The Relationship between the Attitude toward Mathematics and the Frequency of Classroom Observations of Mathematics Lessons by Elementary School Administrators

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Keywords: Mathematics Attitude, Mathematics Anxiety, Elementary Principal Leadership and Mathematics, Principal Observations and Feedback

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ABSTRACT

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. This study considered Approach-Avoidance Motivation as part of the conceptual framework guiding the research. Approach-avoidance motivation refers to a person's approach of tasks that are pleasant or enjoyable and avoidance of tasks that are disliked or not enjoyable. This research sought to answer the questions:

1. What is the academic background in mathematics of elementary school administrators?
2. What is the attitude toward mathematics of elementary school administrators?
3. What is the frequency of classroom observations of mathematics lessons by elementary school administrators?
4. What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

The participants in this study included elementary school principals and assistant principals in one school division in Virginia. Data were collected to investigate the mathematics background, attitude toward mathematics, and frequency of classroom observations of mathematics lessons by elementary school administrators. This study also examined the possible relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons.

The attitude toward mathematics, including related mathematics anxiety, was found to have no relationship with the frequency of both formal and informal classroom observations of mathematics lessons conducted. The sample population data indicated positive attitudes toward mathematics and low levels of mathematics anxiety, which conflicts with some previous research (Dorward & Hadley, 2011; Hembree, 1990). The mathematics background of participants was found to be limited in the number of mathematics courses completed and teaching licensure endorsements specific to mathematics instruction. The findings provide educational leaders with relevant research related to attitude toward mathematics and the instructional leadership practice of observing mathematics classrooms. Central office and school leaders could benefit from explicit expectations relating to the observation of mathematics lessons in schools.

Keywords: mathematics attitude, mathematics anxiety, elementary teachers and mathematics anxiety, elementary principal leadership and mathematics, principal observations

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GENERAL AUDIENCE ABSTRACT

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. This study considered aspects of avoidance theory as part of the conceptual framework guiding the research. Approach-avoidance motivation refers to a person's approach of tasks that are pleasant or enjoyable and avoidance of tasks that are disliked or not enjoyable.

Elementary school principals and assistant principals in one school division in Virginia participated in this study. Data were collected to investigate the mathematics background, attitude toward mathematics, and frequency of classroom observations of mathematics lessons by elementary school administrators. This study also examined the possible relationship between the attitude toward mathematics, including related mathematics anxiety, and classroom observations of mathematics lessons.

The attitude toward mathematics, including related mathematics anxiety, was found to have no relationship with the frequency of classroom observations of mathematics lessons conducted. The study data indicated positive attitudes toward mathematics and low levels of mathematics anxiety in study participants, which conflicts with some previous research (Dorward & Hadley, 2011; Hembree, 1990). The mathematics background of participants was found to be limited in the number of mathematics courses completed and license endorsements specific to mathematics teaching. The findings provide educational leaders with relevant research related to attitude toward mathematics and the instructional leadership practice of observing mathematics classrooms. Central office and school leaders could benefit from explicit expectations relating to the observation of mathematics lessons in schools.

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DEDICATIONS

Without my faith in God, I would not have been successful in this or any endeavor in my life. His support has provided me strength when I felt I had none left. I always knew I could put my life in His hands when my plate felt as if it were overflowing. I dedicate this journey to God, my family, my Crew, two lifelong friends that I gained during this experience, and my mentors who have acted as my “Moms” throughout my professional development as a teacher and leader.

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call you my mentor. As a teacher, you saw leadership potential in me and provided opportunities
call you my mentor. As a teacher, you saw leadership potential in me and provided opportunities
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CHAPTER ONE
THE PROBLEM

Introduction

Mathematics achievement continues to be a focus of headlines in media outlets across the United States: “Report Urges Changes in Teaching Math” (Lewin, 2008); “Sluggish Results Seen in Math Scores” (Dillon, 2009); “Can the U.S. Compete if Only 32% of Students are Proficient in Math?” (Khadaroo, 2011); and, “American Schools v. the World: Expensive, Unequal, Bad at Math” (Ryan, 2013). Consequently, educators seek to understand what is hindering mathematics achievement in schools (Ball, Hill, & Bass, 2005; Firmender, Gavin, & McCoach, 2014; Siegler et al., 2012) and how leadership practices can improve students’ ability to succeed in mathematics curricula (Grissom, Loeb, & Masters, 2013; Robinson, Lloyd, & Rowe, 2008; Stein & Nelson, 2003; Walker & Slear, 2011). Student learning and achievement in mathematics need to improve if learners are going to compete in global economies (National Mathematics Advisory Panel, 2008).

Overview of the Study

Education leaders play a role in student achievement, which includes supporting learning through their instructional leadership practices (Dumay, Boonen, & Van Damme, 2013; Hallinger & Hech, 1996; Leithwood & Jantzi, 2006; Robinson et al., 2008). Mathematics achievement has been a reoccurring concern in the education history in the United States (Fowler, 2013; Klein, 2003; National Mathematics Advisory Panel, 2008; Schlechty, 2009). This study has added to the body of research relating to educational leadership and mathematics achievement by examining the instructional leadership practice of classroom observations. Specifically, this study investigated whether there is a relationship between an educational leader’s attitude toward mathematics at the elementary level and the instructional leadership practice–frequency of classroom observations of mathematics lessons.

Attitude toward mathematics and its connected mathematics anxiety affect people in job and career fields. Research has found that college students majoring in elementary education have some of the highest levels of mathematics anxiety (Hembree, 1990; Kelly & Tomhave, 1985) and poorer attitudes about mathematics and less mathematics competence compared to the general population of college students (Rech, Hartzell, & Stephens, 1993). For some elementary school administrators, previous teaching experience was at the elementary school level before transitioning to an administrative position. Previous education administrative licensure regulations in Virginia included requirements for teaching experience at the school level of the endorsement (C. Cordle, personal communication, December 30, 2016). In a study investigating mathematics content knowledge of principals, Schoen (2010) measured mathematics content knowledge utilizing the Mathematics Knowledge for Teaching (MKT) instrument developed by Hill, Schilling, and Ball (2004). Schoen (2010) suggested that since the instrument was initially developed for use with elementary teachers, it could be said elementary principals in the study had similar levels of mathematics knowledge to elementary teachers.

As instructional leaders, principals are expected to be more than building managers; they are expected to facilitate professional and instructional growth in teachers (Leithwood & Jantzi, 2006; Robinson et al., 2008). One aspect of instructional leadership noted by Horng and Loeb (2010) was that strong instructional leaders are "hands-on leaders, engaged in curriculum and instruction issues, unafraid to work directly with teachers, and often present in classrooms" (p. 66). With quality instructional leadership, teachers' expertise grows, and students benefit from learning experiences provided (Grissom et al., 2013; Horng & Loeb, 2010; Leithwood & Jantzi, 2006; Robinson et al., 2008). Grissom et al. (2013) found predictors of higher achievement growth in mathematics where principals' instructional time use focused on coaching and evaluating teachers and developing the educational program of the school. Instructional leadership involves conducting classroom observations of mathematics lessons and providing coaching through appropriate feedback or specifically identified professional development (Fink & Resnick, 2001; Fox, 2014). Effective observation practices by school leaders can aid student achievement in mathematics (Carver, Steele, & Herbel-Eisenmann, 2010; Grissom et al., 2013).

Historical Perspective

Mathematics education in the United States during the 20th century. Mathematics has been an interest of the United States' educational system dating back many decades (Klein, 2003). Progressivist ideals of the late 1910s and early 1920s, with influencers in education like Dewey and Kilpatrick, touted the significance of student-centered discovery learning and limited academic content for students. Specifically, Kilpatrick opposed the need for arithmetic, algebra, and geometry in schools (Klein, 2003). As the Committee Chair for the National Education Association's Commission on the Reorganization of Secondary Education in 1915, Kilpatrick's report, *The Problem of Mathematics in Secondary Education*, challenged the use of mathematics to promote mental discipline. The committee contained only educators; no mathematicians participated. The committee directly questioned the utilization and need for mathematics in learning (Klein, 2003).

Countering points dismissing mathematics in the Kilpatrick report, the Mathematical Association of America formed its committee, the National Committee on Mathematical Requirements, comprised of mathematicians, prominent teachers, and school system administrators (Klein, 2003). The comprehensive report provided by the committee, *The Reorganization of Mathematics for Secondary Education*, often referred to as the *1923 Report*, included a survey of school curricula, records on the training mathematics teachers received in other countries, and issues relating to the learning of mathematics (Klein, 2003). The report also "justified the study of mathematics in terms of its applications as well as its intrinsic value" (Klein, 2003, p.4). Furthermore, the new found professional organization, the National Council of Teachers of Mathematics (NCTM), established in 1920, played a significant role in disseminating the *1923 Report,* but progressivist views still influenced education and mathematics education into later decades (Klein, 2003).

Progressivist ideals were visible in the 1930s with the needs and interests of students determining school curricula, not academic subjects like mathematics and its application to the job force or industries (Klein, 2003). According to Klein (2003), the familiar mantra of the 1930s–that revisited education in the 1990s–was to say, "We teach children, not subject matter" (p. 5). Education policy and beliefs that de-emphasized subject area content created controversy in the 1940s when military recruits lacked basic arithmetic skills needed to perform necessary tasks associated with their jobs. The academic focus during this timeframe seemed to address the concern for everyday living. As the lack of preparation of military recruits became evident, advances in science and engineering highlighted the importance of mathematics knowledge for evolving technologies and influencing economies of the future (Klein, 2003).

By the 1950s, the number of high school students enrolled in mathematics courses had steadily declined. From the 1909-1910 school year to the 1954-1955 school year, the number of U.S. high school students enrolled in algebra had decreased from 57% to 25%. A similar enrollment decline was seen in geometry, dropping from 31% to 11% (Klein, 2003). During this period, disagreements in the "New Math" era centered on skill-based instruction versus mathematical understanding; nevertheless, historical events brought international mathematics achievement to the forefront of American politics. In the 1960s, the former Soviet Union's launch of an unmanned spacecraft, *Sputnik*, spurred scrutiny of mathematics and science in U.S. curriculum (Fowler, 2013; Klein, 2003; Schlechty, 2009).

Mathematics education discussions continued into the 1970s with many states implementing minimum competency tests (Klein, 2003). A debate ensued in the 1970s around fundamental skills and "open education" where students explored and decided what they wanted to learn. The differing views contributed to the steady decrease in scores on standardized tests. Scores hit bottom in the early 1980s (Klein, 2003).

In 1980, the NCTM's report, *An Agenda for Action*, was released. This report highlighted the decline in the quality of mathematics and science education and led the way for the first NCTM mathematics standards in 1989 (Klein, 2003). Another significant report on mathematics, *A Nation at Risk* (1984), was published by a commission appointed by the U.S. Secretary of Education (Klein, 2003). *A Nation at Risk* (1984) addressed critical areas of concern in mathematics education including the small number of students completing high school mathematics courses, deficits in quality teachers trained in mathematics content area (not just methodology courses), and an availability of rigorous classroom resources (Klein, 2003). By the late 1980s, policymakers and interest groups had noted the low performance of American students on international tests, stimulating investigation into what other countries were doing *right* in mathematics curriculum and instruction. The inquiry found that many countries where students were "outperforming" American students were following national curricula, whereas each state in the United States operated, and continues to function, independently with its established curriculum and standards (Fowler, 2013).

Mathematics education in the United States during the 21st century. The freedom for states to provide for public education has created challenges regarding curriculum differences and education policy. Although the federal government can impact educational decisions through funding, state governments shoulder the responsibility of educating students and provide the bulk of the funding associated with education. The federal government most often utilizes the General Welfare Clause of Article I, Section 8 of the U.S. Constitution (Alexander &

Alexander, 2011), also known as the *Spending Clause,* to give federal funds to education. Federal funds have been attached to several education initiatives over the years including the Elementary and Secondary Education Act (ESEA) of 1965. The instituting of the ESEA marked the federal government's commitment to quality and equality for students in public schools. The government reauthorized ESEA under the No Child Left Behind (NCLB) Act of 2001, which has been reauthorized once again under the title Every Student Succeeds Act (ESSA) (2015). The intent of federal involvement in education with these acts has been academic achievement for U.S. students.

States have freedom to operate independently from one another and focus on the needs of their state and local communities when deciding what to teach in schools (Fowler, 2013). States implement educational standards and practices to meet the needs of their communities. In NCLB, the U.S. Department of Education said that "student progress and achievement will be measured according to state tests and designed to match those state standards and given to every child, every year" (U.S. Department of Education, 2004). If, however, national curricula are benefiting mathematics learning in other countries, it signifies the importance of collaboration between states on curricula to support high academic achievement in mathematics. Additionally, leadership practices aiding mathematics achievement are essential (Dumay et al., 2013; Grissom et al., 2013; Robinson et al., 2008). This study will explore the educational leadership practice of observing mathematics lessons.

Attitudes toward Mathematics and Mathematics Anxiety

According to researchers, early mathematics education plays a role in building mathematics knowledge (Ball et al., 2005; Firmender et al., 2014; Hill et al., 2005; Siegler et al., 2012). Research has also shown a connection between mathematics knowledge and mathematics anxiety (Brush, 1981; Hembree, 1990). Ball et al. (2005) stated, "We are simply failing to reach reasonable standards of mathematical proficiency with most of our students, and those students become the next generation of adults" (p. 14). Less apparent in research is that people, in general, lack mathematics knowledge–perhaps due to distaste for the subject and/or intimidation by the content itself. Several studies support the prevalence of a fear of mathematics or any association with mathematics (Brush, 1981; Hembree, 1990; McLeod, 1994). Researchers refer to this fear as *mathematics anxiety* (Brush, 1981; Hembree, 1990; Richardson & Suinn, 1972).

There are variations to the definition of mathematics anxiety. However, this study defined mathematics anxiety as the lack of comfort, including feelings of tension, helplessness, and mental disorganization one might experience when required to manipulate numbers and shapes or perform mathematically in a given situation (Richardson & Suinn, 1972; Tobias, 1978; Wood, 1988).

In educational research, the prevalent studies on anxiety center on test anxiety and mathematics anxiety. Some researchers have viewed the two as highly related citing a somewhat causal relationship between them; mathematics anxiety creates test anxiety and vice versa (Hembree, 1990). According to Brush (1981), researchers described mathematics anxiety as nothing more than subject-specific test anxiety. Whatever the connection, mathematics anxiety has affected course participation at the secondary level, choice of college major, and choice of career path (Brush, 1981; Hadley & Dorward, 2011; Hembree, 1990).

Statement of the Problem

Facilitating learning that promotes problem-solving in a variety of situations and thinking through mathematical challenges has become more of a necessity with ever-growing technology and interlinking global economies. Mathematics achievement in the United States is a focus in education and among stakeholders (Fowler, 2013). Business and economic growth in the United States is somewhat dependent upon our school system (Fowler, 2013; Schlechty, 2009) and content curricula that provide appropriate opportunities for students to develop mathematical and critical thinking skills (Tienken & Mullen, 2015) for growing our country. Achievement data on global, national, and state assessments continue to spur dialogue among educators and policymakers. Globally, only 7% of U.S. students reached the highest benchmark level on a common international comparison assessment, Trends in International Mathematics and Science Study (TIMSS); Forty-three percent of Singapore's students reached the highest benchmark level (Mullis, Martin, Foy, & Arora, 2012). Nationally, only five states met proficient scores on the National Assessment of Educational Progress (NAEP) assessment in fourth-grade mathematics; Thirty-eight states were at the *below basic* level on the NAEP mathematics assessment in eighth grade (NCES, 2015). According to the National Mathematics Advisory Panel (2008), mathematics education is correlated with the completion of college as well as having an earning potential in the top quartile of employment income. Finding strategies and practices that promote increased mathematics achievement continues to be an emphasis in educational research (Ball et al., 2005; Dumay et al., 2013; Robinson et al., 2008; Walker & Slear, 2011).

Purpose of the Study

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. The independent variable, attitude toward mathematics, was defined as the scale score determined by the Fennema-Sherman Mathematics Attitude Scales-Teacher (FSMAS-T) instrument (Ren, Green, & Smith, 2016). The dependent variable, the frequency of classroom observations of mathematics lessons, was obtained from the number of mathematics classroom lessons observed during formal classroom observations and informal classroom walk-through observations as self-reported by participants in the study for the 2015-2016 school year (SY).

Significance of the Study

Improving the mathematics achievement of the students we serve is a purpose of education (Stigler & Hiebert, 2009). Policymakers and other education stakeholders monitor and compare mathematics achievement among students globally, nationally, and within individual states, like Virginia (ESSA, 2015; Fowler, 2013; Mullen, 2015, Tienken & Mullen, 2015). This study is significant because it:

- provides evidence regarding the relationship between the instructional leadership practice of conducting classroom observations and attitude toward mathematics for elementary school administrators;
- provides information for educational leaders regarding factors for consideration in the staff development of elementary school leaders;
- provides a connection between attitude toward mathematics and its influence on instructional leadership practices that can be carried over to other content areas within schools;
- provides state and central office leadership teams with data about how the lack of comfort with subjects or content areas may lead to avoidance behaviors by school leaders that potentially impact student achievement; and

- provides central office leadership with insights for consideration when seeking to match school needs with the right school leader.

The importance of providing educational leaders with research to support instructional leadership practices is vital in aiding student achievement in mathematics. This significance is demonstrated in the following discussion of mathematics achievement globally, nationally, and at the state level. The comparison of student achievement in mathematics with other countries and among states provided the need for this study exploring the instructional leadership practice of observing mathematics lessons and attitude toward mathematics.

Global comparisons of mathematics achievement. Two assessments are commonly used to measure and compare international student performance in mathematics: 1) The Programme for International Student Assessment (PISA), and 2) Trends in International Mathematics and Science Study (TIMSS). However, comparing international students' test results of the PISA and TIMSS may not be an accurate reflection of students' overall abilities to apply mathematics outside of the classroom. In fact, Tienken and Mullen's (2015) rankings of G20 countries (the 20 major economies in the world) on the PISA and TIMSS assessments did not align with rankings on indices of creativity, innovation, and entrepreneurship analyzed in the study.

The PISA worldwide assessment is used to measure mathematics achievement globally. Data collected from this assessment are used to make comparisons about mathematics performance and motivate decisions in education policy (Fowler, 2013; Mullen, 2015; Tienken & Mullen, 2015). The PISA assessment, administered by the Organisation for Economic Co-operation and Development (OECD), contained 34 member countries and 31 partner countries during the 2012 administration and 72 participating countries and economies during the 2015 administration, and measured 15-year-old student performance in mathematics, science, and reading (OECD, 2013, 2016). The U.S. mean score in mathematics was 10 points below the OECD mean score in 2012 and 20 points below the OECD mean score in 2015 (OECD, 2013, 2016). The mathematics performance of U.S. students has declined in this global picture.

Another common global assessment measuring mathematics performance is the TIMSS. The TIMSS measures mathematics and science performance of fourth graders and/or eighth graders (according to how countries elect to participate). Participation in the most recent published results of TIMSS included 63 countries and 14 benchmarking entities–regional jurisdictions of countries, such as states (Mullis et al., 2012). The top five performing countries in mathematics at both the fourth and eighth grade level of the assessment were the same, although the ranking of the countries varied at the different grade levels. The top performing countries included Singapore, Republic of Korea, Hong Kong SAR (Special Administrative Region), Chinese Taipei, and Japan (Mullis et al., 2012). The United States did place in the top 10 of the participating countries and benchmarking entities but was significantly lower than the noted top performing countries (Mullis et al., 2012).

Mathematics achievement in the United States. The need to evaluate how U.S. students are performing is not limited to international comparisons. To better compare student performance by state, the National Center for Education Statistics (NCES) has published periodic reports utilizing the NAEP as the standard measure for weighing proficiency in reading and mathematics in fourth grade and eighth grade (NCES, 2015). In addition to the NCES' analysis of NAEP data, legislation has provided financial incentives for state participation in NAEP testing to help ensure data are available for comparison among states' student performance. The involvement of all states is significant in that it provides multiple data sets utilizing a common metric for comparing state standards and student achievement, thereby aiding educational decision making.

