<td>1090.82</td>
<td>.32</td>
<td>.574</td>
</tr>
<tr>
<td>Struc &amp; Gend &amp; Race</td>
<td>289.22</td>
<td>289.22</td>
<td>.08</td>
<td>.772</td>
</tr>
</tbody>
</table>

The ANCOVA results, summarized in Table 10, were significant for the factor of classroom organizational structure, $F(1, 230) = 12.50, p < 0.001, 1-\beta = .976, \eta^2_p = .052$. Therefore, there is statistically significant evidence to reject the Null Hypothesis for structure and conclude that there is a difference in the mathematics achievement attained by students based upon the structure of the classroom organizational setting. There was also great strength in the relationship between the students’ mathematics achievement and classroom organizational structure, given the very strong observed power of .976. The effect size was moderate, with a partial eta-squared of .052, being close to .06, the moderate category for effect size according to Cohen’s (1988) published guidelines. The partial eta-squared value also indicates that structure accounts for 5.2%
of the variability not explained by other factors, such as the 2010 Mathematics SOL Test scores, gender, and race.

Given the \( p \)-values shown in Table 10, the results for the remaining null hypotheses were not significant at \( p = .57 \) or greater and did not provide the evidence needed to reject Null Hypotheses 1, 2, 3, 4, 6, and 7. Thus, the researcher is unable to reject Null Hypotheses 1, 2, 3, 4, 6, and 7 because the \( p \)-values, as shown in Table 10, were not statistically significant, which included the null hypotheses for the interactive effect of structure, gender, and race (\( 1-\beta = .061, \eta^2_p < .001 \)), structure and gender (\( 1-\beta = .051, \eta^2_p < .000 \)), structure and race (\( 1-\beta = .071, \eta^2_p < .001 \)), and gender and race (\( 1-\beta = .092, \eta^2_p = .001 \)), in addition to the main effects of gender (\( 1-\beta = .063, \eta^2_p < .001 \)), and race (\( 1-\beta = .094, \eta^2_p = .001 \)). There was weakness in the relationship between the students’ mathematics achievement and the interactions of the factors of structure, gender, and race, in addition to the main factors of gender and race, as the observed power was very weak, ranging from .061 to .094. The effect size was also found to be far below the weak category, with the partial eta-squared ranging from 0.000 to 0.001, as a partial eta-squared of 0.01 is designated as weak, according to Cohen’s (1988) guidelines.

Therefore, the only research question for which the researcher can reject the null hypothesis is Null Hypothesis 5 - \( H_{05} \), as there was a statistically significant difference in students’ fifth grade scaled scores, as measured by the Virginia 2011 Grade 5 Mathematics SOL Test, when comparing student achievement in departmentalized and non-departmentalized settings. The statistical results showed that for departmentalized and non-departmentalized students with the same 2010 Mathematics SOL Test score, in a range that spanned 280 points (from a score of 320 to 600), a departmentalized student on
average scored an estimated 30.55 points higher than a non-departmentalized student \( (SE = 8.64) \) on the 2011 Grade 5 Mathematics SOL Test, which was a significant difference in student achievement.

The 30.55-point difference in mathematics achievement between the departmentalized setting and non-departmentalized setting can be seen in Figure 1 which depicts the means and standard error bars for the departmentalized and non-departmentalized whole groups \( (515.39 - 484.84 = 30.55) \). In Figure 6, the ANCOVA scatterplot shows that the departmentalized whole group attained higher student achievement in mathematics by 30.55 points when compared with the non-departmentalized whole group, which is reflected in the space shown between the departmentalized and non-departmentalized regression lines. The statistically significant difference in student achievement in mathematics obtained in the departmentalized setting indicates that students may benefit greatly from receiving mathematics instruction in a departmentalized setting compared to a non-departmentalized setting, which is the central finding of this study.

The ANCOVA results also showed that the regression coefficient of the 2010 Mathematics SOL Test was .73, indicating that for every additional 1 point earned on the 2010 SOL Test, a student (departmentalized or non-departmentalized) will tend to score .73 \( (SE = .06) \) points higher on average on the 2011 Mathematics SOL Test. Hence, the effect of each point on the 2010 test is .73 points on the 2011 test for all students. Therefore, if a departmentalized student scored one point higher on the 2010 test than a non-departmentalized student, the departmentalized student would score .73 + 30.55 or 31.28 points higher on average on the 2011 test than the non-departmentalized student.
Summary

Descriptive statistics were computed for participants’ 2010 and 2011 Virginia Mathematics SOL Test data for each comparison group and subgroup. Assumptions were tested using appropriate statistical analyses for ANOVA and ANCOVA calculations. A statistical analysis of all of the factors in this study, including structure, gender, and race, and combinations of the three factors, was conducted by applying a three-way ANCOVA calculation to the students’ Virginia 2011 Grade 5 Mathematics SOL Test data, utilizing the students’ Virginia 2010 Grade 4 Mathematics SOL Test data as a covariate to control for previous achievement.

Only two factors showed statistically significant effects on an alpha of < .05 on the response, including “structure” and the 2010 Grade 4 Mathematics SOL Test as the covariate, with the factor of classroom organizational structure having an $F$ Value of 12.50 and a $p$-value of < 0.001. None of the other factors were shown to be statistically significant. Hence, the null hypotheses for research questions 1, 2, 3, 4, 6, and 7—which involved the evaluation of the suggested impact of the interactions of gender, race, and structure, followed by gender and structure, race and structure, gender and race, and the main effects of gender and race upon student achievement—were not rejected.

Therefore, Null Hypothesis 5 - $H_{05}$ was rejected, as there was a statistically significant difference in students’ fifth grade scaled scores, as measured by the Virginia 2011 Grade 5 Mathematics SOL Test, when comparing student achievement in departmentalized and non-departmentalized settings. The effect size was moderate, with a partial eta-squared of .052, being close to .06, the moderate category for effect size according to Cohen’s (1988) published guidelines. The power was .976, and hence, the
chance of a Type II error was very small. For departmentalized and non-departmentalized students with the same 2010 Mathematics SOL Test Score, in a range that spanned 280 points (from a score of 320 to 600), statistical results showed that a departmentalized student on average scored an estimated 30.55 points higher than the non-departmentalized student ($SE = 8.64$) on the 2011 Grade 5 Mathematics SOL Test, which was a significant difference in student achievement.

The ANCOVA results also showed that the regression coefficient of the 2010 Mathematics SOL Test was .73, which indicated that for every additional point earned on the 2010 SOL Test, a departmentalized or non-departmentalized student will tend to score .73 points higher on the 2011 Mathematics SOL Test ($SE = .06$). Therefore, if a departmentalized student scored one point higher on the 2010 test than a non-departmentalized student, the departmentalized student would score $.73 + 30.55$ or 31.28 points higher on average on the 2011 test than the non-departmentalized student.

The statistically significant difference in student achievement in mathematics obtained in the departmentalized setting compared to the non-departmentalized setting indicates that students may benefit greatly from receiving mathematics instruction in a departmentalized setting, which is the central finding of this study.
CHAPTER FIVE: DISCUSSION

The purpose of this causal-comparative study was to examine the application of the teaching and learning theory of social constructivism in order to determine if instruction provided in a departmentalized setting in the key content area of mathematics resulted in a statistically significant difference in student achievement compared with the impact upon student achievement when mathematics instruction was provided in a non-departmentalized setting. A causal-comparative design was chosen for this study for purposes of investigating a possible cause-and-effect relationship between two types of instructional settings, departmentalized and non-departmentalized, and higher student achievement in mathematics.

Chapter 5 provides a summary and discussion of the research findings, followed by the implications of the study’s results in light of the relevant literature and theory. The methodological and practical implications will also be described, along with an outline of the study’s limitations and recommendations for future research.

Summary of the Findings

This quantitative study evaluated the possible cause-and-effect relationship between classroom organizational structure, departmentalized versus non-departmentalized settings (the independent variable), on the measured mathematics achievement (the dependent variable) of heterogeneously grouped, regular fifth grade elementary students by whole group and gender and racial minority/non-minority subgroup. Classroom organizational structures may have a greater or lesser effect on the learning of whole groups or on certain subgroup performance. Therefore, student mathematics achievement results were evaluated by whole group and subgroup (gender
and racial minority/non-minority groups, with gender and race being two additional independent variables) in order to assess the possible cause-and-effect relationship between the classroom organizational settings and student achievement in mathematics.

Departmentalized settings included those classroom organizational structures where the students or the teachers had changed classrooms in order to receive instruction in all content areas from a team of teachers who served as subject area specialists. The number of departmentalized teachers on a team can vary, with a minimum of two teachers serving as a team, or as many as four teachers working together to teach content to multiple classes of students (McGrath & Rust, 2002). Non-departmentalized settings are classroom organizational structures where one regular education teacher teaches all required subject area content (other than perhaps music, art, and physical education) to a class of students all day for the entire school year (McGrath & Rust, 2002).

The population for this study included, and was representative of, regular fifth grade elementary students attending departmentalized and non-departmentalized mathematics classes in non-Title 1, Pre-K to Grade 5 elementary schools, who were not cluster grouped for receipt of special education or gifted services, in an urban school district of between 10,000 and 30,000 students in eastern Virginia. Students attending Title 1 schools were not included as part of the school selection process, as the purpose of this study did not include an evaluation of student achievement of the economically disadvantaged or those who may have received additional special classroom instruction or assistance in mathematics. The population was chosen on a convenience basis for participation based upon their assignment to either a regular departmentalized or regular non-departmentalized fifth grade classroom for mathematics instruction in a non-Title 1
elementary school. The fifth grade regular student population attending non-Title 1, PreK-5 elementary schools was representative of the population of the school district, being close to a 50/50 ratio as of 2012 for gender and racial status, as measured by the U.S. Census Bureau from April 1, 2010, to July 1, 2012, which showed virtually no change in the population statistics during school year of 2010-2011, the time period covered in this study (U.S. Census Bureau, 2013).

The sampling frame for this study included regular fifth grade elementary students attending non-Title 1, Pre-K to Grade 5 elementary schools in 2010-2011 in the participating eastern Virginia urban school district, who attended departmentalized and non-departmentalized classes and who were not cluster grouped for receipt of special education or gifted services. Participants were selected for participation in the study from the sampling frame by utilizing a common support method of matching of students, based upon upper and lower bounds of students’ 2010 Grade 4 Mathematics SOL Test scores for the formation of departmentalized and non-departmentalized comparison groups. Homogeneous subgroups were formed from the list of departmentalized and non-departmentalized comparison groups for evaluation and comparison, based upon gender and racial minority/non-minority status, and a combination of gender and racial minority/non-minority status as reported by the participating school district.