Mathematics education in Virginia. Making use of the mathematics standards from NCTM, the Common Core State Standards (CCSS) initiative, often referred to as *Common Core*, has sought to implement a common curriculum in mathematics and English language arts/literacy in the United States (http://www.corestandards.org). Although Virginia did not adopt Common Core mathematics standards, it recognized the value in emphasizing mathematical thinking over processes and procedures, much like the emphasis of NCTM (1989, 1991, 1995, 2000). The last two revisions of the Mathematics Standards of Learning (SOL) by the Virginia Department of Education (VDOE) have implemented mathematical process goals including mathematical representations, mathematical connections, mathematical reasoning, mathematical problem solving, and mathematical communication (VDOE, 2009, 2016). Additionally, the VDOE's Mathematics SOL are aligned with Common Core standards in mathematical content although the concepts or specific mathematical skills may develop at different grade levels by the curricula (VDOE, 2011). The most recent revisions, 2016 standards, will be fully implemented during the 2018-2019 SY (VDOE, 2016). Whereas a goal of the 2009 revisions was to increase the rigor of mathematics curriculum at all grade levels (Wallinger, 2012), the new 2016 Mathematics SOL continue to incorporate a rigorous curriculum while also strengthening the vertical development of mathematics content throughout the K-12 curriculum (Bolling, 2015).

Another goal of the 2009 mathematics standards was to align Virginia Mathematics SOL with CCSS. Although Common Core and Virginia curricula do not address mathematics content in the same grade levels and/or courses, Virginia's standards include all mathematical understandings associated with Common Core mathematics (VDOE, 2011). The new 2016 Mathematics SOL continue to align with Common Core in curriculum content (VDOE, 2016).

Studies have indicated a relationship between mathematics instruction and student achievement in mathematics. Bruce, Esmonde, Ross, Dookie, and Beatty's (2010) research centered on professional learning with an emphasis on mathematics communication and problem-solving and the effect these instructional practices had on mathematics achievement. Although the focal point of the study was connecting professional development practices and teacher efficacy, the importance of quality mathematics instruction incorporating NCTM process standards was part of the methodology (Bruce et al., 2010). Likewise, Golafshani (2013) and Firmender et al. (2014) supported NCTM (2000) process standards and VDOE (2009) process goals in their research. Both studies illustrated that mathematics instruction incorporating process standards and goals have a positive impact on student achievement in mathematics (Firmender et al., 2014; Golafshani, 2013). Instructional leaders observe classrooms and support mathematics curriculum standards that include more than just skills and procedures. Mathematics instruction taking place in classrooms has an influence on student achievement (Firmender et al., 2014; Golafshani, 2013), which provided support for this study investigating the classroom observation facet of instructional leadership.

In addition to revising its mathematics standards, Virginia also implemented changes in the assessments used to measure student achievement. All core content area assessments in Virginia now include multiple choice items and technology-enhanced items (TEI). The TEI provide opportunities for students to demonstrate mastery of content through fill-in-the-blank, matching, graphical manipulations, and multiple response questions (http://www.doe.virginia.gov/testing/). Furthermore, beginning with the spring 2015 assessment cycle, the Grade 6 Mathematics SOL assessment incorporated computer-adaptive testing (CAT).

The CAT format, designed to assess the individual student, was implemented at additional grade levels in mathematics during the 2015-2016 SY (Staples, 2015, 2016).

Justification of the Study

Views regarding mathematics performance appear to be cyclical based on political input (Klein, 2003), the awareness level of stakeholders (Fowler, 2013), and changing mathematics standards (Mullis et al., 2012; NAEP, 2010; OECD, 2013). Ever-changing technology has increased the need for critical-thinking and problem-solving skills in students (Ball et al., 2005) to ensure U.S. competitiveness in global economies (Fowler, 2013; Schlechty, 2009). These skills are essential components in mathematics curricula (Ball et al., 2005; NCTM, 1989, 1995, 2000; VDOE, 2009); instructional leadership practices include classroom observations to monitor and improve lesson delivery aimed at promoting student achievement (Archer et al., 2016, Fox, 2014; Khachatryan, 2015).

Previous researchers have supported the significance of research-based strategies in instruction (Hattie, 1992; Marzano, 2007; Seidel & Shavelson, 2007). As instructional leaders in school buildings, principal observations of classrooms help "identify effective and ineffective teachers, recognize strengths and weaknesses in instructional practice and provide differentiated professional growth opportunities, which lead to increasingly effective instruction" (Fox, 2014, p. 28). Further investigation of classroom observations and outcomes will add to the body of research available for practitioners.

Aside from the leadership practice of conducting classroom observations, attitude toward mathematics and its anxiety also effects job and career decisions (Hembree, 1990; Ball et al., 2005). Mathematics anxiety enhances avoidance motivation in persons. School administrators with higher levels of mathematics anxiety may be more susceptible to avoiding job-related responsibilities–such as classroom observations of mathematics lessons. After a thorough review of available research, the researcher found no studies completed on the potential relationship between mathematics anxiety or attitudes toward mathematics of administrators and classroom observations. This research was conducted to help expand the knowledge of how principal instructional leadership practices influence student achievement by investigating the possible relationship between attitude toward mathematics and the frequency of classroom observations for mathematics lessons.

Research Questions

Understanding the connection between attitude toward mathematics–including its connection with mathematics anxiety–and the instructional leadership of elementary school administrators provides education leaders with a foundation to aid future decision making. This study sought to answer the following questions to assist leaders in understanding the relationship between attitude toward mathematics and instructional leadership practices of elementary school administrators:

1. What is the academic background in mathematics of elementary school administrators?
2. What is the attitude toward mathematics of elementary school administrators?
3. What is the frequency of classroom observations of mathematics lessons by elementary school administrators?
4. What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

Conceptual Framework

This study explored how the theory of approach-avoidance motivation behaviors can be applied to school leadership. Several fields of research have used approach-avoidance motivation, including the study of pleasure and pain in psychology (Elliott, 2006). The theory indicates that behaviors are influenced by positive and negative stimuli; simply, people avoid things that are uncomfortable or bring about negative feelings and approach things that they are comfortable with or bring about positive feelings (Elliott, 2006). As applied to this study, approach-avoidance motivation held that a conjecture could be made that an elementary school administrator's attitude toward mathematics–including its connection to mathematics anxiety–could influence the frequency of classroom observations of mathematics lessons. According to avoidance motivation, people strive to reduce fear levels by avoiding stimuli relating to the fear. This study investigated whether the attitude toward mathematics and its associated mathematics anxiety influence the avoidance of administrative/instructional tasks, specifically classroom observations, have a connection to mathematics.

As instructional leaders, school administrators are responsible for conducting classroom observations, documenting instruction, and providing feedback to teachers to improve instruction (Fox, 2014), thereby indirectly influencing student achievement (Eyal & Roth, 2011; Robinson et al., 2008). Approach-avoidance motivation supports that a negative attitude toward mathematics and higher levels of mathematics anxiety connected to one's attitude can lead to fewer observed mathematics lessons at the elementary school level. Lack of classroom observations would decrease the feedback provided to teachers aimed at improving mathematics instructional practices. The overall impact would be mathematics achievement for students can be negatively influenced by an administrator's attitude toward mathematics, and the associated mathematics anxiety, in instructional leadership practices by the avoidance of observing mathematics classrooms. Figure 1 represents the conceptual framework for this study illustrating the connection to approach-avoidance motivation.

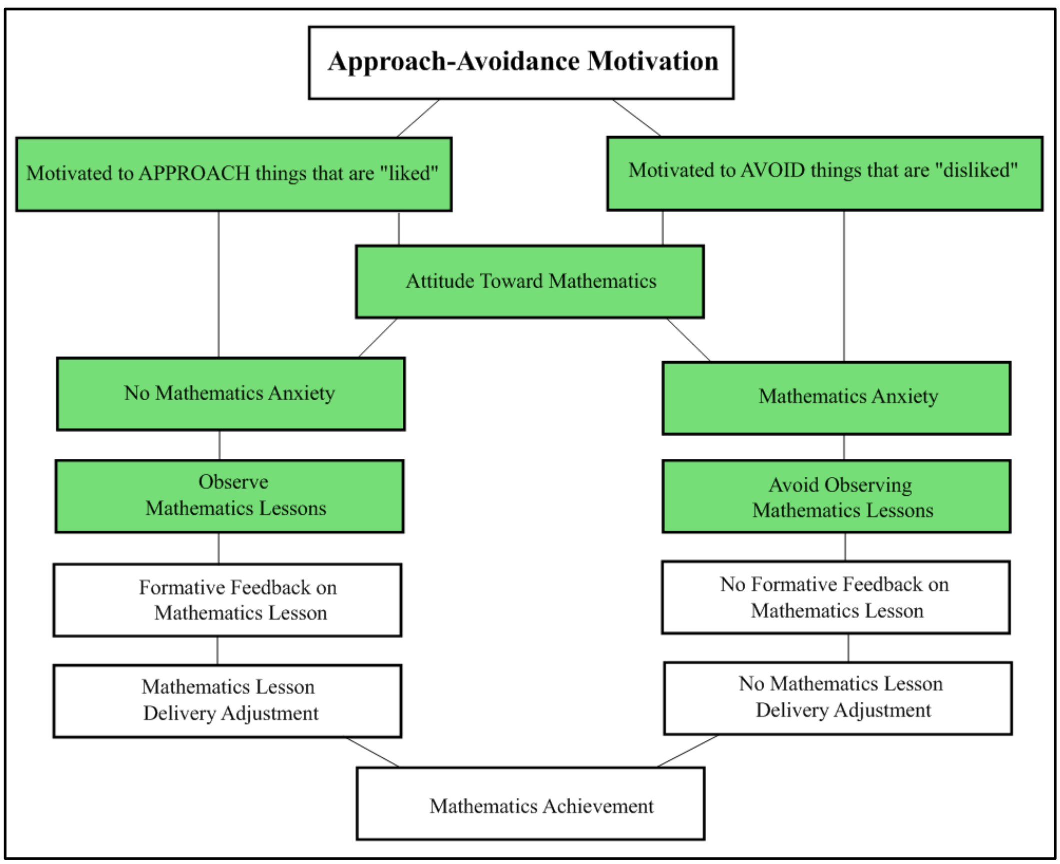

Figure 1. Conceptual Framework - Approach-Avoidance Motivation. The figure illustrates the conceptual framework connecting approach-avoidance motivation and the instructional leadership practice of observing mathematics lessons.

The relationship between approach-avoidance motivation behaviors and elementary school administrators may be influenced by the high mathematics anxiety level of elementary teachers. Studies have found elevated levels of mathematics anxiety or less positive attitudes toward mathematics in elementary teachers. Hembree's (1990) meta-analysis study of attitude toward mathematics and mathematics anxiety noted that elementary majors had the highest level of mathematics anxiety. Hadley and Dorward (2011) found a connection between an elementary teacher's anxiety about teaching mathematics and student achievement. Due to the knowledge of the elementary school operations, there are instances where elementary principals were previous elementary teachers. In Virginia, previous education administrative licensure regulations included requirements for teaching experience at the school level of the endorsement (C. Cordle, personal communication, December 30, 2016). Elementary teachers teach multiple content lessons (reading/language arts, social studies, science, and mathematics). Therefore, administrators at the elementary level have opportunities to observe teaching practices of individual teachers for formal evaluation and coaching in more than one content area; the avoidance of a content area could occur.

The conceptual framework illustrated in Figure 1 guided this study. The study focused on the shaded components: attitude toward mathematics, mathematics anxiety, and observing mathematics lessons. If observations of mathematics lessons are not occurring, then there is no opportunity for feedback for teachers to modify and improve instruction for students' increased achievement.

Assumptions

Assumptions are the portions of a study that are somewhat out of the researcher's control, but without these pieces, the research would be irrelevant (Roberts, 2010). This study made the following assumptions:

1. Participants would complete the survey honestly to the best of their knowledge.
2. As school-level instructional leaders, when conducting classroom observations (whether formal evaluations or informal classroom walk-through observations), teachers were provided relevant and appropriate feedback on instructional practices.
3. Feedback was followed up with specific instructional assistance to promote student achievement.

4. Instructional delivery of mathematics lessons was adjusted based on the feedback and assistance provided.
5. Student achievement was positively impacted when mathematics classrooms were observed by school administrators, feedback was provided, and adjustments to practice were made.

A potential bias could occur when respondents do not answer surveys honestly or provide answers they deem desirable for the study; a Web-based survey tool was used to decrease the potential bias (Fowler, 2009). Conducting the survey using a Web-based survey tool increased the confidential nature of participants' responses (Fowler, 2009). Anonymity and confidentiality were preserved for all participants throughout the research study. Division procedures, protocols, and professional development for administrators deliver guidelines for providing feedback to teachers after formal observations and best practices for informal observations. Each guideline has the intent of helping administrators be strong instructional leaders supporting teacher growth.

Limitations

Limitations are potential weaknesses in a study that are outside the control of the researcher (Roberts, 2010). This study had the following limitations:

1. The participant information questionnaire, observation data questionnaire, and attitude toward mathematics instrument were self-reported by elementary school administrators.
2. The sample size was small and limited the generalizability of the study; the focus of the study was only one Virginia school division.
3. The selected division has requirements for the number of minutes devoted to literacy/reading instruction and mathematics instruction. Mathematics instructions must be 60 minutes daily. Literary/reading instruction is a required 150 minutes daily. These requirements could impact the frequency of observations conducted in the content areas.

These limitations could influence study results. According to Fowler (2009), there is a potential for response bias when utilizing self-administered, self-report survey methods. The use of an online survey tool can minimize this potential validity threat by adding to the confidentiality of the respondents. This study utilized the Web-based survey tool, Qualtrics®, to administer the survey to help minimize the effects of the limitation. Additionally, according to Creswell (2014) and McMillan and Wergin (2010), although a larger sample size will limit the influence of outliers in the data, a small sample can support the generalizability of the study. The target population in this study was small with 57 elementary school administrators within the participating school division.

Delimitations

Delimitations are characteristics of the research study that limit the scope and set the boundaries for the study. Delimitations are within the control of the researcher. This study had the following delimitations:

1. Anxiety associated with mathematics was a focus of this study. This study did not include anxiety in other curricular areas.
2. Only one school division in Virginia was selected for participation in the study.
3. The 2015-2016 classroom observation data were self-reported by elementary school administrators during the study timeframe (November 2016-January 2017). No other data related to administrative time and support for classroom performance were considered.
4. The surveyed participants in this study consisted of principals and assistant principals working in school settings classified as elementary level (K-2, K-3, 3-5, and K-5) within the school division. Central office personnel who may have also contributed to classroom observations were not included.

Definition of Terms

For the purpose of this study, the following terms were identified and defined.

Approach-avoidance motivation. These motivations encompass both the energization and direction of behavior. Approach motivation is an energized behavior in a direction toward positive stimuli (objects, events, possibilities). Avoidance motivation is an energized behavior in a direction away from negative stimuli (objects, events, possibilities) (Elliott, 2006).

Classroom observation. The formal or informal observation of teaching as it is taking place in a classroom or other learning environment. *Classroom observations* are usually conducted by peer teachers, administrators, or instructional specialists to provide teachers with constructive critical feedback. The feedback is intended to assist the improvement of classroom management and instructional techniques. School administrators also regularly observe teachers as an extension of formal job-performance evaluations (Hidden Curriculum, 2014).

Effectance motivation. For the purpose of this study, *effectance motivation* refers to a scale "measure[ing] whether individuals enjoy and seek challenges regarding mathematics" (Ren et al., 2016, p. 309).

Fennema-Sherman Mathematics Attitude Scales-Teacher (FSMAS-T) instrument. Mathematics attitude scales modified from the original work of Fennema and Sherman (1976). The FSMAS-T instrument utilized three scales from the Fennema-Sherman Mathematics Attitude Scales (FSMAS) instrument–*Confidence in Learning Mathematics*, *Effectance Motivation in Mathematics*, and *Mathematics Anxiety*–and was revised for use with teachers at the elementary level by Ren et al. (2016).

Formal classroom observation. The observation of teaching as it is taking place in a classroom or other learning environment. *Formal classroom observations* are usually conducted by administrators or instructional specialists to provide teachers with constructive, critical feedback intended to assist the improvement of classroom management and instructional techniques. School administrators also conduct *formal classroom observations* regularly as an extension of job-performance evaluations (Hidden Curriculum, 2014).

Informal classroom walk-through observation. Classroom visit wherein principals or other administrators collect information about teaching practices or implementation of school initiatives to learn about teacher needs but not intended as an evaluation (David, 2007).

Instructional leadership. *Instructional leadership* refers to leadership practices with direct involvement in curricular and instructional issues that affect student achievement. According to many researchers, the instructional leadership model centers on improving instructional practice within classrooms and involves making decisions to promote student growth and achievement (Dumay et al., 2013; Robinson et al., 2008; Walker & Slear, 2011).

Mathematics anxiety. The general lack of comfort, including feelings of tension, helplessness, and mental disorganization, one might experience when required to manipulate numbers and shapes or perform mathematically in a given situation (Richardson & Suinn, 1972; Tobias, 1978; Wood, 1988).

Mathematics attitude. "A liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless" (Neale, 1969, p. 632).

School leader. School leader can be defined as a school principal, assistant principal, vice principal or other administrative position designated by school division hierarchy (Hidden Curriculum, 2014). For purposes of this study, school leader was defined as a school level principal and assistant principal.

Virginia Standards of Learning. The SOL is an assessment that establishes minimum expectations for what students should know and be able to do at the end of each grade or course in English, mathematics, science, history/social science, and other subjects taught in Virginia (VDOE, 2012).

Organization of the Study

Mathematics achievement is a relevant topic for educational research. This study analyzed literature and investigated the potential relationship between the attitude toward mathematics and the frequency of classroom observations of mathematics lessons by elementary school administrators. This study is organized into five chapters. Chapter One provides an introduction to the study, including: an overview of the study, historical perspective, attitudes toward mathematics and mathematics anxiety, statement of the problem, purpose of the study, significance of the study, justification of the study, research questions, conceptual framework, assumptions, limitations, delimitations, definition of terms, and organization of the study. Chapter Two provides a review of literature relating to the topic of this study–attitude toward mathematics and instructional leadership. This chapter includes search procedures, historical background, attitude toward mathematics and mathematics anxiety, elementary teachers' attitudes about mathematics, mathematics instruction in classrooms, elementary teachers' classroom instruction and content knowledge, principal leadership, instructional leadership, principals' mathematics content knowledge, principals' instructional leadership practices, and a literature review summary. Chapter Three explains the methodology that was used for this study. Included in the methodology are the purpose of the study, research questions, research design, research design justification, population and sample selection, instrument design and validation, procedures, data analysis techniques, and a methodology summary. Chapter Four presents the collected data of this quantitative study, which utilized a descriptive and correlational design with a survey method for collecting data. Chapter Four includes the following sections: response rate of the survey, survey population, research question 1, research question 2, research question 3, research question 4, and data summary. The reported data address the research questions guiding this study. Chapter Five discusses the findings in this study and presents conclusions drawn from the data. Chapter Five also offers suggestions and recommendations for practice and future research.

CHAPTER TWO
THE LITERATURE REVIEW

Introduction

The purpose of the literature review was to highlight research that examined the relationship between attitude toward mathematics, including related mathematics anxiety, and its impact on instructional leadership. The importance of strong educational leadership continues to play a role in successful school divisions, schools, and with students. As such, the Interstate School Leaders Licensure Consortium (ISLLC) (2008) devised standards to provide guidance on the competencies school leaders need. According to the ISLLC Standard 2, an education leader is a leader "who promotes the success of every student by advocating, nurturing, and sustaining a school culture and instructional program conducive to student learning and staff professional growth" (ISLLC, 2008, p. 3). Do school leaders need a particular skill set to effectively meet the needs of teachers and students for mathematics learning? Increased global competition has educators and policymakers looking for ways to improve mathematics skills, such as addressing instructional leadership skills associated with mathematics and overcoming the mathematics anxiety that is present in both students and adults. Students that are uncomfortable with mathematics become adults that avoid careers and professions with connections to mathematics (Ball et al., 2005; Hembree, 1990).

The reviewed literature explored the role that attitude toward mathematics and its connected mathematics anxiety play in education. The review provides connections to attitude toward mathematics and educational leadership. The topics of research examined included: attitude toward mathematics and mathematics anxiety, elementary teachers' attitudes toward mathematics, elementary teachers' content knowledge, elementary teachers' mathematics anxiety, principals' mathematics content knowledge, and principals' instructional leadership practices. In the area of principals' instructional leadership practices, research related to classroom observations and providing feedback to teachers were explored. This review sought to reinforce the need for continued research in the area of elementary school leadership and its relationship to student achievement in mathematics through instructional leadership practices–classroom observations of mathematics lessons. International competition supports the necessity of leadership practices that positively influence student mathematics achievement (Fowler, 2013; Schlechty, 2009; Tienken & Mullen, 2015).