Specifically, the sample for this study was selected from a population of 273 regular education students (not special education or gifted students) attending fifth grade in non-Title 1, Pre-K through Grade 5 elementary schools in the school district participating in the study. The sample size for this study included 239 students out of the population of 273 students, with 90 students identified from departmentalized classes and
149 students identified from non-departmentalized classes, who had both 2010 and 2011 SOL Mathematics Test scores reported by the school district and who met the requirements for the common support method for matching participants. The needed sample size for evaluation and analysis for a causal-comparative study for a population of this size should be approximately 163 participants at a confidence level of 95% (Israel, 2009), and therefore, the greater sample size of 239 chosen for this study produced results with greater statistical power, as they relate to the population from which the sample was drawn.

A statistical analysis of all of the factors in this study—including structure, gender, and race, and combinations of the three factors—was conducted by applying a three-way ANCOVA calculation to the students’ 2011 Virginia Mathematics SOL Test data, utilizing the students’ 2010 Virginia Mathematics SOL Test data as a covariate. Only two factors showed statistically significant effects on the response, including “structure” and the 2010 Grade 4 Mathematics SOL Test as the covariate. None of the other factors were shown to be statistically significant. Therefore, the only research question for which the researcher could reject the null hypothesis, which stated that there was no statistically significant difference, was the fifth research question related to structure.

The slope of the lines on the scatterplot of the ANCOVA calculation that were applied to departmentalized and non-departmentalized whole groups showed the relationship of the 2010 Mathematics SOL Test scores to the 2011 Mathematics SOL Test scores as increasing, indicating that the students with the higher 2010 Mathematics SOL scores tended to have higher 2011 Mathematics Test scores. The distance between
the two lines on the scatterplot, the higher of which represents departmentalized students, indicated that even with the same 2010 Mathematics SOL Test score, a departmentalized student would tend to perform better on the 2011 Mathematics SOL than a non-departmentalized student.

The ANCOVA results also showed that the regression coefficient of the 2010 Mathematics SOL Test was .73, indicating that for every one additional point on the 2010 Mathematics SOL Test, a student would tend to score .73 points higher on the 2011 Mathematics SOL Test than another student. For students with the same 2010 Mathematics SOL Test score, in a range that spanned 280 points (from a score of 320 to 600), a departmentalized student on average scored an estimated 30.55 points higher than the non-departmentalized student ($SE = 8.64$) on the 2011 Grade 5 Mathematics SOL Test, which was a significant difference in student achievement. Therefore, if a departmentalized student scored one point higher on the 2010 test than a non-departmentalized student, the departmentalized student would score $.73 + 30.55$ or $31.28$ points higher on average on the 2011 test than the non-departmentalized student.

The partial eta-squared for this study was .052, identified as a medium effect size, which was calculated based upon the variance between the two groups that evaluated student achievement in departmentalized and non-departmentalized groups, based only on classroom structure and using the students’ 2010 Mathematics SOL Test as a covariate. The power was .976, meaning that if the sample effect size is representative of the true effect size, there was a 97.6% chance of choosing a random sample of individuals the size of the sample in this study who would have a significant difference in their 2011 Mathematics SOL Test scores. The power of .976 strongly indicates that
rejecting the null hypothesis was correct for the fifth research question regarding the suggested impact of the departmentalized setting on student achievement on the 2011 Virginia Mathematics SOL Test, as the chance of a Type II error is very small.

Therefore, the results of this study show that a regular education student receiving instruction in mathematics in an eastern Virginia non-Title 1, PreK-5 elementary school environment, following the identical, state-specified, fifth grade mathematics curriculum in a departmentalized setting, will tend to demonstrate a statistically significant difference in achievement in mathematics, regardless of gender or race, as measured by the 2011 Virginia Grade 5 Mathematics SOL Test, with the students’ 2010 Virginia Grade 4 Mathematics SOL Test scores used as a covariate to control for previous achievement.

**Discussion of the Findings**

**Social Constructivism, Learning, and Achievement**

Social constructivist theory combines major aspects of sociocultural theory and constructivist theory, which formed the theoretical framework for this study. Pritchard and Woollard (2010) noted that, based upon Vygotsky’s social constructivist theory, children construct their own internal understanding when in the classroom, supported by social and collaborative activities, as part of their learning and development. Current research literature supports the fact that departmentalized instructional settings allow teachers to provide the necessary interactive, social settings, along with providing targeted, subject area technical guidance and direct instruction when needed. For instance, departmentalized settings provide the opportunity for teachers to serve as facilitators and foster cooperative learning in designated subject areas by designing collaborative lessons for students, as knowledgeable teachers know how to step back and
allow students to interact and construct their own learning (Abbati, 2012; Baker, 2011; Henderson, 2011; Hood, 2010; Kent, 2010; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011). The departmentalized setting, with a knowledgeable teacher-facilitator, may provide a more beneficial learning environment for students, much as Vygotsky envisioned and Piaget described in 1954 in the book *The Construction of Reality in the Child*.