Search Procedures

In seeking to provide a comprehensive overview of the literature on attitude toward mathematics and mathematics anxiety, in addition to elementary principal leadership as it relates to mathematics instruction and achievement, numerous search strategies were employed. An online database keyword search was the primary method used for identifying scholarly research in the area of attitude toward mathematics and mathematics anxiety in education, which included: teacher mathematics anxiety; principal mathematics anxiety; instruction and leadership; observations and feedback; and school instructional leadership practices. The Virginia Polytechnic Institute and State University library Summon search engine, in addition to Google Scholar, generated approximately 470,000 books, dissertations, journal articles, and other sources when using the terms "mathematics anxiety" and "education." That number was reduced considerably by refining the search and setting parameters for articles published in or after the year 2000. Focusing on research studies conducted in the last 15 years ensured that recent research results were used to determine areas where data are limited or areas where new studies could assist in clarifying mixed results from previously conducted research. Some seminal research was included to provide the history and background from authorities in the field to support ongoing research in the area of attitude toward mathematics, mathematics anxiety, and educational leadership.

Using the search terms, "mathematics anxiety and student achievement;" "mathematics and attitude;" "mathematics anxiety and teachers;" "elementary principals and mathematics content knowledge;" and limiting the search to articles from scholarly publications, the Summon search returned approximately 59,000 results. Searching "mathematics anxiety and principals" produced 8,756 scholarly articles and journals which were reduced to 3,378 by limiting the search to education. A review of these articles yielded no research investigating mathematics attitude and anxiety of school leaders. Finally, the reference lists and works cited in the reviewed literature were examined for inclusion in the review for this study.

Historical Background

Global comparisons of mathematics achievement. Two assessments are commonly used to measure and compare international student performance in mathematics: (a) The Programme for International Student Assessment (PISA) assesses the extent to which students have acquired and can apply mathematics, reading, and science; and (b) Trends in International Mathematics and Science Study (TIMSS) identifies achievement trends in mathematics and science. However, comparing international students' test results of the PISA and TIMSS may not be an accurate reflection of students' overall abilities to apply mathematics outside of the classroom. Tienken and Mullen's (2015) rankings of G20 countries (the 20 major economies in the world) on the PISA and TIMSS assessments did not align with rankings on indices of creativity, innovation, and entrepreneurship analyzed in the study. Despite evidence showing that assessments do not always reflect other key attributes of student achievement, these comparisons of student performance have renewed interest in U.S. curriculum decisions (Ball et al., 2005; Schlechty, 2009). Today, the interlinking of global economies and fear of China's (and other Asian countries) economic dominance (Schlechty, 2009) is once again prompting attention to mathematics education and reform (Ball et al., 2005).

The Programme for International Student Assessment (PISA). As stated, one common global assessment used to measure mathematics achievement is the PISA. Data collected from this assessment are used by governments, political groups, and companies to make comparisons about mathematics performance and motivate decisions in education policy (Fowler, 2013; Mullen, 2015; Tienken & Mullen, 2015). The PISA worldwide assessment, administered by the OECD, contained 34 member countries and 31 partner countries during the 2012 administration and 72 participating countries and economies during the 2015 administration, and measured 15-year-old student performance in mathematics, science, and reading (OECD, 2013, 2016). The data reported for the 2012 test administration showed:

> [Thirty-two percent] of students in all participating countries and economies did not reach the baseline Level 2 in the PISA mathematics assessment. At that level, students can extract relevant information from a single source and can use basic algorithms, formulae, procedures or conventions to solve problems involving whole numbers. (OECD, 2013, p. 4)

Although the United States had a 0.3 annualized change in the share of top performers in mathematics on the 2012 assessment, the U.S. mean score of 384 was 10 points below the OECD mean score of 394 (OECD, 2013). The United States increased its share of top performers in mathematics from 8.8 in 2012 to 13.3 in 2015 while decreasing its share of low performers in mathematics from 25.8 to 13.6 (OECD, 2013, 2016). Unfortunately, difference between the U.S. mean score and the OECD mean score increased on the 2015 assessment with the U.S. score dropping to 370 in 2015 from 384 in 2015 (OECD, 2013, 2016). The 370 mean score is 20 points below the OECD mean score of 390 (OECD, 2016). The data provide evidence of the need for educational practices supporting the increase of mathematics achievement rates.

Trends in Mathematics and Science Study (TIMSS). The other commonly used international assessment designed to measure mathematics performance is the TIMSS. The TIMSS measures mathematics and science performance of fourth graders and/or eighth graders (according to how countries elect to participate). The 2011 administration of TIMSS represented the fifth cycle of the assessment since 1995 and included 63 countries and 14 benchmarking entities (regional jurisdictions of countries, such as states) (Mullis et al., 2012). The top five performing countries at both the fourth and eighth grade level of the 2011 assessment were the same, although the ranking of the countries varied. The top performing countries included Singapore, Republic of Korea, Hong Kong SAR (Special Administrative Region), Chinese Taipei, and Japan (Mullis et al., 2012). The concern Americans have about lagging behind in mathematics compared to Asian countries appears to be validated by these data. However, the performance of students did place the United States among the top 10 countries or benchmarking entities participating in the assessment. Additionally, the U.S. trend data indicate increases in mathematics achievement between 1995 and 2011 for fourth and eighth-grade students. The average scale score for U.S. fourth graders increased 23 points, from 518 to 541, and the eighth graders' scale score improved 17 points, from 492 to 509 (Mullis et al., 2012).

TIMSS scale organization and benchmarks. To better understand the data from the TIMSS assessment, the scale structure and other components were considered. The TIMSS scale structure consists of scores range from 0 to 1000 with a scale center point of 500. Most students score between 300 and 700 on this scale. A key component of the TIMSS is the placement of mathematics achievement at four points along a scale of international benchmarks. As Mullis et al. (2012) reported, these benchmarks are identified as Advanced International Benchmark (625 scale score), High International Benchmark (550 scale score), Intermediate International Benchmark (475 scale score), and Low International Benchmark (400 scale score).

Fourth-grade TIMSS data. The data relating to benchmark levels indicated more countries demonstrated increases at the fourth-grade level, therefore raising the level of performance across the distribution of student achievement. Specifically, the highest performing country at the fourth-grade level, Singapore, had 43% of their students reach the Advanced International Benchmark with a score of 625 or above; this is an increase from 38% of Singapore students reaching the same benchmark level in 1995 (Mullis et al., 2012). Fourth graders attaining the Advanced International Benchmark in the United States increased from 9% in 1995 to 13% in 2011. There is a 30 point difference between the percentages of Singapore and United States students at the Advanced International Benchmark level. Overall, the top 10 countries increased the percentage of students at the Advanced International Benchmark from 0 to 20 points and the percentage of students achieving at the High International Benchmark from -1 to 24 points at the fourth grade level (Mullis et al., 2012).

Eighth-grade TIMSS data. The same increase in benchmark levels was not seen at the eighth-grade level. "At the eighth grade, clearly the East Asian countries, particularly Chinese Taipei, Singapore, and Republic of Korea, are pulling away from the rest of the world by a considerable margin" (Mullis et al., 2012, p. 10). Approximately half of their students (47-49%) reached the Advanced International Benchmark. In contrast, only 7% of U.S. eighth grade students reached the same level of performance (Mullis et al., 2012). Similarly, the United States also falls behind Asian countries when considering average score on the TIMSS.

TIMSS scale scores for U.S. students. The U.S. average scale score at fourth grade was 541 on the 2011 test administration, which was above the TIMSS center point (500 scale score). The U.S. average scale score was still considerably lower than the five top achieving countries, all of which were Asian countries. The top five countries at the fourth-grade level had average scale scores ranging from 585 to 606 (Mullis et al., 2012). Likewise, the U.S. average scale score at eighth grade was 509, which was higher than the center point but still quite lower than the top achieving countries. The highest performing countries at the eighth-grade level had average scale scores ranging from 570 to 613. Despite ranking within the top 10 countries at each assessed grade level, U.S. students' scale scores are significantly lower than the highest performers (Mullis et al., 2012).

TIMSS benchmark levels for U.S. students. According to the TIMSS benchmarks, the U.S. average scale score at both the fourth and eighth-grade levels was identified as reaching only the Intermediate International Benchmark (Mullis et al., 2012). There was a significant difference between benchmark levels of U.S. students, and the benchmark levels of students in the highest-performing countries on the TIMSS. The highest performing country at the fourth-grade level, Singapore, had 43% of their students reaching the highest benchmark level, Advanced Benchmark. In contrast, 13% of students in the United States reached the same benchmark. Similar data were evident at the eighth-grade level. Chineses Taipei had 49% of their students reaching the Advanced Benchmark whereas only 7% of U.S. students reached the same benchmark level (Mullis et al., 2012).

The comparison of TIMSS data between countries assists in validating the appeal for education reform and specific focus directed at improving mathematics achievement. The TIMSS data support the view that there is room for improvement in mathematics education, especially as U.S. education programs seek to prepare students to compete internationally in the career/job market (Schlechty, 2009). The impact a school leaders' attitude toward mathematics has on mathematics achievement is an area where further research is needed.

Background of mathematics education in the United States. Mathematics education has followed a cyclical pattern in the United States for the past 75 years as the emphasis on mathematics learning and achievement has been affected by political trends (Klein, 2003). The former Soviet Union's launch of the unmanned spacecraft, *Sputnik,* sparked a renewed interest in America's investment in mathematics and science instruction in the 1960s to stay competitive and dominant in world economies and politics. America once feared being outperformed by the former Soviet Union; higher scores on mathematical assessments by Asian countries have reignited discussions about mathematics leadership, curriculum, and instruction in the United States to maintain viability in global economies (Schlechty, 2009).

National Assessment of Educational Progress (NAEP). The need to evaluate how U.S. students are performing is not limited to international comparisons. In the United States, the 2001 reauthorization of the ESEA of 1965 allowed states to develop assessments and proficiency standards to measure student achievement. States were mandated to define what was required for a student to be labeled *basic* or *proficient* for curriculum standards (NCES, 2015). As a result, this created considerable variation among states in both standards and assessments.

Individual state standards and cut scores (the score distinguishing proficiency on the state assessment) made determining proficiency between states difficult. There has been uncertainty as to whether a student meeting proficiency standards in one state would be able to meet the proficiency standards set in another state for the same course (i.e., Algebra I). The lack of uniformity across state standards and assessments has made it difficult to compare state education programs by only considering the percentages of students meeting state proficient standards (NCES, 2015).

To assist in comparing student performance by state, the NCES has published periodic reports utilizing the NAEP as the common measure for weighing proficiency in reading and mathematics in fourth and eighth grade (NCES, 2015). In addition to the NCES' analysis of NAEP data, legislation has provided financial incentives for state participation in NAEP testing to help ensure data are available to compare student performance among states with different curriculum standards and assessments. In all,

> A significant change to state NAEP occurred in 2001 with the reauthorization of the Elementary and Secondary Education Act legislation. This legislation requires states who receive Title I funding to participate in state NAEP in reading and mathematics at grades 4 and 8 every two years. State participation in other state NAEP subjects, science and writing, remain voluntary. (NAEP, 2010. p.1)

Participation in NAEP testing increased after legislation revisions impacting funding. All states participated in NAEP testing during the 2003, 2005, 2008, and 2011 cycles (NAEP, 2010). The participation of all states in recent testing cycles is important in that it provides multiple data sets utilizing a common metric for comparison between state standards and student performance.

NAEP mapping and scale. The most recent NAEP assessment was administered in 2013. Utilizing NAEP data and state assessment data, NCES has mapped state standards onto the NAEP scale. The NCES has connected the NAEP score that corresponds to states' standards by "direct application of equipercentile mapping" (NCES, 2015, p. 3). This mapping methodology allows for percentages of students performing at proficient levels on state assessments to be matched to the NAEP achievement scale (ranging from 0-500) corresponding to that percentage. This score is referred to as the NAEP equivalent scale score (NCES, 2015).

Fourth-grade NAEP data. For the 2013 assessment, the cut scores for the basic and proficient level for the NAEP equivalent scale score at fourth grade were 214 and 249, respectively. Forty-two states scored at the basic level in fourth grade, including Virginia. Virginia's equivalent scale score was 226. Scores for states surrounding Virginia include Delaware, 225; Maryland, 208; North Carolina, 248; and, West Virginia, 241. The reported data indicated five states as proficient (Massachusetts, North Carolina (248 [±2 standard errors], New York, Texas, and Wisconsin) and four states (Alabama, Georgia, Maryland, and Idaho) scoring below basic (NCES, 2015).

Eighth-grade NAEP data. For the 2013 assessment, there was a different cut score on the equivalent scale at the eighth-grade level; the basic cut score was 262 and a proficient cut score was 299. The mapping study indicated that Virginia and California were not included, citing they did not assess general mathematics in eighth grade (NCES, 2015). Scores for states around Virginia include Delaware, 261; Maryland, 269; North Carolina, 302; and, West Virginia, 281. Overall, 38 states were at the basic level. North Carolina, Texas, and New York were the three states scoring at or above proficient. Eight states (Alabama, Connecticut, District of Columbia, Georgia, Idaho, Indiana, Mississippi, and Ohio) fell below the basic level (NCES, 2015). In all, the NAEP equivalent scale score provides the common metric for comparison of student performance in mathematics between states. This common metric provides stakeholders and policymakers with information for educational decision making.

NAEP trends and summary. Despite underperformance in comparison to other countries, mathematics achievement in the United States is on an upward trend according to NAEP data. The data from NAEP assessments indicate that states continue to make small gains in mathematics performance. According to the NCES (2015) mapping study, the highest NAEP equivalent scale score in fourth-grade mathematics increased from 255 in 2009 to 256 in 2013. The scale scores exceeded the established proficient cut score of 249 at the fourth-grade level. Although an increase was also seen in the lowest equivalent scale score at the fourth-grade level, from 196 in 2009 to 207 in 2013, these scores do not meet the identified cut score for basic performance (NCES, 2015). However, at this grade level, the number of states scoring in the proficient range in mathematics increased from one in 2009 to five in 2013 (NCES, 2015).

Similar trends were seen in eighth-grade mathematics. The NCES (2015) mapping study showed an increase of the highest NAEP equivalent scale score for eighth grade from 300 in

2009 to 304 in 2013, both of which were above the proficient cut score of 299. Like fourth grade, the lowest NAEP equivalent scale score in eighth grade also increased, rising from 229 in 2009 to 244 in 2013. Unfortunately, neither of these scores met nor exceeded the cut score of 299 at the basic performance level for eighth grade. The number of states at the proficient level in eighth grade did increase from one in 2009 to three in 2013 (NCES, 2015). Collectively, the data demonstrated growth in student mathematics performance within the United States but also indicate the need for continued refinement of practices to positively impact mathematics achievement. The relationship between an elementary principals' mathematics attitude and instructional leadership in mathematics may provide new information for improving student achievement.

Mathematics curriculum. Different state curricula along with disparities among student performance within states have increased conversations about reforming mathematics curriculum (Mullen, 2015) and instructional practices aligning mathematics curricula across the United States. Professional organizations like NCTM continue to emphasize critical thinking and mathematical problem solving (over skills and procedures alone) in mathematics instruction and have provided fuel for policy discussions about mathematics curriculum (NCTM, 1989, 1991, 1995, 2000). Making use of the mathematics standards from NCTM, Common Core has sought to implement a common curriculum in mathematics and English language arts/literacy in the United States (http://www.corestandards.org). The majority of states have adopted the Common Core mathematics curriculum, but others, like Virginia, have not. Since the initial implementation of the Common Core mathematics curriculum, some states have repealed the legislation associated with CCSS (Education Week, 2015). There are several reasons for the repeal of Common Core by states including the lack of planning for professional development needs of teachers and staff, which led to poor implementation of the standards and assessment process (Education Week, 2015).

Mathematics education in Virginia. Although Virginia did not adopt Common Core mathematics standards, the state has independently recognized the value in emphasizing mathematical thinking over processes and procedures. Virginia has defended its decision to not adopt the Common Core mathematics curriculum. According to the VDOE (2011), the 2009 revisions to the Mathematics SOL provided the same rigor in mathematics as CCSS. Additionally, the VDOE's Mathematics SOL are aligned with Common Core in mathematical content although the concepts or specific mathematical skills may be developed at different grade levels by the curricula (VDOE, 2011).

Virginia Standards of Learning mathematics curriculum. Mathematical process goals are included in the VDOE Mathematics SOL at all grade levels and courses. There are five process goals stated: mathematical representations, mathematical connections, mathematical reasoning, mathematical problem solving, and mathematical communication (VDOE, 2009). The process goals emphasize the incorporation of critical thinking into the curriculum through real-world applications to provide students with opportunities to expand and connect mathematical thinking and understanding to other subject areas.

Instructional practices that include lessons focused on problem solving, communication, reasoning, representations, and connections a focus of the NCTM (2000) process standards and the VDOE (2009) mathematics process goals. Mathematics instruction has a connection to mathematics student achievement. The research of Bruce et al. (2010) focused on professional learning, with an emphasis on mathematical communication and problem solving. The research examined the effect instructional practices that integrate mathematical communication and problem solving had on mathematics achievement. Although the focal point of the study was connecting professional development practices and teacher efficacy, the importance of quality mathematics instruction incorporating NCTM process standards was part of the research methodology (Bruce et al., 2010). Likewise, Golafshani's (2013) study utilizing manipulatives in instruction and the research of Firmender et al. (2014) integrating mathematics communication and vocabulary in mathematics instruction support NCTM (2000) process standards and VDOE (2009) mathematics process goals. Both studies illustrated that mathematics instruction incorporating process standards and goals have a positive impact on student achievement (Firmender et al., 2014; Golafshani, 2013). Instructional leaders are tasked with observing and supporting mathematics curriculum standards, which encompass mathematical processes and critical thinking.

Virginia Standards of Learning assessment. The Virginia Mathematics SOL recently went through another revision process although full implementation of the new standards will not take place until the 2018-2019 SY (VDOE, 2016). Whereas a goal of the 2009 revisions was to increase the rigor of mathematics curriculum at all grade levels (Wallinger, 2012), the new 2016 Mathematics SOL continue to incorporate a rigorous curriculum while also strengthening the vertical development of mathematics content throughout the K-12 curriculum (Bolling, 2015).

Another goal of the 2009 mathematics standards was to align Virginia Mathematics SOL with CCSS. Although Common Core and Virginia curricula do not address mathematics content in the same grade levels and/or courses, Virginia's standards include all mathematical understandings associated with Common Core mathematics (VDOE, 2011). The new 2016 Mathematics SOL continue to align with Common Core in curriculum content (VDOE, 2016).

In addition to revising its mathematics standards, Virginia has also implemented changes in the assessments used to measure student achievement. All core content area assessments in Virginia now include multiple choice items and technology-enhanced items (TEI). The TEI provide opportunities for students to demonstrate mastery of content through fill-in-the-blank, matching, graphical manipulations, and multiple response questions. Additionally, beginning with the spring 2015 assessment cycle, the Grade 6 Mathematics SOL assessment incorporated computer-adaptive testing (CAT) (Staples, 2015). The CAT format, designed to assess individual students, began implementation at the third, seventh, and eighth-grade levels in mathematics during the 2015-2016 SY (Staples, 2015, 2016).

Attitude toward Mathematics and Mathematics Anxiety

Confidence with numeracy and computation has a role in the attitude one has about mathematics and mathematics growth (Siegler et al., 2012). Many people openly admit to a dislike or lack of comfort with the subject. This attitude toward mathematics can have an impact on life decisions such as coursework attempted in high school or college, job opportunities and career choices, and even daily activities (Brush, 1981; Hadley & Dorward, 2011; Hembree, 1990). Neale (1969) describes mathematics attitude as a liking or disliking of the subject that affects a person's tendency to participate in or avoid mathematical activities. This attitude is also connected to one's belief in their ability or inability to do mathematical tasks and whether they see a usefulness for mathematics (Neale, 1969).

One's attitude about mathematics may impact anxiety associated with the subject. Mathematics anxiety is defined as a general lack of comfort, including feelings of tension, helplessness, and mental disorganization, one might experience when required to manipulate numbers and shapes or perform mathematically in a given situation (Richardson & Suinn, 1972;

Tobias, 1978; Wood, 1988). Hembree (1990) found a negative correlation between positive attitudes toward mathematics and lower mathematics anxiety; a better attitude about mathematics was related to lower levels of anxiety with the subject.