It was theorized in this study that the level of learning achieved by students is dependent upon their social interactions with their teachers and other students in the classroom, as they construct and internalize their own learning in accordance with social constructivist theory. Given the results of this study, which suggest that the departmentalized setting had a statistically significant impact upon student learning and achievement in mathematics, making classroom structural choices that align with social constructivist theory could have the greatest impact upon student learning. These findings should take on heightened importance as part of the decision-making process when administrators and teachers consider which classroom organizational structure should be implemented at the fifth grade level in mathematics, given the potential of the departmentalized structure to positively impact student learning. Departmentalized settings may, in and of themselves, create an environment where students can learn best, as they communicate with each other and their teachers in a social setting, gaining new knowledge, developing proficiency, and testing their critical thinking skills by working with knowledgeable teachers and other students, who are more advanced in the content area.
Nasir and Hand (2006) noted that a number of studies showed the importance of the social, interpersonal process on development and learning, also known as scaffolding. The departmentalized setting may provide the structure where teachers can make a real difference in children’s learning and achievement, helping them to become more independent thinkers, which can result in those leaps of learning and in-depth understanding along with construction of knowledge, envisioned by Vygotsky (1978), Piaget (1954), Borenstein and Bruner (1989), Bruner (1971, 2008) and Dewey (1910, 1916). Departmentalized settings may provide an ideal environment where children can explore cooperative activities and engage in problem-solving with other children, as they interact with a number of knowledgeable teachers (Page, 2009; Yearwood, 2011) who provide opportunities for students to enhance their own learning and levels of conceptual understanding. This rich environment for exploration, cooperation, communication, and critical thinking may lead to a level of knowledge acquirement, supported by the application of a variety of practice skills, individually and with other students, that results in higher student achievement, which can be documented and measured, as was done in this study.

**Increased Student Achievement in Mathematics**

The results of this study show a statistically significant difference in the mathematics achievement of regular fifth grade students who are learning in the departmentalized setting versus the non-departmentalized setting. Hence, structuring mathematics instruction in a departmentalized setting at the fifth grade level could be the solution for helping our students gain a better understanding in mathematics at an early age, prior to moving onto the middle grades. In addition, the learning that can take place
in the departmentalized setting could help to offset the move towards extreme standardization of content instruction and testing, which go hand-in-hand with increased accountability. Samuelson (2012) noted that the cognitive development of children has become stagnated with efforts to pursue greater proficiency on standardized tests, which have negatively impacted the development of diverse learning opportunities in the classroom. The implementation of the departmentalized setting in mathematics at the fifth grade level could offset the impact of standardization by providing opportunities for knowledgeable teachers and their students to work cooperatively on engaging learning activities that significantly impact student learning in a positive way, thereby meeting the goal of increasing student achievement while establishing a solid foundation for mathematical understanding by each child.

**Closing the Achievement Gap**

As noted in the literature review, if educational leaders are to make a difference in the overall mathematics achievement of students, along with potentially helping to close the achievement gap between racial minority and non-minority students and boys and girls, they are going to need to make decisions about choosing classroom organization structures at the upper elementary levels, particularly in mathematics, that will positively impact the depth of the learning that occurs in classrooms every day. If the departmentalized approach can be effective in helping all students become proficient in mathematics, as the results of this study suggest, the consistent implementation of departmentalization could make a difference in student achievement for all students in the long term and help to close the achievement gap moving forward. It is possible that implementing departmentalization at the fifth grade level in mathematics will also help to
establish a solid foundation in mathematical concepts and understanding for all students and level the playing field so that they can be successful in higher levels of mathematics and science in the middle and high school grades, and at the post-secondary level.

In fact, the results of this study show that the achievement gap may not be related to gender or race, but rather, to the instructional setting and level of instruction that is occurring in that setting. The departmentalized setting made a statistically significant difference in the learning and achievement of all students in this study, which should encourage educational leaders to seriously consider the establishment of departmentalized settings at the fifth grade level in the subject area of mathematics.

**Content Area Specialists in the Elementary Mathematics Classroom**

The results of this study strongly support the implementation of the departmentalized setting in mathematics at the fifth grade level in an elementary environment. The implementation of the departmentalized classroom organizational structure necessitates the presence of highly qualified teachers who are well prepared in the content area of mathematics. The results of studies by Cavanagh and Hoff (2008), Connell (2009), Gulpinar, (2005), Slavin et al. (2009), Slavin and Lake (2008), and VanTassel-Baska et al. (2008) support the need for having qualified teachers who serve as content area specialists in the regular classroom. These studies suggest that content area specialists are more capable of creating the type of differentiated, social constructivist learning environment in a departmentalized setting, which promote student engagement.

It is interesting to note that in this study, while qualifications of the teachers were similar, with all the departmentalized and non-departmentalized teachers holding
Professional Teaching Licenses from the Commonwealth of Virginia, along with having a minimum of 4 years of average teaching experience, that the non-departmentalized teachers had ten more years of average teaching experience than the departmentalized teachers, and that 44% of the non-departmentalized teachers had masters degrees, but the students in the departmentalized classes demonstrated higher achievement in mathematics that was statistically significant compared with the achievement of the non-departmentalized classes. The results of this study suggest that mathematics instruction provided in a departmentalized setting results in increased learning and achievement for all students, and it may be a far more favorable environment for learning than the non-departmentalized setting, even with some differences in the teacher’s formal education and teaching experience.

School districts could make the most of the departmentalized instructional setting for mathematics by placing content area specialists in those classrooms and by providing targeted professional development in mathematics for those teachers, who can then focus on the subject area of mathematics. It appeared that the ability of departmentalized mathematics instructors to focus on preparing for and presenting mathematical content and activities was proven to have a positive impact on student achievement in this study, as the departmentalized teachers had fewer years of average teaching experience compared with the non-departmentalized teachers, and yet students had higher achievement in the departmentalized classes.