Understanding the impact of mathematics anxiety reaches beyond K-12 education. Mathematics anxiety can have a large impact on life decisions. It affects productivity as a nation "when otherwise capable students avoid the study of mathematics, their options regarding careers are reduced, eroding the country's resource base in science and technology" (Hembree, 1990, p. 34). The NCTM (2000) has made similar declarations stating, "[T]hose who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures" (p. 5). Understanding mathematics is essential for increasing opportunities for adults in the workforce (Hembree, 1990; NCTM, 2000) and aiding the United States' ability to grow economically in ever-changing science and technology sectors (Schlechty, 2009).

Research has found mathematics anxiety has a negative impact on mathematics achievement. In Hembree's (1990) meta-analysis, 151 studies were reviewed. One purpose of Hembree's (1990) study was to investigate the causal relationship between mathematics anxiety and mathematics performance (as measured by student achievement subsets relating to computation, concepts, problem solving, abstract reasoning, spatial ability, and grades in mathematics courses). The mean correlation or effect size was utilized for the comparison among the analyzed studies. Hembree (1990) reported findings of high levels of mathematics anxiety correlating with lower mathematics achievement. The correlation between mathematics anxiety and the subtests for mathematics performance were statistically significant, $p < .01$, ranging from $r = -.25$ to $r = -.30$. Although some studies examined in the meta-analysis spanned multiple grade levels, only two included studies investigating mathematics anxiety at the elementary level (grades 1-5); the studies were at the third and fifth-grade levels (Hembree, 1990). The body of research relating to mathematics anxiety and student performance has largely considered secondary levels (grades 6-12 and postsecondary) over elementary levels (grades K-5). Further research is needed in elementary grade in pursuit of increasing students' mathematics achievement. Hembree (1990) posits mathematics anxiety as a learned behavior over a cognitive nature. Mathematics anxiety as a learned behavior could support educational leadership accentuating positive attitudes toward mathematics, in general, being beneficial to the improved performance of students in mathematics.

There were similar findings in Ma's (1999) meta-analysis examining mathematics anxiety. The study reported a negative population correlation between mathematics anxiety and mathematics achievement, $R = -.27$, $p < .01$. Again, the relationship between increased mathematics anxiety and decreased mathematics performance was apparent (Hembree, 1990; Ma, 1999). Knowledge of how mathematics anxiety impacts student mathematics performance can provide vital information to education leaders. These findings suggest the need for more research examining the relationship between mathematics anxiety, school leadership, and leadership practices.

Elementary Teachers' Attitudes about Mathematics and Mathematics Anxiety

Elementary education majors have consistently shown one of the highest levels of mathematics anxiety in studies (Hadley & Dorward, 2011; Hembree, 1990; Kelly & Tomhave, 1985). According to Hembree's (1990) meta-analysis of studies relating to attitude toward mathematics and mathematics anxiety, elementary education majors had the highest mean scale score for level of anxiety relating to mathematics, 219.2, compared to other college majors (math/science, 166.5; business, 187.8; social sciences, 190.3; health sciences, 187.5; physical sciences, 149.4; and humanities, 198.5). Additionally, a higher mean scale score for mathematics anxiety levels was noted for students taking college mathematics courses targeted for elementary teachers (i.e., mathematics for elementary teachers) over other mathematics courses, even developmental mathematics, and remedial algebra. The mean scale score for mathematics anxiety level for mathematics for elementary teachers courses was 243.0 whereas developmental mathematics and remedial algebra courses had scale scores of 236.3 and 206.1, respectively (Hembree, 1990). These data indicate that preservice elementary teachers exhibited high levels of anxiety associated with mathematics.

In a study conducted by Peker and Ertekin (2011), mathematics anxiety data were collected in surveys completed by 316 preservice teachers. Peker's (2006, as cited by Peker & Ertekin, 2011) Mathematics Teaching Anxiety Scale (MATAS) and the Mathematics Anxiety Scale (MAS) developed by Erktin, Donmez, and Ozel (2006, as cited by Peker & Ertekin, 2011) were the instruments used to collect and measure mathematics anxiety. Using a five-point Likert scale, the MATAS consists of four factors: anxiety caused by content knowledge, anxiety caused by self-confidence, anxiety caused by attitude towards teaching mathematics, and anxiety caused by methodological knowledge (Peker, 2006, as cited in Peker & Ertekin, 2011). The MAS also measures four factors: mathematics test and evaluation anxiety, anxiety towards mathematics lessons, mathematics in daily life, and self-confidence in mathematics (Erktin et al., 2006, as cited by Peker & Ertekin, 2011). Statistically significant correlations were found between all four factors of the MATAS and MAS, ranging from $r = .177$ (anxiety caused by methodological knowledge and self-confidence in mathematics) to $r = .396$ (anxiety caused by self-confidence and anxiety towards the mathematics lesson) (Peker & Ertekin, 2011). A stronger correlation was calculated between the MATAS total scores and MAS total scores, $r = .46$, $p < .001$ (Peker & Ertekin, 2011). In other words, when teachers' mathematics anxiety increased so did their anxiety about teaching mathematics. Conversely, lower levels of anxiety about teaching mathematics relate to lower levels of mathematics anxiety in general.

Research by Hadley and Dorward (2011) also investigated mathematics anxiety of teachers at the elementary level and had similar findings. Lack of comfort with mathematics has the potential to increase anxiousness in people. Hadley and Dorward (2011) investigated the relationship between elementary teachers' anxiety about mathematics, anxiety about teaching mathematics, student mathematics achievement, and classroom mathematics instructional practices in a correlational analysis. Study results indicated a positive relationship between anxiety about mathematics and anxiety about teaching mathematics, $r = .42$, $p < .001$. Elementary teachers ($N = 692$) demonstrating lower levels of mathematics anxiety were less anxious about teaching mathematics (Hadley & Dorward, 2011). Additionally, the research indicated that anxiety about teaching mathematics impacts student achievement. A weak, but statistically significant relationship, was found between increased student achievement and lower levels of anxiety relating to mathematics teaching, $r = -.09$, $p < .05$; however, no relationship was found between mathematics anxiety, in general, and student achievement (Hadley & Dorward, 2011). These outcomes suggest that when teachers are comfortable teaching mathematics, students can achieve higher levels regardless of a teacher's overall comfort level with the content area.

Mathematics Instruction in Classrooms

Mathematics plays a role in the success of schools. Until recently, much of the research regarding mathematics instruction has focused more heavily on teachers than administrators.

Researchers have begun to direct attention to the relationship between principals and teachers concerning views on mathematics instruction (Dumay et al., 2013; Robinson et al., 2008; Schoen, 2010; Walker & Slear, 2011). The current research in this area is growing but still very limited.

Elementary Teachers' Classroom Instruction and Content Knowledge

Classroom instruction. Instructional practices at the elementary level are essential to achievement as students grow in their mathematical knowledge and understanding. In a study conducted at lower elementary grade levels, Firmender et al. (2014) found instruction focused on mathematical communication and vocabulary provided a benefit to students' overall mathematical understanding. The study reported that the inclusion of verbal communication and mathematical language into instructional practices was a statistically significant predictor for increases in student achievement outcomes in kindergarten, first grade, and second grade (Firmender et al., 2014).

Similarly, research conducted by Siegler et al. (2012) sought to connect previous theories of mathematical growth associated with number sense by Siegler, Thompson, and Schneider (2011) and Case and Okamoto (1996). The research focused on numerical development related to magnitudes of numbers (Siegler et al., 2011). Case and Okamoto's (1996) study was directed at numerical development associated with properties of whole numbers, such as numbers not decreasing with addition and multiplication, that are not true with numbers in general and rational numbers specifically. Properties of numbers are common misconceptions by students; they mistakenly believe that all numbers behave as whole numbers when mathematical operations are applied, especially fractions. This absence of depth of understanding relating to rational numbers hinders learning in more complex mathematics (Case & Okamoto, 1996).

Siegler et al. (2012) found that a predictive relationship exists between the understanding of fractions and division at the elementary level and later success in mathematics at the secondary level. The study showed a strong correlation between the knowledge and understanding of 10- to 12-year-old students and high school mathematics achievement. When other factors of growth were statistically controlled (i.e., child's intellectual ability, age, family income, family size, and social class of parents and highest level of education of parents), the longitudinal data sets utilized in the study indicated a strong correlation between knowledge of fractions and overall mathematics achievement in later years in both Britain (U.K.) and the U.S., $r = .81$ and $r = .87$, respectively (Siegler et al., 2012). The research asserts, "elementary school students' knowledge of fractions and division predicts their mathematics achievement in high school, above and beyond the contributions of whole number arithmetic knowledge, verbal and non-verbal IQ, working memory, and family education and income" (p. 10) for both lower and higher achieving students (Siegler et al., 2012). In all, mathematics understanding at the elementary level has been found to play a fundamental role in mathematics achievement.

Moseley, Okamoto, and Ishida (2007) found that many U.S. elementary and middle school teachers were unable to provide an explanation for why the algorithm of inverting and multiplying was a reasonable procedure for dividing fractions; whereas most teachers in Japan and China could provide more than one justification to the same question. Moseley et al. (2007) propose that elementary teachers need a firm conceptual understanding of essential mathematical concepts, like fractions and division, and mathematical instructional leadership to increase student achievement. Collectively, research indicates that instructional emphasis affects student achievement in mathematics. The research provides evidence of the importance of mathematics instruction and learning at the elementary level (Firmender et al., 2014; Moseley et al., 2007; Siegler et al., 2012).

Content knowledge. Foundational concepts and learning practices established at early ages impact mathematical learning in secondary settings and have a positive effect on future learning (OECD, 2013; Siegler et al., 2012). Therefore, it is important that students grasp basic mathematical concepts at the elementary level to succeed in complex mathematics in later, advanced mathematics courses (Siegler et al., 2012). While studies such as Williams (2010) and Schoen (2010) sought to understand the role that principals' mathematics content knowledge or perceptions play in student achievement, other studies examined teacher content knowledge. A discerning fact is that several studies over the last 15 years have revealed that teachers responsible for the mathematical learning of students are lacking mathematical content knowledge themselves (Ball et al., 2005; Ma, 1999; Moseley et al., 2007).

Content knowledge of elementary teachers plays a role in mathematics achievement. The longitudinal research of Hill, Rowan, and Ball (2005) found that elementary teachers' knowledge *for* teaching mathematics significantly predicted the size of student gains on the Terra Nova assessment. The research included the analysis of responses by teachers relating to common and specialized content knowledge questions and almost 3,000 students' achievement on the assessment (Hill et al., 2005). The study found teachers' content knowledge for teaching mathematics was a significant predictor of student gains at the first and third-grade level (Hill et al., 2005). In contrast to teachers' content knowledge for teaching mathematics predicting student gains, a teacher's content knowledge of a subject was not found to be significantly correlated to any of the teacher preparation or experience variables in first grade (number of mathematics methods and mathematics content courses, certified or noncertified to teach; and number of years teaching). Only a small correlation with teacher certification in third grade was reported. Despite being unable to draw causal conclusions from the analysis, the patterns do suggest that practices of ensuring teacher certification and subject-matter methodology courses do not necessarily provide a teacher with strong content knowledge for teaching mathematics at the elementary level (Hill et al., 2005).

Studies have also shown a relationship between teacher efficacy and content knowledge. The researchers Newton, Evans, Leonard, and Eastburn (2012) found a statistically significant correlation between elementary teachers' personal efficacy for mathematics instruction and mathematics content knowledge. Teachers with more mathematics content knowledge had higher efficacy in teaching the content (Newton et al., 2012). Collectively, the research demonstrates that content knowledge in mathematics at the elementary level can impact student achievement in mathematics (Hill et al., 2005; Newton et al., 2012).

Principal Leadership

Student learning is profoundly affected by the teaching that takes place in classrooms and the leadership of principals within schools (The Wallace Foundation, 2012). According to a six-year study conducted by The Wallace Foundation (2012) involving 180 schools in nine states, leadership is the second most important factor behind teaching that influences student learning. The study stated, "To date we have not found a single case of a school improving its student achievement record in the absence of talented leadership" (The Wallace Foundation, 2012, p. 3). This evidence provides a springboard for improving mathematics achievement through effective instructional leadership in mathematics. Other researchers also agree that principals play an essential role in model instructional leadership model (Elmore, 2000; Robinson et al., 2008; Williams, 2010). Moreover, "studies have shown that school leadership affects student outcomes (i.e., students' rates of attendance, achievement, graduation, and college enrollment) indirectly, by creating the conditions that support teachers' abilities to teach and students' learning rather than directly" (Eyal & Roth, 2011, p. 260).

The continued focus on mathematics in media headlines accentuates the need for research investigating school leadership practices and mathematics achievement. Several studies have examined mathematics instruction and principal leadership. Dumay and colleagues (2013) found that principal leadership positively influences teacher efficacy and collective efficacy in schools, as well as provided the foundation for efficacy to positively impact mathematics achievement. The study indicated that effective instructional practices and mathematics content knowledge bolstered teachers' ability to meet the needs of students (Dumay et al., 2013). Therefore, principals' comfort with mathematics and mathematics instruction could have an effect on overall mathematics achievement. Principals can aid building teacher efficacy through their knowledge of mathematics teaching (Dumay et al., 2013) and monitoring instruction based on established high standards and creating a culture of learning and professionalism (Hallinger & Heck, 1996).

Instructional Leadership

Instructional leadership contributes to student academic outcomes. A meta-analysis of research completed between 1978 and 2006 by Robinson et al. (2008) examined 22 studies and 251 effect sizes within the studies. The researchers investigated the impact of transformational leadership, instructional leadership, and other leadership (e.g., social network theory) on student outcomes. Robinson et al. (2008) found a substantial difference in the mean effect size estimates of the three leadership variables on student outcomes with instructional leadership providing the largest (ES = .42) compared to transformational leadership (ES = .11) and other types of leadership (ES = .30). There were, however, inconsistencies with the impact instructional leadership had on student achievement. Robinson et al. (2008) attributed the variations to "between-group designs or analyses" (p. 657). Overall, the comparison indicated considerable differences between instructional leadership and academic outcomes for otherwise similar performing schools, whether high or low achieving. The study concluded that teachers of higher performing schools required school leaders to be "more focused on teaching and learning, to be a stronger instructional resource for teachers, and to be more active participants in and leaders of teacher learning and development" (Robinson et al., 2008, p. 657).

Effective principal leadership must fulfill the leadership needs of their staff, especially teachers. Teachers with varying levels of teaching experience need different leadership characteristics in their principals (Walker & Slear, 2011). Using Tschannen-Moran and Hoy's (2001) Teacher Sense of Efficacy Scale (TSES), Walker and Slear (2011) investigated teacher efficacy with 11 characteristics of school principals and experience level of teachers; principal characteristics and teacher experience were independent variables. Based on Tschannen-Moran and Hoy (2001) determining that the total score from the TSES survey best measured teacher efficacy when considering both novice and experienced teachers, Walker and Slear (2011) used the TSES total score as the measure of efficacy in their study. The research reported that the relationship between teacher efficacy and specific principal leadership characteristics changed with the experience level of teachers. New teachers (0-3 years) and experienced teachers (4-7 years) needed principals modeling instructional expectations to help build their efficacy. While this characteristic of a principal (modeling instructional expectations) was found to be important for very experienced teachers (8-14 years) and extensively experienced teachers (15+ years) as well, other principal characteristics had a greater influence on teacher efficacy at these levels. More experienced teachers needed communication and consideration from administrators. Walker and Slear (2011) found experienced teachers want the principal to "inspire group purpose" (p. 56) towards a common school, division, or state goal. Teachers relied on their principals to share their vision, provide resources, and work collaboratively to increase student outcomes. In short, principals who model instructional expectations for teachers assist in building teacher efficacy (Walker & Slear, 2011).

Principals juggle many duties and responsibilities as school administrators, especially as an instructional leader responsible for facilitating effective lessons by teachers aimed at student learning. Instructional leadership is essential in promoting academic achievement. As Leithwood and Jantzi (2006) wrote:

> There is a significant gulf between classroom practices that are "changed" and practices that actually lead to greater pupil learning; the potency of leadership for increasing student learning hinges on the specific classroom practices that leaders stimulate, encourage and promote. (p. 223)

The research of Robinson and colleagues (2008) supports the link between instructional leadership and student achievement finding that instructional leadership encompassing a focus on teaching and learning, and the active participation of school leaders in teacher learning and development, can increase the effect size of student academic achievement.

Similarly, in a multiple regression analysis conducted by Williams (2010), the connection between a principal's knowledge of mathematics and student achievement was investigated. The predictor variables measuring knowledge of mathematics were: the principal (0-no mathematics or related major/minor, 1-mathematics or related major/minor); certification of the principal (0-no mathematics certification, 1-mathematics certification); number of mathematics courses completed in high school; number of mathematics courses completed in college; and, number of years teaching mathematics. The outcome variable was students' proficiency in mathematics in fourth grade, as measured by spring 2009, Louisiana Educational Assessment Program (LEAP) test. The results of the study indicated that there was no significant relationship between the predictor variables and proficiency in mathematics, R^2 = .27, p = .524 (Williams, 2010). The research of Williams (2010) and Schoen (2010) contradict other studies that suggest a relationship between mathematics content knowledge and mathematics student achievement exists (Dumay et al., 2013; Hill et al., 2005). The inconsistency of these outcomes supports the need for further research examining potential relationships between content knowledge of education leaders and mathematics achievement.

Principals' Mathematics Content Knowledge

Research has indicated that mathematics content knowledge has a role in instructional leadership for mathematics (Carver et al., 2010; Reed, Goldsmith, Nelson, & Nelson, 2006; Stein & Nelson, 2003). As part of The Building Capacity in Algebra: Teaching, Learning, and Leading project funded through the Michigan Department of Education, university-based facilitators held principal study group sessions to develop principals' mathematical knowledge for teaching algebra (Carver et al., 2010). A principal participating in the study groups summed up the power of mathematical content knowledge for school leaders when he or she said:

> I am NOT a math person. I never have been. The way I learned math (sit-and-get) contributed to my anxiety about math. Through the principal study group, I have been exposed to a different style/technique for math instruction, and I'm actually learning

math. It's a message I can share with my staff since many kids feel the same way about math that I did. (Carver et al., 2010, p. 33)

The influence of leadership practices aiding mathematics teaching is show in Figure 2. The data subtly suggested "that the development of leadership content knowledge (i.e. knowledge of the subject, knowledge of teaching and learning the subject) among participants coincided with their ability to envision leadership practice that extended beyond supervision to include teacher support and development" (Carver et al., 2010, p. 33). Outcomes from the principal study group sessions provide evidence supporting the relationship that content knowledge has with leadership practices that influence student achievement. Instructional leaders need to be comfortable with content they are tasked with supporting. Observing mathematics classrooms and providing specific feedback (Khachatryan, 2015) improves teaching and school leaders' instructional leadership (Carver et al., 2010, Reed et al., 2006; Stein & Nelson, 2003).

Leadership Moves for Algebra Teaching	
Algebra teaching	**Potential leadership moves**
LESSON PLANNING	
A teacher's selection of mathematical tasks has critical implication for what students can learn.	• Encourage a vision for algebra that puts an emphasis on mathematical reasoning. • Reassure teachers that time spent on high-level tasks will be rewarded. • Help teacher secure needed curricular and instructional resources. • When observing in the classroom, pay attention to the cognitive demand of selected tasks.
LESSON DELIVERY	
A teacher's skill at facilitating discussion around mathematical tasks, including the questions asked, has critical implication for what students can learn.	• Acknowledge teachers for engaging students in discourse around the big ideas of algebra. • Assist teachers in learning how to become more skilled at facilitating discussion-based classrooms. • When observing in the classroom, pay attention to how questions get asked and how discussions are facilitated.
A teacher's willingness to all students time to muddle through problems together has critical implication for what students can learn.	• Acknowledge the trade-offs that come from devoting time to high-level mathematical problem solving with teachers. • Help teachers manage the press of state content standards and benchmarks by clarifying local expectations. • When observing in the classroom, track student engagement with the task.
ATTENDING TO STUDENT THINKING	
Teaching for conceptual understanding requires that we listen closely to student thinking.	• Support and encourage the collaborative analysis of student work by teachers. • When observing in classrooms, pay attention to teacher-to-student talk and student-to-student talk.

Figure 2. Leadership Moves for Algebra Teaching. How instructional leadership can influence and assist teaching mathematics. Adapted from "Principals + Algebra (-Fear) = Instructional Leadership" by C. L. Carver with M. Steele and B. Herbel-Eisenmann, 2010, *Journal of Staff Development*, *31*(5), 31-33.

Not all studies support a connection between school principals' mathematics knowledge and mathematics achievement. In a mixed method study conducted by Schoen (2010), principals' mathematics knowledge was measured using the MKT elementary patterns, functions, and algebra instrument developed by Hill et al. (2004) to measure elementary teachers' mathematics knowledge. Schoen (2010) suggested that since the MKT was initially developed for use with elementary teachers, it could be said that the group of principals in the study had levels of mathematics knowledge similar to elementary teachers. Schoen's (2010) study also sought to test the theory of Leadership Content Knowledge (Stein & Nelson, 2003) which proposed that principal instructional leadership regarding mathematics has a relationship with content knowledge of mathematics. Schoen (2010) strove to measure the depth of principal content knowledge relating to elementary mathematics content. Additionally, principal observation expertise with mathematics instruction was measured using video lessons and the Reformed Teaching Observation Protocol (RTOP) observation instrument. The intent was to analyze the scores obtained on the MKT with ratings of the videos using the RTOP to examine the relationship between principal's mathematics content knowledge and principal instructional leadership (Schoen, 2010).

Schoen (2010) found principals' MKT scores were normally distributed with a mean score of -0.049 and a *SD* of 0.0035. While 3% of the principals in this study had a grades 6-12 mathematics certification and 1% had middle grades mathematics certification, the majority (67%) of principals had certifications in elementary education; twenty-one percent had prekindergarten/primary endorsements (Schoen, 2010). Moreover, no "obvious relationship between mathematics knowledge for teaching (MKT scale score) and observation expertise (k_n) was found" (Schoen, 2010, p. 77). A question that might be posed from this study is whether the results would be similar if the teaching certification of the principals were different, with higher number of certifications at the secondary level.

According to some researchers, content knowledge in a subject area is important for education leaders. Khachatryan (2015) stated that secondary teachers have a disadvantage with administrators having a potential lack of content knowledge to best provide actionable feedback. As noted by Stein and Nelson (2003), "Without knowledge that connects subject matter, learning, and teaching to acts of leadership, leadership floats disconnected from the very processes it is designed to govern" (p. 446).

Principals' Instructional Leadership Practices

Principals play a significant role in the effectiveness of schools. Second to teachers, school leaders indirectly influence student learning in a school (Hallinger & Heck, 1996; Khachatryan, 2015). Principals impact student achievement through instructional leadership practices (Robinson et al., 2008), which include conducting classroom observations and providing feedback and coaching to teachers (Archer et al., 2016; Khachatryan, 2015).

Classroom observations. Instructional leadership involves observing teachers. A primary responsibility of a school principal "is to ensure that all students consistently receive high-quality instruction" (Fox, 2014, p. 28). Conducting classroom observations is a tool to monitor instruction and learning. Principals participating in study groups facilitated by Carver et al. (2010) reported gaining new insights for observing algebra instruction and moderating mathematical conversations with staff members. Understanding mathematics content and teaching pedagogy positively influenced study group participants' observations of mathematics classrooms and the debriefing of teachers (Carver et al., 2010). Observing classroom lessons are essential to help "the principal identify effective and ineffective teachers, recognize strengths and weaknesses in instructional practice and provide differentiated professional growth opportunities, which lead to increasingly effective instruction" (Fox, 2014, p. 28).

Providing feedback and coaching. Following classroom observations, administrators have an opportunity to provide feedback to teachers to aid teacher growth in the professional practice of quality instruction. According to Archer et al. (2016), "Effective feedback is specific, practical, and focused on improvement. A teacher should leave the feedback conversation with a clear idea of how to put a strategy into immediate use" (p. 181). According to Khachatryan (2015), secondary teachers may be at a disadvantage when it comes to actionable feedback due to a possible lack of content knowledge by the observing administrator. The study focused on the type of feedback given to teachers. Khachatryan's (2015) research suggested that feedback focused on the details of the lesson prompts teachers' self-learning thereby changes in teaching.

Literature Review Summary

Collectively, the review of literature explored areas within education that support the overarching topic–improving mathematics achievement for students. The explored areas included a historical background of mathematics achievement including global, national, and state mathematics performance; attitude toward mathematics and mathematics anxiety; elementary teachers' attitudes about mathematics and mathematics anxiety; mathematics instruction in classrooms; elementary teachers' classroom instruction and content knowledge; principal leadership; instructional leadership; principals' mathematics content knowledge; and principals' instructional leadership practices including classroom observations, providing feedback, and coaching. Hembree (1990) found a negative correlation between positive attitudes toward mathematics and lower mathematics anxiety. According to researchers, there is a connection between anxiety about teaching mathematics and mathematics content knowledge with student achievement (Ball et al., 2005; Hadley & Dorward, 2011; Hill et al., 2005) and the role of content knowledge in instructional leadership for mathematics achievement (Carver et al., 2010; Stein & Nelson, 2003). Robinson et al. (2008) found a substantial difference in the mean effect size estimates of instructional leadership on student outcomes over other leadership variables. Using previous research to support the need for further exploration, this study investigated the relationship between an elementary school leader's attitude toward mathematics and the instructional leadership practice of observing teachers. Coaching and feedback from classroom observations help improve instructional practice (Khachatryan, 2015); however, observations must take place for coaching and feedback to happen. This research honed in on the relationship between mathematics attitude and the frequency of classroom observations of mathematics lessons.

CHAPTER THREE
THE METHODOLOGY

Introduction

This quantitative research explored approach-avoidance motivation as it related to attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. An administrator's attitude toward mathematics refers to a "liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless" (Neale, 1969, p. 632). Mathematics anxiety refers to the general lack of comfort, including feelings of tension, helplessness, and mental disorganization, one might experience when required to manipulate numbers and shapes or perform mathematically in a given situation (Richardson & Suinn, 1972; Tobias, 1978; Wood, 1988). Research has found a correlation between attitude toward mathematics and mathematics anxiety levels. Hembree's (1990) meta-analysis, which examined 151 studies, found a consistent relationship between a positive attitude toward mathematics and lower levels of mathematics anxiety (Hembree, 1990). Anxiety associated with mathematics was connected to a positive attitude toward the subject.

Instructional leadership encompasses classroom observations aimed at identifying strengths and weaknesses in instruction and planning for professional development opportunities to enhance teaching and learning in classrooms (Fox, 2014). Attitude toward mathematics and the level of mathematics anxiety of instructional leaders have the potential to influence the number of observations conducted by school administrators and, therefore, the feedback provided to teachers; the relationship can impact student achievement. This quantitative research sought to investigate the possible link between avoidance theory–approach-avoidance motivation–and educational leadership practices. According to McMillan and Wergin (2010), linking research to a theory is a principle of quality research; "When research is linked to theory the results are more generalizable" (p. 2).

Purpose of the Study

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. The independent variable, attitude toward mathematics, was defined as the scale score determined by the FSMAS-T instrument (Ren et al., 2016). The dependent variable was the frequency of classroom observations of mathematics lessons. Mathematics classroom observation data conveyed the frequency of classroom lessons observed during formal classroom observations and informal classroom walk-through observations.

Research Questions

According to McMillan and Wergin (2010), educational research poses questions that, when answered, can be investigated empirically to provide benefits to practice or an existing body of knowledge. This study collected, analyzed, interpreted, and reported data to answer the following research questions:

1. What is the academic background in mathematics of elementary school administrators?
2. What is the attitude toward mathematics of elementary school administrators?
3. What is the frequency of classroom observations of mathematics lessons by elementary school administrators?
4. What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

Research Design

Research is a systematic investigation designed to analyze information to answer a question or contribute to the knowledge of a theory or practice (McMillan & Wergin, 2010). This quantitative study applied a descriptive and correlational design and utilized a survey methodology. Collected data were used to describe the mathematics background, attitude toward mathematics, and frequency of classroom observations of elementary school administrators. Additionally, the data were used to investigate the relationship between the study variables, attitude toward mathematics and classroom observations. A survey method was employed to collect data to answer the four research questions guiding this study.

Research Design Justification

Quantitative research. Quantitative research was used to compare data in a systematic way to make generalizations to the whole population (Creswell, 2014). This study sought to describe elementary school administrators'–principals and assistant principals–mathematics background, the frequency of classroom observations of mathematics lessons, and attitude toward mathematics. A quantitative approach provided numerical data to summarize, describe, and explore the traits in elementary school administrators (McMillan & Wergin, 2010). Correlational designs examine the relationship between study variables. Calculated correlation coefficients range from -1 to +1 and describe the direction and magnitude of a relationship between variables (McMillan & Wergin, 2010). The correlation coefficient of the collected data in this study was used to determine whether a relationship existed between attitude toward mathematics and the frequency of classroom observations of mathematics lessons by elementary school administrators. Overall, the analyzed data in this survey methods study allowed the researcher to make inferences from the sample to the study population of elementary school administrators in one Virginia school division (Creswell, 2014).

Descriptive and correlational design. This quantitative study investigated the overarching theme of attitude toward mathematics, including related mathematics anxiety, and avoidance behavior theory applying a descriptive and correlational research design. According to McMillan and Wergin (2010), a descriptive study design allows the researcher to describe a phenomenon with statistics such as frequencies, percentages, means, and measures of variance. Correlational designs enable the investigation of relationships among variables through the calculation of correlational coefficients (McMillan & Wergin, 2010).

Descriptive design. This study described the mathematics background (e.g., mathematics courses completed in high school and college, mathematics teaching endorsement(s), and the number of years' experience teaching mathematics), the frequency of classroom observations of mathematics lessons, and attitude toward mathematics of participating elementary school administrators. McMillan and Wergin (2010) stated that descriptive research designs are particularly valuable when an area of investigation is first researched. After a thorough review of the available research, the researcher found no previous studies investigating the attitude toward mathematics of elementary school administrators. Descriptive statistics in this study provide relevant data for future studies in the area of educational leadership and mathematics achievement. Data collected from participating elementary school administrators were reported with descriptive statistics to address research questions one, two, and three.

1. What is the academic background in mathematics of elementary school administrators?
2. What is the attitude toward mathematics of elementary school administrators?
3. What is the frequency of classroom observations of mathematics lessons by elementary school administrators?

Moreover, the descriptive statistics associated with participants' mathematics background provide a frame of reference for further exploring the potential relationship attitude toward mathematics–and its connected mathematics anxiety–has on the frequency of classroom observations of mathematics lessons.

Correlational design. Correlational designs investigate the relationship between at least two measured variables in a study (McMillan & Wergin, 2010). The calculation of a correlation coefficient between variables allows the researcher to determine the direction and magnitude of a found relationship. This study investigated the relationship between elementary school administrators' attitude toward mathematics and the frequency of classroom observations of mathematics lessons using a Pearson product-moment correlation. The calculated correlation coefficient examining the relationship between variables was used to answer research question four.

4. What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

The collected data enabled the researcher to quantify the extent any relationship existed between attitude toward mathematics and the frequency of classroom observations of mathematics lessons.

Survey methodology. According to Creswell (2014), a survey method offers "a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population" (p. 155). This study utilized a survey allowing the researcher to gather measurements for numerical analysis of the collected data. The survey instrument for data collection in this study contained three components: Participant Information Questionnaire, Classroom Observation Questionnaire, and FSMAS-T (Ren et al., 2016) instrument. The purpose of survey research is to generalize a sample to a population to make inferences about the traits and behaviors of the population (Fowler, 2009). The survey data collected from elementary school administrators in one Virginia school division provided sample data on the attitude toward mathematics–and its connected mathematics anxiety–and the frequency of classroom observations of mathematics lessons by elementary school administrators that can be generalized to the population of elementary school administrators in other similar school divisions.

This survey methods study was cross-sectional, meaning that data were collected at one point in time as compared to longitudinal, which collects data over a period (Creswell, 2014). This study administered the survey to elementary school administrators one time during the research timeframe for data collection. This study collected data from elementary school administrators on their current attitude toward mathematics and the frequency of classroom observations of mathematics lessons during the 2015-2016 SY.

Advantages of survey methods. Correlational designs are common in educational research and commonly use survey methods (McMillan & Wergin, 2010). This study utilized both a descriptive and correlational design with survey methods. There are benefits to the use of survey methods. One advantage is that a survey permits the identification of attributes of a large population from a small group of individuals (Fowler, 2009). Other advantages of survey research are the economy of the design (Creswell, 2014) and the rapid turnaround rate in data collection (Fowler, 2009). Additionally, the use of a Web-based survey tool can streamline the data collection process in a survey methodology (Fowler, 2009). The response rate for the study can also be positively influenced by the use of a Web-based survey (Creswell, 2014); participants can conveniently participate in the study when provided a direct link to the study's survey online. This study utilized Qualtrics, a Web-based survey tool approved by Virginia Polytechnic Institute and State University, to collect data from elementary school administrators in one school division in Virginia ($N = 57$).

Disadvantages of survey methods. According to Fowler (2009), there are possible errors with survey methods associated with who responds to the questionnaire and the answers provided by the respondents. Sampling error and bias can occur based on who responds to the survey. Sampling error refers to the "random variation from the true characteristics of the population" (Fowler, 2009, p. 13). The variation stems from the fact that collected data are from a sample rather than the entire population.

Bias is another potential error associated with survey methods. Fowler (2009) refers to bias as "some systematic way the people responding to the survey are different from the target population as a whole" (p. 13). While bias is inherent in survey methods, such effects may be limited or reduced by using random sampling procedures (Fowler, 2009). Since all elementary administrators in the selected school division were invited to participate in the study ($N = 57$), the use of sampling procedures to reduce the threat of bias were not necessary. All members of the study population had an equal probability of participating in the research.

The use of a self-administered, self-report survey for the data collection process of a study has a potential error associated with the answers respondents provide (Fowler, 2009); the error creates a potential validity threat to the research. Errors in answers provided on survey instruments can occur for many reasons, including the misunderstanding of questions asked, not having the information available to provide the answer, and distorting answers to provide more favorable responses (Fowler, 2009). To alleviate the potential misunderstanding of requested information on the survey instrument, the participant information and classroom observation questionnaires were reviewed by other doctoral candidates who were also education practitioners. The reviewers provided feedback on the wording within the questionnaires to assist the researcher in ensuring the study respondents would have a clear understanding of the data requested by the survey questions; questions were modified for clarity based on feedback provided by reviewers. Additionally, the classroom observation questionnaire included definitions of key terms to assist participants' understanding of the requested observation data and to assist in the accuracy of the data collected (e.g., frequency of all formal classroom observations and formal classroom observations of mathematics lessons; frequency or estimated percent of informal classroom walk-through observations in each subject area).

To further reduce the potential error associated with answers provided in the survey, this study used an instrument to measure elementary school administrators' attitude toward mathematics that had been modified from a widely-used and validated research tool; the FSMAS instrument was developed by Fennema and Sherman in 1976. The FSMAS-T (Ren et al., 2016) instrument used in this study was an adaptation of Fennema and Sherman's (1976) research. In the research review conducted during the reliability and validity study for the FSMAS-T instrument, Ren et al. (2016) noted the FSMAS instrument had been used extensively in previous empirical studies.

Finally, the potential distortion of answers provided by self-administered, self-report survey methods can be lessened by the utilization of a Web-based survey tool (Fowler, 2009). The use of a Web-based survey tool increases the anonymity of the participants in the study. This survey study utilized questionnaires and instruments that have been reviewed for clarity and tested for reliability and validity to reduce potential errors in results. Furthermore, the survey was administered through the use of the Web-based survey tool, Qualtrics®, to not only increase the response rate and anonymity in the study but decrease the potential error in the answers provided by respondents.

Population and Sample Selection

Site selection. The population selected for participation in this study was elementary school administrators–principals and assistant principals–in one Virginia school division. At the time of the study, the school division had a population of approximately 39,000 students and consisted of 47 school settings, which included elementary school, middle school, and high school settings, in addition to two specialized centers. The selected school division's elementary school settings included the following grade-level groupings: K-2, K-3, 3-5, and K-5. There were a total of 28 elementary school settings in the selected school division for the study. With one exception, each elementary school in the school division had two school administrators–a principal and an assistant principal; one school had a principal and two assistant principals.

Population. This study sought the voluntary participation of all elementary school administrators in the selected school division in Virginia. The population for this study was elementary school administrators, which included both the principal and assistant principal(s) responsible for each of the 28 elementary school settings within the school division ($N = 57$). All principals and assistant principals within the selected school division were invited to participate in the survey; Division guidelines and protocols were followed for the invitation process.

Sampling procedure. A single-stage sampling procedure was used in this research study. According to Creswell (2014), single-stage sampling procedure is defined as sampling where the researcher has access to names in the population and can sample directly from the population. The population in this study consisted of 57 elementary school administrators in one Virginia school division. The population of potential participant names was accessible to the researcher through the school division's public website. The researcher had e-mail contact information for each administrator in the population (*N* = 57); the entire population was invited to participate in this survey study via e-mail communication with a link to the Web-based survey in Qualtrics. The survey responses determined the sample of the population used for statistical analysis.

The participant information component of the Qualtrics® survey asked potential respondents to select their current administrative position (elementary principal, elementary assistant principal, or other) and their administrative position during the 2015-2016 SY (elementary principal, elementary assistant principal, or other). Responses to these two questions were used to exclude participation in the study. Respondents who were not currently in an elementary principal or assistant principal position, or who were not in one of these administrative positions during the 2015-2016 SY, did not meet the criteria for this study. The sample analyzed for this study consisted of respondents to the online survey that met the study criteria.

Instrument Design and Validation

The survey used in this study consisted of the three components described in the following section. The components were combined into one survey instrument (see Appendix A) divided into three sections that were administered to the study participants via Qualtrics®. The three components of the survey were: Participant Information Questionnaire, Classroom Observation Questionnaire, and FSMAS-T (attitude toward mathematics) instrument.

Participant information questionnaire. The Participant Information Questionnaire was a component of the survey tool used in this study. The questionnaire was the first of three sections in the online survey. The questionnaire contained nine items that served multiple purposes. All items on the questionnaire collected data from participants, which allowed the researcher to describe the sample in the study using statistics such as frequencies, percentages, means, and measures of variation. Items one and two in this section also ensured that participants met the criteria of the study; participants had to currently be in an elementary school principal or assistant principal position. Additionally, participants had to have been an elementary principal or assistant principal during the 2015-2016 SY–the period in which the classroom observation data were reported. Descriptive statistics were used to describe the number of survey respondents (*n*) and current administrative position and during the 2015-2016 SY; years of administrative experience; mathematics coursework completed in high school and college; Virginia licensure endorsements; and teaching experience, for all items in the participant information questionnaire. Data are reported in tables and figures with brief narratives. The reported data are organized according to the order of the survey items. The participant information questionnaire was used to answer research question one in this study.

Classroom observation questionnaire. The Classroom Observation Questionnaire was the second component of the survey tool used in this study. This questionnaire was the second of three sections in the survey that were used to collect data relating to classroom observations conducted during the 2015-2016 SY. Directions for reporting observation data were provided with the questionnaire. Additionally, key terms in the questionnaire were defined for participants based on definitions expressed in the study. Participants were provided the definition of *formal classroom observation* and *informal classroom walk-through observation* to provide a clear understanding of the requested information sought in the survey. Participants were asked to provide the frequency of formal classroom observations conducted in classrooms along with the frequency of formal classroom observations of mathematics lessons conducted during the 2015-2016 SY. Furthermore, the classroom observation questionnaire asked participants to provide the frequency of informal classroom walk-through observations carried out in English, mathematics, science, social studies/social sciences, and other classroom settings during the 2015-2016 SY. If exact frequencies of informal classroom walk-through observations conducted were not known, participants were asked to provide an estimate of the percentage of informal classroom walk-through observations conducted in the curricular areas.

Attitude toward mathematics instrument. Elementary school administrators' attitude toward mathematics were measured using the FSMAS-T instrument (Ren et al., 2016). The FSMAS-T instrument was the third section of the survey tool used in this study. The researcher contacted and received permission to use the FSMAS-T instrument from Ren et al. (2016) (see Appendix B).