The departmentalized setting for the teaching of mathematics is naturally more conducive for implementing the types of social activities that result in increased levels of student achievement, as shown by the results of this study, which is supported by key
elements of social constructivist theory. Social constructivist theory clearly supports the idea that learning is not just an individual process but rather a social one. Social constructivists believe there is a social community in which learning takes place, where individuals learn and further their own development by participating in social activities or practice. Therefore, it is critical that teachers have an in-depth understanding of their subject area, particularly in mathematics, in order to be able to design and coordinate cooperative learning activities that support the types of social interaction that will engage a diverse group of student learners.

The departmentalized mathematics instructor can concentrate on planning for either just mathematics or for mathematics and one or two other subjects every day, and he or she can focus on developing challenging, engaging, and interactive mathematics lessons that include social group activities, discussion, and the use of manipulatives and computer technology, which will inspire student learning. Therefore, the results of this study suggest that it could be highly beneficial to select more content area specialists in mathematics to teach in departmentalized settings at the elementary level. A movement by school districts, schools, administrators, and teachers to implement a greater number of departmentalized settings at the elementary level in mathematics, and perhaps in other subject areas as well, would set the stage for identifying teachers who have the skills for serving as content area specialists at the elementary level.

**Addressing the Gap in the Literature**

This study addressed a gap in the literature with regard to which classroom organizational structure, departmentalized or non-departmentalized, may be more effective in terms of documented student achievement at the elementary level (Abbati,
2012; Baker, 2011; Chang, et al., 2008; Henderson, 2011; Hood, 2010; Kent, 2010; McGrath & Rust, 2002; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011). This investigation also addressed a gap in the literature with regard to the achievement of targeted subgroups who were receiving instruction in departmentalized and non-departmentalized settings. Given that few studies have been conducted that compare departmentalized and non-departmentalized instruction at the elementary level (Kent, 2010) and that the results of these studies have been contradictory, more evidence was needed in order to evaluate the impact of these classroom organizational structures on student learning.

The factors of gender and race, individually or interacting with each other or with classroom organizational structure, were not statistically significant with regard to their impact upon student performance on the Virginia 2011 Grade 5 Mathematics SOL Test. While the results of this study did not show a statistically significant difference in achievement by gender and racial subgroups based upon classroom organizational structure, additional studies on this topic would add to the field of knowledge in this area.

Educators will need to decide how to move forward to best serve their students, given that achievement is measured by whole group and subgroup performance. This is particularly so because of the documented achievement gaps in mathematics and reading between minority and non-minority groups, along with the goals that have been set for closing the achievement gap established in the past by NCLB and for the future by the VDOE. In fact, the VDOE has set new requirements under ESEA Flexibility, in which annual benchmark goals had to be established for student learning that would reduce the
failure rate by 50% in reading and mathematics for students overall and for each student subgroup, within a six-year period, which was announced in June of 2012.

Teachers are expected to focus their efforts on the achievement of all students, along with paying special attention to the achievement of identified subgroups in order to meet targeted goals. The results of this study on student achievement in mathematics in departmentalized settings may provide evidence for structuring instruction in mathematics in departmentalized settings in the future and for utilizing content area specialist on a consistent basis in order to better serve students in whole groups and in targeted subgroups in order to meet new achievement goals set by the VDOE.

Teachers have also repeatedly stated that they prefer to teach in a departmentalized setting, particularly in the content area of mathematics, as was reported by respondents in a study by Moore (2008). Teachers indicated on a survey that they preferred to teach in a departmentalized setting, particularly at the fifth grade level (fourth grade teachers – 56% and fifth grade teachers – 72%). With increasing pressure to improve students’ scores on achievement tests, which will impact teachers’ performance evaluations in Virginia, more elementary teachers than ever may favor departmentalized settings for instruction, compared with teaching in traditional, non-departmentalized settings, where they have to serve as subject matter experts in every subject and are responsible for higher student achievement in all of these areas.

Given the demands of the content areas at the fifth grade level and the pressure to increase levels of student achievement, particularly in mathematics and reading, the departmentalized approach may serve as the solution to allowing teachers to teach in the subject areas they know best, where students will have increased opportunities to learn
and experience mathematics and achieve at higher levels, and teachers will experience
greater job satisfaction and higher performance evaluation results. Implementation of the
departmentalized setting at the fifth grade level for mathematics could be a win-win for
students, parents, teachers, administrators, schools, and school districts, given the results
of this study.

Study Limitations

Departmentalized and non-departmentalized classes were already established by
the school administrators in the non-Title 1 elementary schools from the local school
district participating in the study. Therefore, there was an internal selection threat to
validity, given that the placement of the students in the classes had already occurred and
the selections were not at random for purposes of the study. The researcher controlled for
this selection threat by creating a control group of regular education fifth grade students,
the non-departmentalized group, for purposes of statistical comparison and evaluation
with the departmentalized group of regular education fifth grade students. The researcher
also used the common support matching procedure for purposes of selecting study
participants from both groups that would be statistically matched to minimize the
selection threat.

The departmentalized and non-departmentalized teachers were also selected by
school administrators for the regular education classes that had already been established
at the fifth grade level. In addition, the education and experience levels of the teachers
were varied and posed a selection threat to effective implementation of departmentalized
instruction, which could have impacted student achievement and test score results. The
differences between the experience levels of the teachers may have played a factor in the
results obtained in this study and may have skewed the results to some degree, since the non-departmentalized teachers had an average of 14 years of experience, compared with an average of 4 years of experience for the departmentalized teachers. However, the results of this study also suggest that students may perform at a higher level in the departmentalized mathematics classroom, despite the fact that the departmentalized teachers had an average of 10 fewer years of teaching experience compared to the non-departmentalized classroom teachers.

Results will need to be interpreted with caution, as advised by Gruber and Onwuegbuzie (2001), given the variability in teacher selection and implementation. This selection threat to internal validity was controlled for by the sustained efforts by the VDOE to standardize curriculum and instruction, with the goal of addressing variability in teacher preparation and experience in order to standardize the presentation of the content material to students in the classroom. In addition, the departmentalized and non-departmentalized teachers for the classes participating in this study had a minimum average of 4 years of teaching experience to further minimize this selection threat to internal validity.

Another selection threat to internal validity was the variability in the students’ level of academic preparation for 5th grade mathematics. This threat was minimized by applying the ANCOVA calculation, using the covariate of the students’ 2010 Grade 4 Mathematics SOL Test results, to control for previous achievement. The ANCOVA analysis resulted in a more robust calculation with regard to measuring whether there was a statistically significant difference in 2011 Grade 5 Mathematics SOL Test results
between the departmentalized group and the non-departmentalized (control) group that were being compared, minimizing the threat.

There was also a limited maturation threat, given that students have varying levels of cognitive and emotional development over time in fifth grade, leading to a selection-maturation interaction that could impact student test results. However, all of the students in the departmentalized and non-departmentalized groups matured at approximately the same average rate for a typical group of regular education students, which minimized this threat to the variability in the students’ mathematics achievement scores on the 2011 Mathematics SOL Test.

The instrumentation threat to internal validity was extremely small. There were two versions of the same test provided by the VDOE in 2011, identified as Core 1 and Core 2. The two different cores, or different versions of the test, covered the same strands and were equated to ensure equality in difficulty, even though they did not have the exact same test questions (D. Keeling, personal communication, March 1, 2013), greatly minimizing the instrumentation threat.

The generalizability of the results of this study is limited to the fifth grade level in the school district included in the study or to non-Title 1 regular elementary schools in a school district with similar demographics in eastern Virginia. Because the specific instructional strategies utilized by departmentalized teachers vary widely, there would not be a specific description available of exactly how to duplicate each teacher’s particular instructional methods used in the departmentalized setting. However, the focus of this study revolved around the possible impact of the departmentalized setting on student achievement in mathematics and not the particular methods employed in the classroom,
so replication of this study to determine a possible relationship between the use of departmentalized settings in mathematics and higher student achievement would be possible.

**Implications**

The implication of the results of this study suggest that school districts, administrators, and teachers should re-evaluate the current methodological approach to choosing the classroom organizational structure for instruction in mathematics at the fifth grade level. The current favored methodological approach based on research at the elementary level is to provide instruction in the traditional, non-departmentalized setting in all content subject areas for the entire school day. The results of this study suggest that it may be far more advantageous for students to receive mathematics instruction in a departmentalized setting at the fifth grade level because there may be a far greater positive impact upon their learning and understanding of mathematical concepts and skills, which they can successfully apply in a testing setting, thereby documenting higher achievement.

In addition, the current tendency to structure all of the elementary grades in an elementary school as non-departmentalized settings, with occasional structuring of classes in fourth and fifth grade in departmentalized settings at the request of an administrator or teacher, results in an inconsistent approach to classroom organizational structure at the upper elementary grade levels. Choosing different classroom organizational structures from year to year, school to school, or grade level to grade level may result in inconsistent learning by students at the upper elementary grade levels within a school district. In particular, students need to experience learning opportunities
at the fifth grade level that are consistent, where the organizational structure of the
departmentalized class is the norm and not a hit-or-miss proposition. Students should
expect to receive the best mathematics instruction in the most favorable instructional
setting possible, which based upon the results of this study, may be the departmentalized
setting.

Fifth grade students need to be able to develop a solid foundation in mathematics
before they move on to the middle grades, which are, in fact, departmentalized. By
exposing fifth graders on a consistent basis to mathematics instruction in a
departmentalized setting, educators may be not only providing students with the
possibility of greater learning and achievement resulting in higher test scores, but be
preparing them more effectively for the transition to the middle school and its
departmentalized settings, which are already in place.

Educators face several practical challenges to implementing departmentalized
settings for all fifth graders in the subject area of mathematics or for other subject areas.
These challenges include considering the norms of the school, the instructional strengths
of the existing fifth grade faculty, and the need to garner support by communicating the
structural changes and requirements to parents. The logistics of helping students adjust to
moving from class to class, or from teacher to teacher, to experience learning
mathematics in a departmentalized setting should also be considered. The results of this
study show that the positive impact may be well worth the effort to structure mathematics
instruction at the fifth grade level in departmentalized settings, which could be the most
beneficial learning environment for fifth grade students.
Fifth grade teachers may also face a learning curve and may need additional staff development or coursework in mathematics in order to serve as departmentalized instructors in mathematics in this setting. It would be recommended, based upon the current research which indicates that departmentalized teachers should be highly knowledgeable in their content area, that teachers should apply for and be interviewed for teaching positions in departmentalized settings in mathematics to verify their interest level and ensure their preparation for the task at hand. Implementation of departmentalized settings at the fifth grade level will also require a team-effort approach in order to be successful because of the multiple grade level and institutional challenges related to scheduling and student movement (Baker, 2011). In addition, administrators and teachers will need to work together in order to arrange scheduling for students and to provide common planning times for the departmentalized mathematics teachers to meet with each other and other subject area teachers in order to coordinate instruction and maintain open lines of communication among team members.