Fennema and Sherman's (1976) FSMAS instrument is a popular tool used to measure attitude toward mathematics. The review of literature involving the use of the FSMAS instrument in research by Ren et al. (2016) found the scales within the FSMAS instrument had been modified and adapted for use with a variety of populations and constructs, including students, male/female domains, mother/father confidence and effect on students, and teacher confidence. The literature suggested that the nine scales in the first FSMAS instrument had been used all together or separately making the instrument flexible in research (Ren et al., 2016). Mulhem and Rae (1998) conducted a study to produce a shortened version of the FSMAS instrument; the study reported internal consistency for each of the scales of the FSMAS instrument. The three scales included in the FSMAS-T instrument (Confidence in Learning Mathematics, Effectance Motivation in Mathematics, and Mathematics Anxiety) were appropriate scales to address the research questions for this study. In the research of Mulhem and Rae (1998), the Cronbach's alpha for the scales included in the FSMAS-T instrument was calculated as follows: Confidence in Learning Mathematics, $\alpha = 0.91$; Effectance Motivation in Mathematics, $\alpha = 0.86$; and Mathematics Anxiety, $\alpha = 0.90$. For this study, the FSMAS-T instrument was chosen as the measurement instrument for attitude toward mathematics because (a) mathematics anxiety is one of the scales included in the instrument, and (b) it was tested for reliability and validity in measuring elementary teachers' mathematics attitude by Ren et al. (2016). In a study of principal's content knowledge, Schoen (2010) employed an instrument initially developed for use with elementary teachers. Since the instrument was developed for use with elementary teachers, Schoen (2010) suggested it could be said elementary principals in the study had similar levels of mathematics knowledge to elementary teachers. Moreover, previous education administrative licensure regulations in Virginia included requirements for teaching experience at the school level of the endorsement (C. Cordle, personal communication, December 30, 2016) thereby supporting the use of the FSMAS-T instrument to measure elementary school administrators' attitude toward mathematics in this study.

Ren et al. (2016) conducted analyses on four different sample groups to determine reliability and validity of the FSMAS-T instrument. The four samples included a pilot study (n = 65), confirmatory factor analysis (CFA) sample (n = 225), cross-validation sample (n = 171), and evaluation study sample (n = 39). From the analysis conducted with the samples, three questions from the original FSMAS instrument scales were removed; two questions from the Confidence in Learning Mathematics scale and one question from the Effectance Motivation in Mathematics scale were removed. Ren et al. (2016) then examined a three-factor model containing the scales Confidence in Learning Mathematics, Effectance Motivation in Mathematics, and Mathematics Anxiety where the factors were correlated using the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). According to Ren et al. (2016), "the model obtained an acceptable fit, $X^2(492) = 896.771$ ($p < 0.001$), CFI = 0.911, TLI = 0.905, RMSEA = 0.060 (90% CI = 0.054~0.067), SRMS 0.054. The three factors were highly correlated, with correlation coefficients ranging from 0.837 to 0.962" (Ren et. al, 2016, p. 318).

The FSMAS-T instrument, which was used in this study, consists of 33 items with ten items within the Confidence in Learning Mathematics scale, 11 items within the Effectance Motivation in Mathematics scale, and 12 items within the Mathematics Anxiety scale (Ren et al., 2016). Figure 3 provides examples of questions within each of the scales of the FSMAS-T instrument.

Question/Statement by Scale
Confidence in Learning Mathematics
Most subjects I can handle O.K., but I have a tendency to mess up math.
Generally, I have felt secure about attempting mathematics.
Effectance Motivation in Mathematics
Mathematics is enjoyable and stimulating to me.
I don't understand how some people can spend so much time on math and seem to enjoy it.
Mathematics Anxiety
Mathematics makes me feel uncomfortable, restless, irritable, or impatient.
It wouldn't bother me at all to take more math courses.

Figure 3. Sample Questions within the Scales for the FSMAS-T Instrument. The figure provides two sample questions in each of the three scales comprising the FSMAS-T instrument.

Procedures

As part of the requirements to conduct this study, the researcher, who received Institutional Review Board (IRB) training (see Appendix C), gained approval to conduct the study from Virginia Polytechnic Institute and State University's (VT) IRB (see Appendix D) by submitting an IRB Proposal Request Application. Once IRB approval was received from the University, the researcher then sought approval from the school division invited to participate in the study. The researcher followed division guidelines and protocols by submitting an outline of the research proposal, the VT IRB approval letter, and the survey instrument to the Staff Development department within the school division. Permission to conduct research within the selected school division was granted (see Appendix E).

Upon VT IRB and school division approval, the researcher loaded the online survey in Qualtrics® using the three components described in the instrumentation section. A contact list of all elementary school administrators (*N* = 57) within the selected school division was created in Qualtrics® to disseminate of the study survey. An overview of the study, approximate length of the study, and consent to participate in the research by submitting the online survey was conveyed to invited participants in the e-mail sent with the survey link (see Appendix F). Participation was entirely voluntary; this was indicated in the invitation to participate. The Qualtrics® link to the survey was distributed electronically to the invited participants via school division e-mail addresses. Participants were sent four reminders to encourage completion of the survey during the 6-week duration of the study. The data collected in Qualtrics® were inputted into Excel® and SPSS® for analysis.

Use of Web-based survey methods assisted with the anonymity and confidentiality of the respondents during the data collection process (Creswell, 2014; Roberts, 2010). Moreover, the researcher upheld the anonymity and confidentiality of all survey data collected. All data were stored in a secure database during the data gathering and analysis process. After the successful completion of the dissertation defense, all data will be destroyed to maintain security and confidentiality of the participants.

Data Analysis Techniques

The online surveying tool Qualtrics was utilized for data collection. The software programs Excel® and SPSS® were used for descriptive and inferential data organization and analysis. Creswell's (2014) model for data analysis guided this study. Data collected from this study:

- were organized through examination of the number of participants in the sample and the percentages of respondents,
- accounted for any missing data,
- discussed possible response bias, and
- presented descriptive and inferential data analysis including the significance of findings. (Creswell, 2014)

Methodology Summary

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. The methodology guided the data collection and analysis to address the four research questions for this study. The final goals of the data collection and analysis were as follow: (a) report the mathematics background of elementary school administrators; (b) report the frequency of classroom observations completed for mathematics lessons by elementary administrators; (c) report the attitude toward mathematics, including related mathematics anxiety, of elementary administrators; and (d) determine and report the relationship between attitude toward mathematics and the frequency of mathematics classroom observations conducted.

CHAPTER FOUR
THE DATA

Introduction

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. A Web-based survey was distributed to the population of elementary school principals and assistant principals in one Virginia school division for participation in the study. This study collected and reported data to answer the following research questions:

1. What is the academic background in mathematics of elementary school administrators?
2. What is the attitude toward mathematics of elementary school administrators?
3. What is the frequency of classroom observations of mathematics lessons by elementary school administrators?
4. What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

The data from the study were conveyed according to the order of the survey and the research questions. Creswell's (2014) model for data analysis guided this study, which included (a) an examination of the number of participants in the sample and the percentages of respondents, (b) accounting for any missing data, (c) discussing possible response bias, and (d) presenting descriptive and inferential data analysis along with the significance of findings. The following sections systematically report the data collected during this study.

Response Rate to the Survey

The researcher invited all elementary school principals and assistant principals ($N = 57$) in one Virginia school division to participate in this study. Of the 57 prospective participants, 45 completed the Web-based survey as requested. According to Fowler (2009), the response rate of a survey is calculated by dividing the number of respondents who completed the survey by the number of participants invited to complete the survey (e.g., $45 \div 57$). The response rate to the survey used for this study was approximately 78.9%, which was considered an adequate rate to generalize the population of elementary school administrators in the selected school division (Creswell, 2014; Fowler, 2009). The survey population used during the study is described in the following section.

Survey Population

Inclusions/exclusions. The population for this study consisted of elementary school administrators in one Virginia school division ($N = 57$). For the purpose of this study, elementary school administrators refers to elementary school principals and elementary school assistant principals. The entire population was invited to participate in the study by completing the Web-based survey in Qualtrics®. The survey asked respondents to identify their current position and their position for the previous school year (2015-2016) as elementary school principal, elementary school assistant principal, or other, which would indicate another administrative position in the division or school faculty. The answers to these questions allowed the researcher to determine if a respondent met the criteria for participation in the study (i.e., current elementary school administrator and elementary school administrator during the 2015-2016 SY). Of the 45 respondents to the survey, six identified *other* as their position during the 2015-2016 SY.

Prior to the data analysis process, the data were reviewed for inclusion in the study and possible errors in the data. The researcher's review of the data found two respondents' data containing mathematical errors; the data from these respondents were excluded from the study. The first excluded respondent indicated the total number of formal classroom observations completed as 21 and the number of formal classroom observations completed of mathematics lessons as 30; the number of formal classroom observations of mathematics lessons cannot exceed the total number of formal classroom observations conducted overall. The second excluded respondent provided percentages of informal classroom walk-through observations of English, mathematics, science, social studies/social science, and resource classes totaling over 300%. Due to the anonymity of the survey, the researcher was unable to contact respondents to clarify the data provided. The researcher made the decision to remove all data reported by the two participants prior to data analysis. Overall, the data from the six respondents not meeting the criteria for the study and the two respondents whose answers indicated mathematical errors were removed prior to data analysis. Based upon all exclusions described, the study's population was reduced from 57 to 51 ($N = 51$) and the study's sample from 45 to 37 ($n = 37$). As such, the sample analyzed for the study ($n = 37$) represented about 72.5% of the population ($N = 51$).

Administrative position. The Virginia school division selected for this study employed 28 elementary school principals and 29 elementary school assistant principals during the timeframe of the study. The study sample population ($n = 37$) was comprised of 23 current elementary school principals and 14 current elementary school assistant principals representing approximately 62.2% and 37.8% of the study sample, respectively. Figure 4 illustrates the frequency of the current administrative position of study participants.

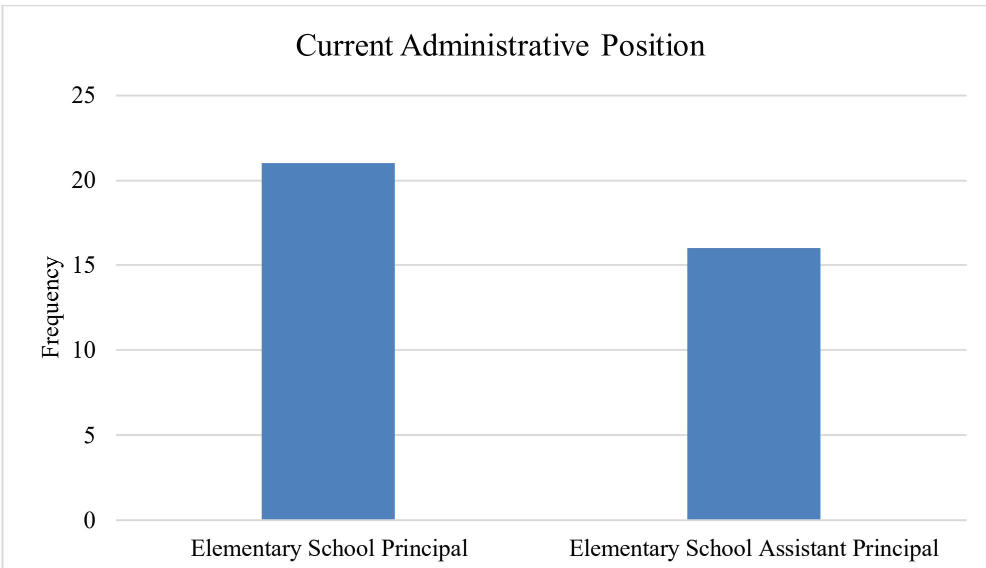

Figure 4. Current Administrative Positions of Study Participants. This figure illustrates the number of study participants currently in elementary school principal and elementary school assistant principal positions.

The classroom observation data collected from participants were based on classroom observations conducted during the 2015-2016 SY. Participants were asked to identify their position during the 2015-2016 SY. Of the 37 participants, 21 participants (56.8%) were elementary school principals and 16 participants (43.2%) were elementary school assistant principals during the 2015-2016 SY. Figure 5 illustrates the frequency of administrative positions held by participants during the 2015-2016 SY.

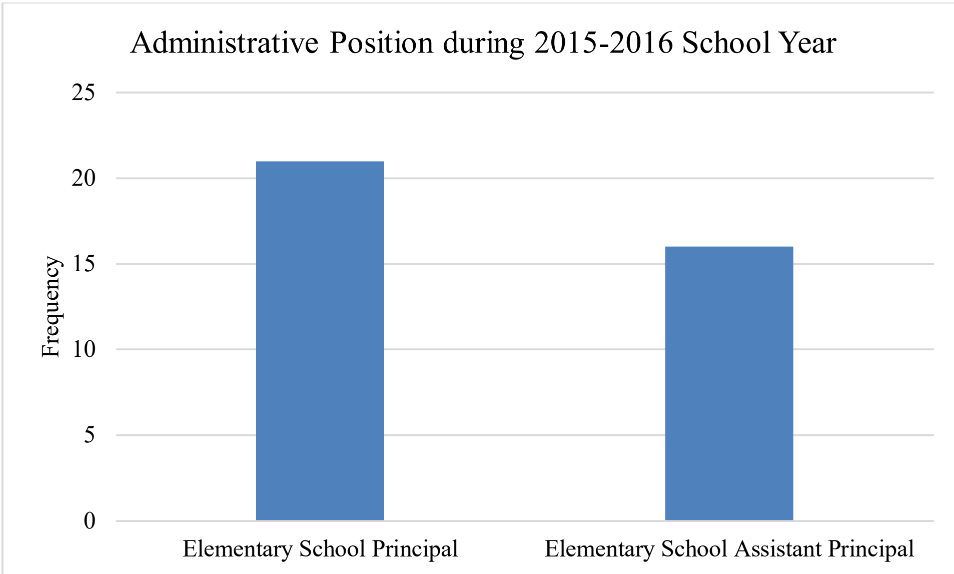

Figure 5. Administrative Positions during 2015-2016 School Year of Study Participants. The figure illustrates the administrative position that participants held during the 2015-2016 SY in which observation data were reported for the study.

Experience in administration. Participants were asked to indicate the number of years they have served in an administrative position in education. Collectively, the study sample had a total of 429 years of experience in educational administration. The mean number of years for all administrators was 11.59 with a *SD* of 5.87. The number of years of administrative service ranged from 4 to 26 years for all study participants. Administrative experience for current elementary school principals ranged from 4 to 26 years; administrative experience for current elementary school assistant principals ranged from 4 to 25 years.

Meeting state benchmarks for accreditation. Participants were asked to indicate whether their school met all benchmarks for accreditation in mathematics for the 2014-2015 SY and the 2015-2016 SY. This question was posed to provide a potential perspective for the number of classroom observations conducted for mathematics lessons during the 2015-2016 SY. If accreditation in mathematics was not reached, the VDOE and/or the school division may have provided specific guidelines or expectations for administrators in some instructional leadership areas including observations of mathematics classrooms. In this study, 34 out of 37 participants indicated that their school met all benchmarks for accreditation in mathematics for the 2014-2015 SY. This represented approximately 91.9% of the participants in the study. Additionally, 36 out of 37 participants (97.3%) indicated that their school met all benchmarks for accreditation in mathematics for the 2015-2016 SY.

Research Question 1

What is the academic background in mathematics of elementary school administrators?

Mathematics coursework. Participants in the study were asked to identify mathematics courses they completed in high school and college from a list provided. High school courses on the list included Algebra I, Geometry, Algebra II, Mathematical Analysis, Probability and Statistics, Trigonometry, Calculus, and Other. College courses listed in the survey included College Algebra, College Geometry, Probability and Statistics, Mathematics for Elementary Teachers, Mathematics for Business, Applied Mathematics, Calculus I, Calculus II, Calculus III, and Other.

Figure 6 displays the frequency of responses for participants in the completion of mathematics courses in high school; Figure 7 displays the frequency of responses indicating the completion of mathematics courses in college. The mean number of reported mathematics courses completed in high school was 3.35 with a *SD* of 1.11. The number of high school mathematics courses completed by study participants ranged from 1 to 6 courses.

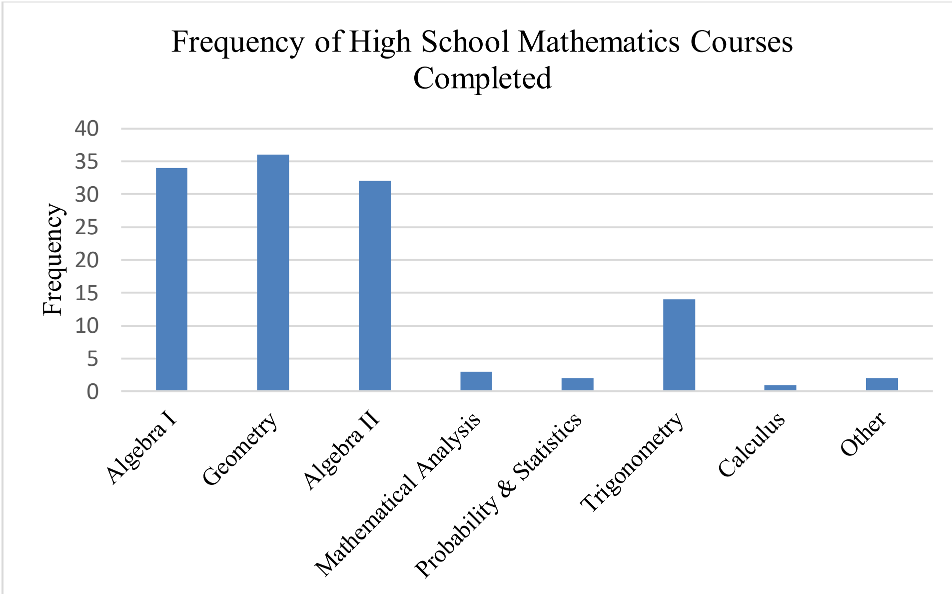

Figure 6. Frequency of High School Mathematics Courses Completed by Study Participants. The figure displays the number of participants indicating the completion of each high school mathematics course listed in the survey.

Figure 7 illustrates the frequency of mathematics courses completed in college by participants in the study. The mean number of reported mathematics courses completed in college was 2.70 with a *SD* of 1.35. The number of college mathematics courses completed by study participants ranged from 1 to 5 courses.

The study participants completed a total of 124 mathematics courses in high school and 100 mathematics courses in college. Completing the course, Mathematics for Elementary Teachers, was reported by 26 participants, which represented approximately 70.3% of the study sample. Of the participants, approximately 56.8% completed three or fewer high school mathematics courses; Twenty-five of the 37 participants (67.6%) completed three or fewer college mathematics courses.

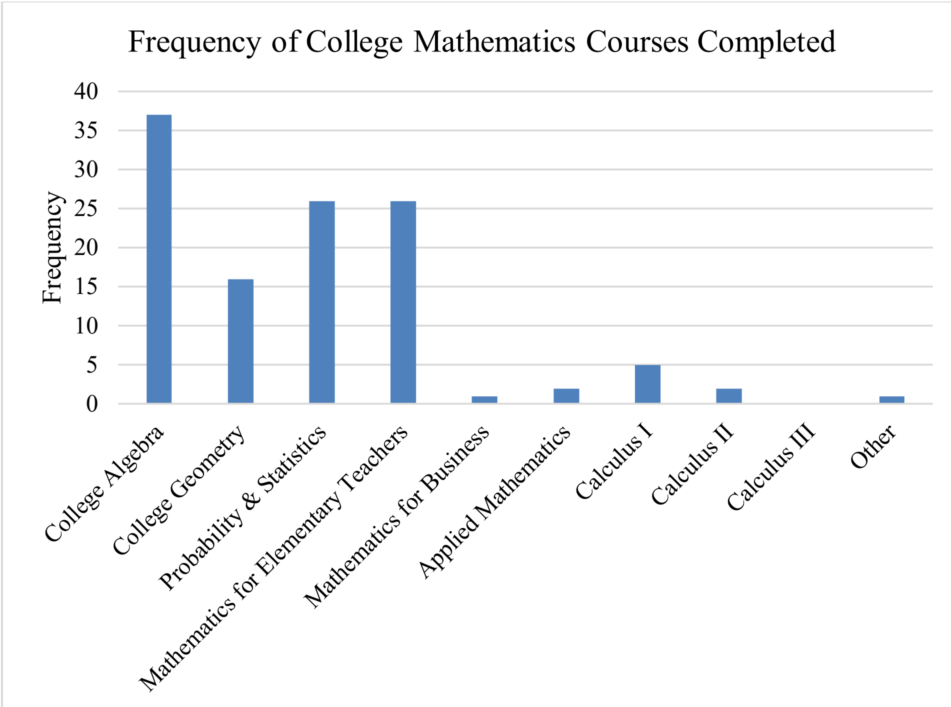

Figure 7. Frequency of College Mathematics Courses Completed by Study Participants. The figure displays the number of participants indicating the completion of each college mathematics course listed in the survey.