Mentoring programs will also need to be established in order to support the fifth grade departmentalized team and to prepare other teachers who may want to join the departmentalized fifth grade group or who may want to expand the departmentalized settings in mathematics to the fourth grade level, which has been done from time to time at schools in the region. School administrators should refrain from moving teachers from grade level to grade level frequently, as this prevents the formation of cohesive departmentalized teaching teams and can inhibit the academic progress that can be made by students in departmentalized settings. The departmentalized approach will require that the whole school and entire grade levels coordinate their efforts in order to ensure the
successful implementation of departmentalized instruction in mathematics at the fifth grade level or beyond. However, as the results of this study show, it may be well worth the effort, given what students can learn and achieve in mathematics in departmentalized settings.

The school division participating in this study required each elementary teacher to conduct reading instruction for his or her own homeroom class. However, the departmentalized teachers were fully departmentalized for the participants of mathematics, science, social studies, and for one school, writing as well. The implementation of departmentalized settings for mathematics and one or two other subject areas (i.e. science and social studies) would make implementation of a departmentalized schedule more feasible for a fifth grade team of teachers and may, in fact, prove to have a positive impact upon student learning in these other subjects as well.

**Recommendations for Future Research**

This study addressed a gap in the literature with regard to which classroom organizational structure, departmentalized or non-departmentalized, may be more effective in terms of documented student achievement at the elementary level (Abbati, 2012; Baker, 2011; Chang, et al., 2008; Henderson, 2011; Hood, 2010; Kent, 2010; McGrath & Rust, 2002; Moore, 2008; Patton, 2003; Ponder, 2008; Williams, 2009; Yearwood, 2011). The results of this causal-comparative study made a contribution to the field of education as a result of the investigation of the possible cause-and-effect relationship between two key classroom organizational structures and the achievement of regular fifth grade elementary students in mathematics by showing that there was a
statistically significant difference in student achievement in the departmentalized setting compared to the achievement attained by students in the non-departmentalized setting. The results of this study are consistent with the results obtained by Moore (2008), Williams (2009), and Yearwood (2011), who all found that fifth graders receiving instruction in departmentalized classes scored higher on mathematics achievement tests than students who received instruction in the same curriculum in non-departmentalized classes.

The statistically significant results of this study showed that for every one additional point on the 2010 Mathematics SOL Test, a student will tend to score .73 points higher on the 2011 Mathematics SOL Test than another student. For students with the same 2010 Mathematics SOL Test score, the difference between the achievement of a departmentalized and non-departmentalized student was estimated to be 30.55 points, on a scale from 0 to 600, with 400 being a passing score and 500 and over indicating advanced proficiency. This is a very significant difference in mathematics achievement based upon the independent variable of departmentalized classroom organizational structure, which deserves attention by the educational community and should add empirical evidence to the debate as to whether fifth grade instruction should be provided in a departmentalized setting for all students in mathematics.

Further studies are needed in order to provide more empirical evidence to school districts, school administrators, and teachers about which instructional setting, departmentalized or non-departmentalized, may make a significant difference in student learning and achievement, particularly in mathematics, as noted in studies conducted by Moore (2008), Ponder (2009), Williams (2009), and Yearwood (2011). Given the
increasing levels of accountability that will continue to be imposed as a result of comprehensive ESEA flexibility plans that are being implemented in Virginia, which include teacher evaluations that are based upon student performance, additional investigations need to be made with regard to which classroom organizational structure, departmentalized or non-departmentalized, may result in a statistically significant difference in student achievement in mathematics. The results of future studies may produce a preponderance of the evidence that will point educators in the right direction, in terms of highlighting which classroom organizational structure and/or other factors consistently impact student learning at the upper elementary level.

Therefore, it is recommended that further research be conducted to evaluate the effectiveness of instruction in departmentalized and non-departmentalized settings, along with the evaluation of the performance of gender and racial subgroups in these settings. Research relevant to the academic achievement of gender and racial subgroups at the elementary level is particularly lacking (Patton, 2003; Ponder, 2008), and it is clear that more studies need to be conducted to establish which independent variables, including departmentalized or non-departmentalized classroom organizational structures, might positively impact the performance of these subgroups. While the results of this study did not show a statistically significant difference in achievement by gender and racial subgroups based upon classroom organizational structure, additional studies on this topic would add to the field of knowledge in this area, and there may be other independent variables that impact mathematical achievement by these subgroups.

Research studies on the effectiveness of classroom organizational structure should also be conducted at the fourth grade level in mathematics and at the fourth and fifth
grade levels in other content areas in addition to the content area of mathematics. It is recommended that these studies be both qualitative and quantitative in nature. For instance, case studies that involve observation of teaching practice and effectiveness that can be compared between the departmentalized and non-departmentalized classrooms could prove helpful and provide a qualitative aspect that could be considered, in addition to the results of quantitative studies. Research studies that incorporate other instructional strategies in the classroom, such as flexible grouping or intensive small group tutoring in the regular education classroom, within the departmentalized or non-departmentalized settings, could produce interesting results.

These future research studies could also be expanded to include Title 1 schools to evaluate the impact of departmentalized and non-departmentalized settings on the learning of the socioeconomically disadvantaged, who receive additional instructional assistance in the regular education classroom as part of the Title 1 program. Also, additional research on the potential impact of departmentalized and non-departmentalized settings should be conducted utilizing classes that are ability grouped, such as inclusion or gifted cluster classes, which were not included in this study. Future research studies could also include other variables linked to student learning that are related to teacher preparation, such as teacher educational programs, teacher competency, professional development, mentoring program effectiveness, and teacher preference related to classroom organizational structure.