Teaching licensure and experience. Participants were asked to indicate the teaching licensure endorsements they had from a provided list. All elementary teaching endorsements, the general middle school endorsement, and all mathematics teaching endorsements available in the Commonwealth of Virginia (www.doe.virginia.gov) were listed for selection, as well as *other.* Participants reported a total of 60 teaching licensure endorsements. Only two of the licensure endorsements reported by participants were specific to mathematics teaching (e.g., middle education 6-8 mathematics and mathematics-Algebra I); this represented approximately 3.3% (2 out of 60) of the teaching licensure endorsements of participants. While the middle education 6-8 mathematics endorsement requires meeting a minimum score on a Praxis exam, the Algebra I endorsement requires the successful completion of a set of higher level mathematics courses to attain the teaching licensure endorsement in this area (www.doe.virginia.edu). Seven participants selected only other from the provided list of endorsements; this represented approximately18.9% of the participants. Based on all elementary school, general middle school, and all mathematics endorsements being listed, these seven participants may have had special education endorsements, secondary endorsements in content areas other than mathematics, or other teaching endorsements not listed. Figure 8 provides the frequency of licensure endorsements noted by the study participants.

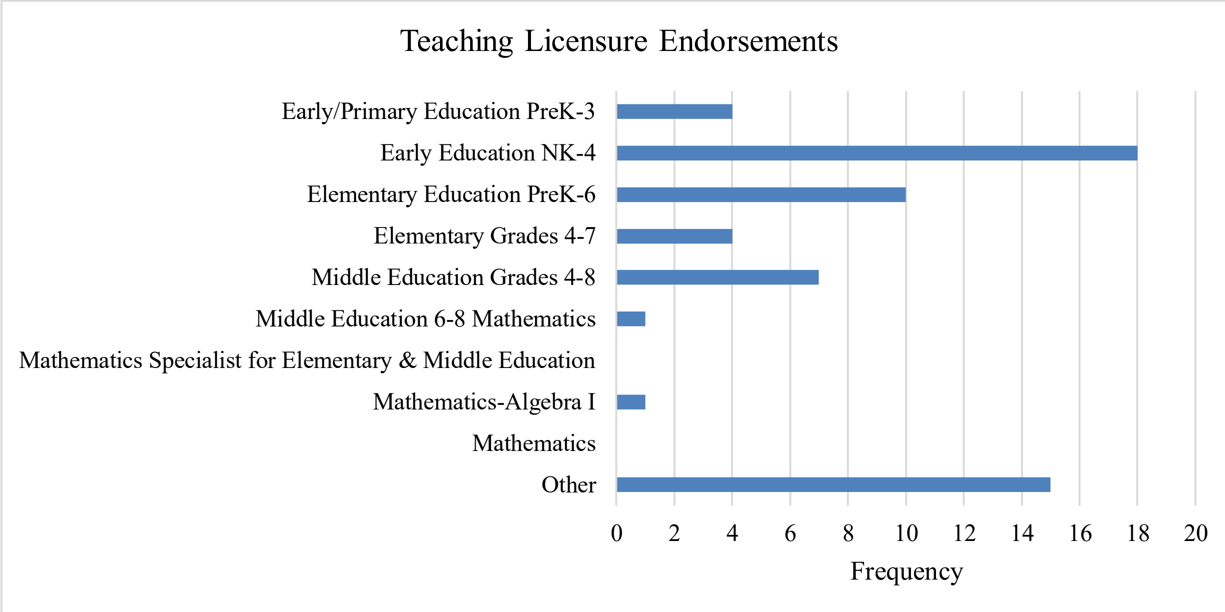

Figure 8. Teaching Licensure Endorsements of Study Participants. The figure illustrates the frequency of Virginia teaching licensure endorsements reported by the study participants.

Twenty-six out of the 37 participants (70.3%) indicated having one or more teaching licensure endorsements in the area of elementary education (e.g., early/primary education preK-3, early education NK-4, elementary education preK-6, and elementary grades 4-7). The two participants indicating a specific mathematics endorsement also had at least one of the elementary endorsements indicated.

In addition to teaching licensure endorsements, participants were asked to indicate the total number of years teaching experience (excluding administrative experience) and the total number of years teaching experience in a mathematics classroom. Together, participants reported a total of 548 years of teaching experience and 256 years of teaching experience in mathematics classrooms. The number of years teaching experience for the participants ranged from 4 to 39 years with a mean of 14.81 years and a *SD* of 7.07. The number of years teaching experiences in a mathematics classroom reported by the participants ranged from 0 to 27 years with a mean of 6.92 and a *SD* of 6.90. Eleven of the 37 participants (29.7%) reported the same number of years teaching experience in a mathematics classroom as their total number of years teaching experience (e.g., 8 years total teaching experience and 8 years teaching experience in a mathematics classroom). Over 75% of the participants indicated 10 or more years teaching experience. Contrarily, almost 70% of the participants reported fewer than 10 years teaching experience in a mathematics classroom.

Research Question 2

What is the attitude toward mathematics of elementary school administrators?

Fennema-Sherman Mathematics Attitude Scales-Teacher instrument. The instrument developed to measure mathematics attitude, FSMAS, was comprised of nine separate scales (Fennema & Sherman, 1976). The adapted scales for use with elementary teachers, the FSMAS-T instrument, utilizes three scales from the original instrument: Confidence in Learning Mathematics, Effectance Motivation in Mathematics, and Mathematics Anxiety (Ren et al., 2016). The FSMAS-T instrument is comprised of 33 questions within the three scales and designed to measure attitude toward mathematics (Ren et al., 2016). Study participants were asked to respond to statements about mathematics attitude using a 5-point Likert scale (from "strongly agree" to "strongly disagree"). Responses to each statement relating to attitude toward mathematics were coded with a score of 1 to 5 according to the Likert scale. Positive statements received a score of 5 for "strongly agree." Conversely, negative statements received a score of 1 for "strongly agree" (Mulhern & Rae, 1998). Appendix G provides the sequence each statement was delivered in the survey, the statement, whether the statement is positive or negative, and whether the coding was reversed for determining the scale score (Mulhern & Rae, 1998; Ren et al., 2016).

To calculate the attitude toward mathematics total scale score for each participant, the scores for responses to each of the 33 items were added together. The total scale score for the FSMAS-T instrument ranged from 33-165. A higher scale score represented a *more positive* attitude toward mathematics. Likewise, a lower scale score represented *a less positive* attitude toward mathematics. As shown in Figure 9, study participants were grouped according to scale scores as having a Low, Moderate, or High attitude toward mathematics. The Low group had the least positive attitude whereas the High group had the most positive attitude.

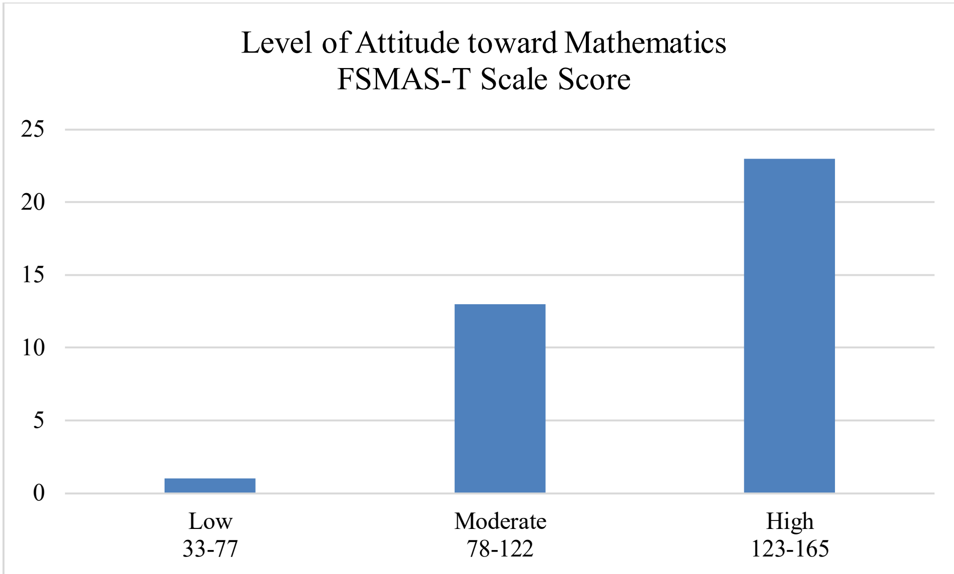

Figure 9. Level of Attitude toward Mathematics FSMAS-T Total Scale Score. This figure illustrates the level of participants' attitude toward mathematics. Participants in the Low group have a less positive attitude toward mathematics. Participants in the High group have a more positive attitude toward mathematics.

Table 1 provides the range, minimum value, maximum value, mean, and *SD* of the three scales within the FSMAS-T instrument as well as the total scale score for all participants (*n* = 37). The Mathematics Anxiety scale had the largest range of scores among the three scales; the range of scores was 36. Relative to the mean score and maximum score in each scale, the Effectance Motivation in Mathematics scale had the lowest mean scale score of 39.73 out of a maximum of 55 (72.2%). The Confidence in Learning Mathematics scale and Mathematics Anxiety scale mean scores represented about 79.7% and 75.5% of the maximum scores within the respective scales. Scale scores reflected participants were strongest in their confidence to learn mathematics and weakest in their beliefs about their capabilities to complete mathematical tasks well (i.e., effectance motivation).

Table 1

Descriptive Statistics for Scale Scores and FSMAS-T Instrument Total Scale Score

	Range	Min	Max	Mean	Std. Deviation
Confidence in Learning Mathematics (max = 50)	30	20	50	39.86	8.30
Effectance Motivation in Mathematics (max = 55)	25	25	50	39.73	6.58
Mathematics Anxiety (max = 60)	36	24	60	45.27	9.91
FSMAS-T Total (max = 165)	89	71	160	124.86	23.28

Confidence in Learning Mathematics scale. The Confidence in Learning Mathematics scale contained 10 statements. The maximum score for this scale was 50. Scale scores for participants in the study ranged from 20 to 50 with a mean scale score of 39.86; the *SD* was 8.30. Figure 10 illustrates the frequency of the scale scores of participants. Less than 25% of the participants had a scale score at or below 35 for Confidence in Learning Mathematics.

Participant responses to the 10 questions within the Confidence in Learning Mathematics scale are shown in Table 2. Seventy percent of the participants responded “strongly agree” to the statement, “I am sure that I can learn mathematics,” indicating a high level of confidence in the content area. Additionally, approximately 81% of the participants responded “strongly agree” or “somewhat agree” to the statement, “Generally I have felt secure about attempting mathematics.” Overall, participant responses within the confidence scale support a high level of confidence in the content area of mathematics.

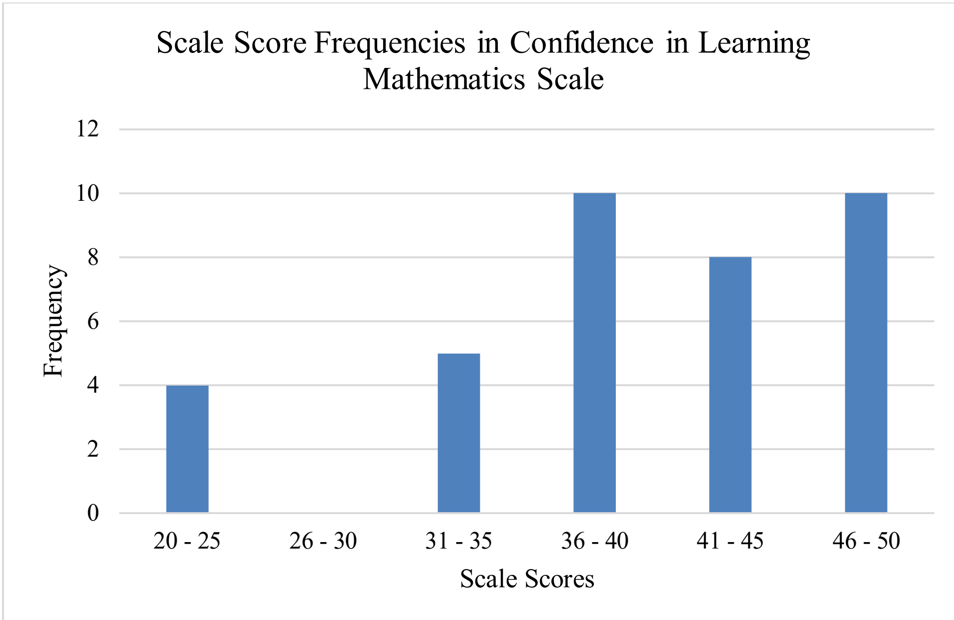

Figure 10. Scale Score Frequencies in Confidence in Learning Mathematics Scale. The figure shows the frequency of scale scores in the Confidence in Learning Mathematics scale of study participants.

Table 2

Frequency and Percentage of Responses to Items in the Confidence in Learning Mathematics Scale

	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree
Most subjects I can handle O.K., but I have a tendency to mess up math.	0 (0%)	4 (11%)	7 (19%)	8 (22%)	18 (49%)
I am sure that I can learn mathematics.	26 (70%)	8 (22%)	1 (3%)	2 (5%)	0 (0%)
I'm not the type to do well in math.	0 (0%)	5 (14%)	2 (5%)	13 (35%)	17 (46%)
Generally, I have felt secure about attempting mathematics	16 (43%)	14 (38%)	1 (3%)	6 (16%)	0 (0%)
Math was my worse subject.	4 (11%)	2 (5%)	4 (11%)	14 (38%)	13 (35%)
I have a lot of self-confidence when it comes to math.	6 (16%)	19 (51%)	5 (14%)	7 (19%)	0 (0%)
I think I could handle more difficult mathematics.	5 (14%)	15 (41%)	9 (24%)	6 (16%)	2 (5%)
I'm no good at math.	1 (3%)	2 (5%)	3 (8%)	13 (35%)	18 (49%)
I can get good grades in mathematics	13 (35%)	19 (51%)	2 (5%)	2 (5%)	1 (3%)
For some reason even though I study, math seems unusually hard for me.	1 (3%)	4 (11%)	6 (16%)	16 (43%)	10 (27%)

Effectance Motivation in Mathematics scale. The Effectance Motivation in Mathematics scale contained 11 statements. The maximum score for this scale was 55. Scale scores for participants in the study ranged from 25 to 50 with a mean scale score of 39.73; the *SD* was 6.58. Figure 11 illustrates the frequency of the scale scores of participants. Approximately 27% of the participants had a scale score at or below 35 for Effectance Motivation in Mathematics. Although this was similar to the percentage in the Confidence in Learning Mathematics scale, there was only one participant in the lowest interval in the Effectance

Motivation in Mathematics scale compared to four participants in the lowest interval in the Confidence in Learning Mathematics.

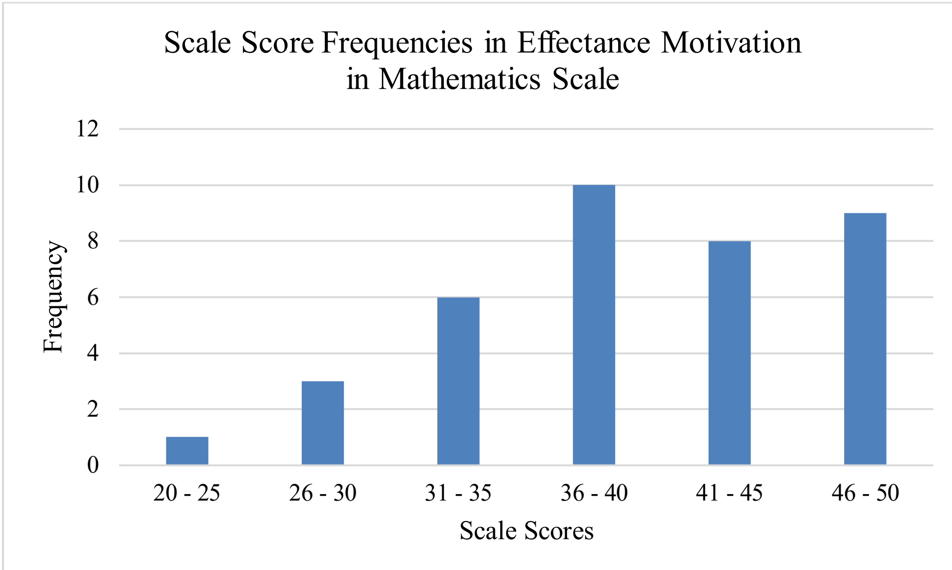

Figure 11. Scale Score Frequencies in Effectance Motivation in Mathematics Scale. The figure shows the frequency of scale scores in the Effectance Motivation in Mathematics scale of study participants.

Participant responses to the 11 questions within the Effectance Motivation in Mathematics scale are shown in Table 3. Approximately 65% of the participants responded “strongly agree” or “somewhat agree” to the statement, “I am challenged by math problems I can't understand immediately.” Similarly, about 71% of the participants also responded “strongly agree” or “somewhat agree” for the statement, “When a math problem arises that I can’t immediately solve, I stick with it until I have a solution.” Responses to these two statements support strong beliefs by participants in their ability to be successful with difficult mathematical tasks.

Table 3

Frequency and Percentage of Responses to Items in the Effectance Motivation in Mathematics

	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree

Scale

When a question is left unanswered in math class, I continue to think about it afterward.	5 (14%)	21 (57%)	6 (16%)	2 (5%)	3 (8%)
Mathematics is enjoyable and stimulating to me.	9 (24%)	17 (46%)	5 (14%)	4 (11%)	2 (5%)
I don't understand how some people can spend so much time on math and seem to enjoy it.	0 (0%)	5 (14%)	12 (32%)	9 (24%)	11 (30%)
I am challenged by math problems I can't understand immediately.	5 (14%)	19 (51%)	4 (11%)	6 (16%)	3 (8%)
The challenge of math problems does not appeal to me.	0 (0%)	8 (22%)	7 (19%)	15 (41%)	7 (19%)
Math puzzles are boring.	0 (0%)	5 (14%)	9 (24%)	11 (30%)	12 (32%)
Once I start trying to work on a math puzzle, I find it hard to stop.	5 (14%)	11 (30%)	10 (27%)	9 (24%)	2 (5%)
Figuring out mathematical problems does not appeal to me.	1 (3%)	6 (16%)	12 (32%)	13 (35%)	5 (14%)
When a math problem arises that I can't immediately solve, I stick with it until I have the solution.	5 (14%)	21 (57%)	5 (14%)	5 (14%)	1 (3%)
I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.	0 (0%)	5 (14%)	8 (22%)	19 (51%)	5 (14%)
I do as little work in math as possible.	0 (0%)	5 (14%)	5 (14%)	15 (41%)	12 (32%)

Mathematics anxiety scale. The Mathematics Anxiety scale contained 12 statements. The maximum score for this scale was 60. Scale scores for participants in the study ranged from 24 to 60 with a mean scale score of 45.27; the *SD* was 9.91. The Mathematics Anxiety scale had the highest *SD* indicating a wider spread of data from the mean than the other scales. A higher score on the scale indicated less mathematics anxiety. Figure 12 illustrates the frequency of the scale scores of study participants. Approximately 92% of the study participants had a scale score above 30 (the median of the 60-point scale).

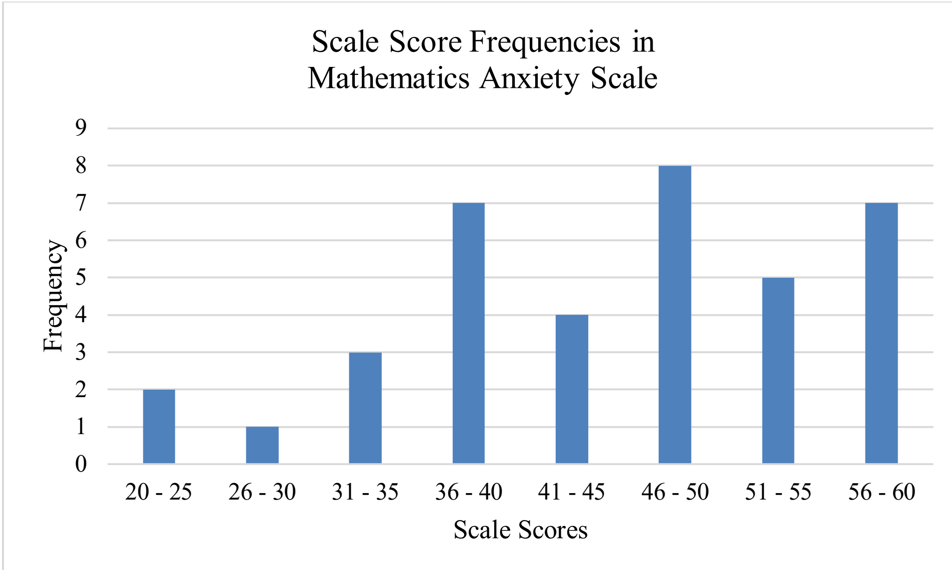

Figure 12. Scale Score Frequencies in Mathematics Anxiety Scale. The figure shows the frequency of scale scores in the Mathematics Anxiety scale of study participants.