Most of the studies reviewed on classroom organizational structures that specified a conceptual framework chose sociocultural (Eddy, 2008; Marsh, 2008), constructivist (Abbati, 2012; Moore, 2008), or organizational (Lee, 2010) theories as the foundation for
their work. Yearwood (2011) based her study on a theoretical framework of sociocultural, constructivism, and social constructivist theory, which was the theoretical framework established for this study. Based upon the results of this study, the departmentalized setting, which has the potential to provide a more social, interactive community environment of learning for students in the hands of a knowledgeable teacher, may establish a learning platform that encourages students to be engaged in their own learning and achievement as they learn from others who are more advanced (Vygotsky, 1978), thereby internalizing higher levels of knowledge and understanding (Piaget, 1954).

The results of the studies by Cavanagh and Hoff (2008), Connell (2009), Gulpinar, (2005), Slavin et al. (2009), Slavin and Lake (2008), and VanTassel-Baska et al. (2008) supported having qualified teachers who serve as content area specialists in the regular classroom. These studies suggested that content area specialists are more capable of creating the type of differentiated, social constructivist learning environment in a departmentalized setting, which will promote student engagement, learning, and achievement at all ability levels. Therefore, given the results of this study, with a departmentalized approach at the fifth grade level, schools could have highly qualified teachers working in their areas of expertise, helping students meet the increasing ESEA flexibility and state achievement expectations, by using teaching resources already at their fingertips.

As suggested by the results of this study and studies by Moore (2008), Williams (2009), and Yearwood (2011), elementary teacher preparation programs should be designed to focus their own curriculum on specialization in content areas, such as mathematics, in order to properly prepare teachers to provide instruction by content area
at the upper elementary grade levels. State licensing agencies may want to consider modifying their elementary licensure for the upper elementary grades of fourth and fifth grade, whereby teachers will be required to become certified to teach elementary mathematics, in order to become a teacher of mathematics in an upper elementary classroom, as opposed to earning a general license to teach PreK-5 in the elementary grades. An organized approach to implementing targeted upper elementary teacher preparation programs and licensure requirements for teachers of mathematics (and perhaps other subject areas) at the fourth and fifth grade levels would lead to more effective, comprehensive lesson preparation and instruction by teachers that will help to ensure more meaningful learning experiences for students as envisioned by Piaget (1952) and Vygotsky (1978), resulting in higher student achievement.

This study could be replicated at the fifth grade level in this school district or in another similar eastern Virginia school district. This study could also be conducted at the fourth grade level in a similar district to see if the departmentalized setting shows a statistically significant difference in student achievement at that grade level. This research design, with its independent and dependent variables and covariate, could also be utilized in other larger school divisions in Virginia and in other states, using other reliable state test results for comparison. By conducting additional research studies in similar school divisions and in school divisions which are different in size and in diversity of population, more empirical data and qualitative information could be collected and evaluated, adding to the body of knowledge about how a departmentalized classroom organizational structure may positively impact student achievement in mathematics.
REFERENCES


for all students. Austin, TX: Pro-Ed.


Disseler, S. A. (2010). *A comparison of attitudes and achievements for students*
transitioning to middle school from different elementary school organizational patterns (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. 3445887)


classrooms (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. 9029387)


Kent, K. P. (2010). *Self-contained versus departmentalized school organization and the impact on fourth and fifth grade student achievement in reading and mathematics as determined by the Kentucky core content test* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. 3479929)


Marsh, S. K. (2008). *Organizational systems school leaders implement to facilitate*
effective classroom instruction in urban schools: A case study (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. 3324972)


McPartland, J. M., Coldiron, J. R., & Braddock, J. H., II (1987). School structures and


http://www2.ed.gov/policy/elsec/leg/esea02/pg1.html


Virginia Department of Education. (2011, January 13). *Comparison of Virginia’s 2009


Virginia Department of Education. (n.d.-a). Accountability & Virginia public schools –


May 6, 2013

Karen Ann Nelson
IRB Exemption 1094.050613: The Effect of Departmentalized Fifth Grade Mathematics Instruction on Student Achievement

Dear Karen,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and that no further IRB oversight is required.

Your study falls under exemption category 45.101 (b)(4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption, or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Please retain this letter for your records. Also, if you are conducting research as part of the requirements for a master’s thesis or doctoral dissertation, this approval letter should be included as an appendix to your completed thesis or dissertation.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

Liberty University | Training Champions for Christ since 1971
February 28, 2013

Karen Nelson

Dear Ms. Nelson,

Thank you for your request to extend your research in [obscured] Schools. The Research Committee has approved your revised proposal on “The Effect of Departmentalized Fifth Grade Mathematics Instruction on Student Achievement”.

Please be advised that your approval has been extended to August 17, 2013. If you are unable to complete your research within this time frame, please contact me. Again, an extension will need to be requested and granted by the Research Committee in order to proceed with the research.

The data that you have requested is ready and can be released to you upon our receipt of your IRB approval. Please forward a copy of that approval as well as a brief request to release the data previously identified.

It is our expectation to receive a copy of your findings once the research has been completed. We wish you success in your research.

Sincerely,

[obscured]

Executive Director of Research, Planning and Evaluation