Participant responses to the 12 questions within the Mathematics Anxiety scale are shown in Table 4. Responses throughout the anxiety scale were somewhat consistent with the majority of participants' responses indicating a low level of mathematics anxiety. However, three statements stood out with higher percentages of discomfort with mathematics compared to the overall responses within the anxiety scale. The statements, "It wouldn't bother me at all to take more math courses," "I don't worry about being able to solve math problems," and "I almost never get nervous during a math test" had approximately 27%, 30%, and 36%, respectively, of participant responses indicating more anxiety with mathematics whereas other responses to statements indicating higher levels of mathematics anxiety ranged from 11-22%.

Table 4

Frequency and Percentage of Responses to Items in the Mathematics Anxiety Scale

	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree
I almost never get nervous during a math test.	10 (27%)	11 (30%)	3 (8%)	8 (22%)	5 (14%)
My mind goes blank and I am unable to think clearly when doing mathematics.	0 (0%)	5 (14%)	2 (5%)	11 (30%)	19 (51%)
I usually have been at ease during math tests.	12 (32%)	16 (43%)	3 (8%)	6 (16%)	0 (0%)
Mathematics makes me feel uncomfortable, restless, irritable, or impatient.	0 (0%)	5 (14%)	3 (8%)	14 (38%)	15 (41%)
I don't usually worry about being able to solve math problems.	6 (16%)	11 (30%)	9 (24%)	10 (27%)	1 (3%)
I usually have been at ease in math classes.	9 (24%)	19 (51%)	3 (8%)	6 (16%)	0 (0%)
I get a sinking feeling when I think of trying hard math problems.	0 (0%)	7 (19%)	6 (16%)	14 (38%)	10 (27%)
A math test would scare me.	1 (3%)	4 (11%)	3 (8%)	19 (51%)	10 (27%)
Mathematics usually makes me feel uncomfortable and nervous.	1 (3%)	3 (8%)	2 (5%)	18 (49%)	13 (35%)
It wouldn't bother me at all to take more math courses.	6 (16%)	13 (35%)	8 (22%)	10 (27%)	0 (0%)
Mathematics makes me feel uneasy or confused.	0 (0%)	5 (14%)	4 (11%)	15 (41%)	13 (35%)
Math doesn't scare me at all.	8 (22%)	14 (38%)	7 (19%)	7 (19%)	1 (3%)

Research Question 3

What is the frequency of classroom observations of mathematics lessons by elementary school administrators?

Formal observations. Study participants reported conducting 1,311 formal classroom observations (including resource classes) during the 2015-2016 SY. The number of formal classroom observations conducted by individual respondents ranged from 15 to 108 observations with the mean calculated at 35.43. The *SD* of total formal classroom observations conducted was 17.06.

The total number of formal classroom observations (including resource classes) conducted for mathematics lessons by the study participants during the 2015-2016 SY was 490 observations. In all, approximately 37.4% (490 out of 1,311) of the formal classroom observations conducted were for mathematics lessons. The number of formal classroom observations conducted for mathematics lessons ranged from 5 to 54 observations. The mean number of formal observations conducted for a mathematics lesson was 13.24 with a *SD* of 9.44.

Informal classroom walk-through observations. For this study, participants were also asked to provide the number of informal classroom walk-through observations conducted for the specific content areas of English, mathematics, science, social studies/social science, or resource lessons. If records of informal classroom walk-through observations were not available, participants were asked to assign an estimated percentage of their total informal classroom walk-through observations that were conducted in each of the curricular areas noted (equaling 100%). Twenty of the participants reported the number of informal classroom walk-through observations conducted in each of the content areas. The remaining 17 participants reported estimated percentages of their informal classroom walk-through observations conducted in each of the content areas.

Participants (n = 20) who reported numbers for informal classroom walk-through observations in each content area conducted a total of 2,036 informal classroom walk-through observations. Of those observations, approximately 50% of them were conducted for English lessons. Mathematics lessons were observed informally about 25% of the time. Table 5 provides the frequency, range, mean, *SD*, and percentages of informal classroom walk-through observations for the content areas provided in the survey.

Table 5

Observation Data of Total Number of Informal Classroom Walk-through Observations

	n	Frequency	Range	Mean	Std. Deviation	Percent (%) of Classroom Walk-Through Observations
English	20	993	140	49.65	40.692	48.8%
Mathematics	20	491	55	24.55	14.630	24.1%
Science	20	167	30	8.35	8.028	8.2%
Social studies/social sciences	20	162	34	8.10	9.142	8.0%
Resource	20	223	27	11.15	6.953	11.0%
Total	20	2,036				100.0%

Of the 37 participants, 17 respondents (*n* = 17) provided approximate percentages for informal classroom walk-through observations in each of the content areas listed (e.g., English, mathematics, science, social studies/social sciences, and resource classes). Participants indicated the percentage of informal classroom walk-through observations conducted for mathematics lessons ranged from about 9% to 40% of their total informal classroom walk-through observations conducted. The mean percentage indicated for informal classroom walk-through observations of mathematics lessons was approximately 23.5% with an *SD* of 11.36. These data are presented in Table 6.

Table 6

Estimated Percentages of Informal Classroom Walk-through Observations in all Content Areas

	n	Range	Min	Max	Mean	Std. Deviation
English	17	60	20.0	80.0	52.29	18.80
Mathematics	17	31	9.0	40.0	23.47	11.36
Science	17	20	0.0	20.0	8.12	5.67
Social studies/social sciences	17	10	0.0	20.0	5.67	5.02
Resource	17	15	0.0	15.0	7.77	4.01

Collectively, the majority of participants (89.2%) reported the percentage of informal classroom walk-through observations conducted for English lessons was either equal to or greater than the percentage of informal classroom walk-through observations conducted for mathematics lessons. Table 7 provides a summary of the percentage of informal classroom walk-through observations conducted in each of the content areas listed in the survey. Overall, mathematics lessons were observed informally about half as often compared to English lessons.

Table 7

Summary of Informal Classroom Walk-through Observations (Totals and Estimations)

	n	Range	Min	Max	Mean	Std. Deviation
English	37	68.7	18.5	87.2	49.02	17.61
Mathematics	37	41.4	5.8	47.2	24.89	10.34
Science	37	22.1	0.0	22.1	8.07	5.69
Social studies/social sciences	37	20.0	0.0	20.0	6.85	5.47
Resource	37	27.8	0.0	27.8	10.10	5.65

Research Question 4

What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

Attitude toward mathematics and classroom observations. For this study, elementary school administrators' attitudes toward mathematics were measured using the FSMAS-T instrument. The total scale score from the instrument ranged from 33 to 165 with a higher score indicating a more positive attitude toward mathematics and a lower score indicating a less positive attitude toward mathematics. The FSMAS-T instrument is comprised of three scales, which are identified in the summary table for the correlational analysis (Table 8). Scale scores were calculated for each scale within the FSMAS-T instrument in addition to the total scale score for each participant.

The observations of elementary school administrators were measured on a scale ranging from 0 to 100. The scale score was calculated using the frequency of classroom observations of mathematics lessons divided by the total number of classroom observations conducted (i.e., 8 mathematics lessons observed ÷ 42 total classroom observations conducted = 19.0). For the correlational analysis, each participant had two classroom observation scores: formal classroom observations of mathematics lessons and informal classroom walk-through observations of mathematics lessons.

Analysis of the relationship. To investigate the relationship between attitude toward mathematics and the frequency of classroom observations of mathematics lessons, a correlational analysis of the data were conducted. The Pearson product-moment correlation was calculated to assess the relationship between attitude toward mathematics and the frequency of classroom observations of mathematics lessons. In order to conduct a Pearson's correlation coefficient, there are five assumptions that should be met, which include:

(a) The study design has two continuous variables;

(b) The variables are being paired;

(c) A linear relationship exists between variables;

(d) There are no significant outliers; and

(e) The data were normally distributed within the variables (Laerd Statistics, 2015).

The first two assumptions were part of the design of this study. To test assumption three, scatter plots between study variables were examined using SPSS®. Although the data were widely spread, the researcher determined a linear relationship did exist through a visual inspection of the scatter plots. A visual inspection of the scatter plots did not indicate significant outliers in the data, but due to the spread within the scatter plots, the researcher performed calculations to identify any outliers within the data for formal classroom observations of mathematics lessons, informal classroom walk-through observations, FSMAS-T total scale score, Confidence in Learning Mathematics scale score, Effectance Motivation in Mathematics scale score, and Mathematics Anxiety scale score. The calculations determined there were two outliers within the formal classroom observation data. The researcher made the decision to analyze the correlation with and without the identified outlier data to determine if there was a considerable difference in the results; there was no considerable difference found. The last assumption, normality of the distributions, was examined using the Shapiro-Wilks test; not all variables were found to be normally distributed. The data for formal classroom observations of mathematics lessons and Confidence in Learning Mathematics scale scores within the FSMAS-T instrument did not pass the Shapiro-Wilks test. The researcher made the decision to run a

Pearson product-moment correlation despite these two data sets not being normally distributed, because Pearson's correlation is considered "somewhat robust in deviations from normality" (Laerd Statistics, 2015).

Pearson's correlation coefficients were calculated between formal classroom observations of mathematics lessons and the FSMAS-T total scale score, including the three scales within the instrument. Additionally, the correlation coefficients were calculated between informal classroom observations of mathematics lessons and the FSMAS-T total scale score, including the three scales within the instrument. Based on the analysis conducted with the data provided by study participants, there was no significant correlation found between the two variables, attitude toward mathematics and the frequency of classroom observations. A summary of the calculated correlation coefficients is provided in Table 8.

Table 8

Summary of the Pearson Product-Moment Correlations between Classroom Observations and Attitude toward Mathematics

		Formal Observations Mathematics	Informal Observations Mathematics	*M*	*SD*
Confidence	Pearson Correlation	-.095	-.024	39.86	8.30
	Sig. (2-tailed)	.577	.889		
	N	37	37		
Effectance Motivation	Pearson Correlation	-.121	-.021	39.73	6.58
	Sig. (2-tailed)	.477	.902		
	N	37	37		
Math Anxiety	Pearson Correlation	-.177	.006	45.27	9.91
	Sig. (2-tailed)	.294	.973		
	N	37	37		
FSMAS-T Total Score	Pearson Correlation	-.143	-.012	124.86	23.28
	Sig. (2-tailed)	.398	.944		
	N	37	37		
M		38.53	24.89		
SD		21.01	10.34		

Data Summary

This study sought to answer four research questions relating to the mathematics background, attitude toward mathematics, and the frequency of classroom observations conducted for mathematics lessons by elementary school administrators. In this chapter, the results of analyses were presented to address the research questions. The research questions were (a) What is the academic background in mathematics of elementary school administrators?; (b) What is the attitude toward mathematics of elementary school administrators?; (c) What is the frequency of classroom observations of mathematics lessons by elementary school administrators?; (d) What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators? The analysis utilized descriptive statistics and the Pearson product-moment correlation. The correlation coefficients were calculated for formal classroom observations and the FSMAS-T total scale score (including the three scales within the instrument) and informal walk-through classroom observations and the FSMAS-T total scale score (including the three scales within the instrument). The descriptive statistics results for mathematics background, attitude toward mathematics, and classroom observations were presented. Additionally, the results of the Pearson product-moment correlational analysis were also presented. In Chapter Five, the findings, implications of the findings, and suggestions for further research will be discussed.

CHAPTER FIVE
THE FINDINGS AND IMPLICATIONS

Introduction

Chapter Five contains a review of the purpose of the study, the research questions guiding the study, and the methodology applied in the study. This is followed by the findings presented along with implications for practice and suggestions for future research relating to this study. The chapter concludes with the researcher's summary and reflection of the process and experiences gained while conducting this study.

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. This study sought to investigate the following research questions:

1. What is the academic background in mathematics of elementary school administrators?
2. What is the attitude toward mathematics of elementary school administrators?
3. What is the frequency of classroom observations of mathematics lessons by elementary school administrators?
4. What, if any, is the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators?

The mathematics background, attitude toward mathematics, and the frequency of classroom observations of mathematics lessons by elementary school administrators were examined using descriptive statistics. The relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators were tested using the Pearson product-moment correlation. Following are the findings of the study.

Summary of Findings

The data were analyzed according to the research questions guiding this study. Several findings were identified from the analyses conducted. The findings are identified, supported by data, and connections to prior research are presented in the following paragraphs.

Finding 1. Elementary school administrators within the selected school division completed algebra and geometry courses in high school. A survey question in the study asked participants, "Which of the following mathematics courses did you complete during high school?" and provided courses for selection. Thirty-three of the 37 participants completed Algebra I, Geometry, and Algebra II in high school representing approximately 89% of the study sample. According to the VDOE graduation requirements, the mathematics courses Mathematical Analysis, Probability and Statistics, Trigonometry, and Calculus are considered to be at or above the level of Algebra II (www.doe.virginia.gov). Utilizing these requirements for comparison, less than 50% of the study participants completed a high school mathematics course beyond the level of Algebra II. About 18% (22 out of 124) of the reported high school mathematics courses completed by participants were above the level of Algebra II.

This finding supports Williams (2010) who found elementary school administrators completed a similar number of mathematics courses in high school (M = 3.35, SD = 1.26). The mean number of mathematics courses completed by participants in this study was 3.35 also, but the *SD* was 1.11. Stein and Nelson (2003) provide relevance in their research that found that mathematics content knowledge has a role in instructional leadership.

Finding 2. All elementary school administrators in the study completed College Algebra but few other college mathematics courses (aside from Mathematics for Elementary Teachers). All 37 participants in the study sample completed College Algebra, and approximately 70% (26 participants) completed the course Mathematics for Elementary Teachers in college. While 32 participants (86%) reported completing a college mathematics course other than College Algebra or Mathematics for Elementary Teachers, approximately 38% of these participants (12 out of 32) reported the only other course was Probability and Statistics. Only 9% (9 out of 100) of the college mathematics courses completed by participants were higher-level mathematics (e.g., College Geometry or Calculus).

This finding is in contrast with the work of Williams (2010) who reported a higher number of college mathematics courses completed by elementary school principals (M = 3.80, *SD* = 1.57). The mean number of college mathematics courses reported in this study was 2.70 with a *SD* of 1.35. Moreover, the large number of participants in this study that reported completing the Mathematics for Elementary Teachers course, yet indicating minimal mathematics anxiety, differs from Hembree (1990). Hembree (1990) found a relationship between college students taking mathematics courses targeted to elementary school teachers and their higher level of mathematics anxiety compared to students in other college mathematics courses.

Finding 3. Elementary school administrators in this study did not have teaching licensure endorsements specific to mathematics instruction. Approximately 95% (35 out of 37) of the participants did not have teaching licensure endorsements specific to mathematics. Two study participants did report having a teaching licensure endorsement relating to mathematics instruction (e.g. middle educations 6-8 mathematics and mathematics-Algebra I); this represented approximately 5.4% of the study sample. Study participants reported a total of 60 teaching licensure endorsements; therefore, the two mathematics endorsements represented only 3.3% of all teaching licensure endorsements held by the elementary school administrators in this study sample.

This finding is consistent with both Schoen (2010) and Williams (2010) who found the majority of elementary school principals held certifications in elementary education and few held certifications in mathematics. Only 3% of principals in Schoen's (2010) study held grades 6-12 mathematics certification, and 1% had certification in middle grades mathematics. Williams (2010) found about 4.5% of elementary principals had certifications in Grades 6-12 Mathematics or Grades 4-8 Mathematics. The research of Stein and Nelson (2003) has found the need for mathematics content knowledge in instructional leadership, "Without knowledge that connects subject matter, learning, and teaching to acts of leadership, leadership floats disconnected from the very processes it is designed to govern" (p. 446).

Finding 4. Elementary school administrators in this study had teaching licensure endorsements in elementary education. About 75% of the study sample reported a teaching licensure endorsement in the area of elementary education. Of the 60 teaching licensure endorsements reported by participants, 36 were an elementary teaching endorsement. This represented 60% of the total number of licensure endorsements noted.

This finding supports Schoen (2010) who found that 67% of principals in his study had an elementary education certification. Twenty-one percent of Schoen's (2010) participants had prekindergarten certifications as well. This finding also aligns with the research of Williams (2010) who found only 4.5% of the elementary principals in his study had any sort of mathematics teaching endorsement.

Finding 5. Elementary school administrators in this study had low levels of mathematics anxiety. Approximately 92% of the study sample had Mathematics Anxiety scale scores above the median of 30 on the 60-point scale. The mean scale score for participants was 45.27 with a *SD* of 9.91.

This finding differs from Hembree (1990) who found that elementary education majors in college had one of the highest levels of mathematics anxiety. This study does not support a high level of mathematics anxiety present in elementary school administrators who may have had training in elementary education college preparation programs.

Finding 6. Elementary school administrators in this study had a positive attitude toward mathematics. Using the FSMAS-T instrument to measure elementary school administrators' attitude toward mathematics, this study found that 23 out of 37 participants, approximately 62.2%, had total scale scores that indicated a more positive attitude toward mathematics. Participants were considered to have to a more positive attitude toward mathematics with a total scale score of 123 to 165.

This finding differs from Hembree (1990) who found less positive attitudes toward mathematics and higher levels of mathematics anxiety in college students majoring in elementary education. Elementary education majors represented the highest level of mathematics anxiety in scale scores compared to other college majors (Hembree, 1990).

Finding 7. Elementary school administrators in this study conducted observations of mathematics lessons half as often as they conducted observations of English lessons. Participants conducted informal classroom walk-through observations of mathematics lessons at a rate of approximately 25% compared to all informal classroom walk-through observations conducted. Participants reported conducting informal classroom walk-through observations of English lessons at a rate of approximately 50%. This study did not collect data for formal observations in content areas other than mathematics.

This finding has connections to the research of Robinson and colleagues (2008) who found that instructional leadership focused on active participation of school leaders in teacher learning and development can increase the effect size on student achievement. Although this study did not focus on student achievement as an outcome, it did assume that student achievement is influenced when teacher observations are conducted and feedback is provided to enhance instructional practices. This finding also supports both Archer et al. (2016) and Khachatryan (2015) who found conducting classroom observations and providing feedback and coaching to teachers can improve classroom instruction. Feedback and coaching appears to be happening at a lower rate in mathematics instruction according to this study's collected data.

Finding 8. There was no relationship between the attitude toward mathematics and the frequency of classroom observations of mathematics lessons for elementary school administrators in this study. The Pearson product-moment analysis found no significant relationship between the study variables, attitude toward mathematics and the frequency of classroom observations of mathematics lessons. This finding suggests that an elementary school administrator's attitude toward mathematics does not impact the number of observations conducted for mathematics lesson.

Schoen (2010) found no obvious relationship between mathematics knowledge for teaching and observation expertise in elementary school principals. While his study did not address the number of observations and mathematics knowledge, it did imply observation expertise was not related to mathematics knowledge. Other studies have found significant relationships with mathematics anxiety and attitude toward mathematics. Hadley and Dorward (2011) found a relationship indicating that elementary teachers with less mathematics anxiety were also less anxious about teaching mathematics. Both Hadley and Dorward (2011) and Hembree (1990) found mathematics anxiety and attitude toward mathematics impact decisions to participate in mathematical related jobs and tasks.

Implications of Findings

The results of this study have implications for school and division leaders. Education leaders can use the findings in this study to help improve instructional leadership practices that influence student achievement. The following provides implications for leadership practices.

Implication 1. Central office should consider a focused professional development for principals on the vertical articulation of mathematics concepts beyond the elementary level. The elementary school administrators in this study had limited exposure to higher level mathematics coursework and mathematics teaching licensure endorsements as indicated in Findings 1, 2, 3, and 4. The data showed the majority of elementary school administrators in this study completed mathematics courses at the level of Algebra I (n = 34, 92%) and College Algebra (n = 37, 100%) and only two participants had mathematics teaching licensure endorsements. Elementary school administrators require a broad understanding of how elementary level mathematics concepts connect to advance mathematical thinking and would benefit from exposure to the vertical articulation of mathematics through focused professional development. Dumay et al. (2013) reported a relationship between content knowledge and student achievement via the instructional leadership that principals provide. Siegler et al. (2012) found a predictive relationship between elementary level mathematics content and success in later mathematics courses. Research has continued to note the importance of early mathematics learning in building a strong mathematical knowledge base (Ball et al., 2005; Firmender et al., 2014; Siegler et al., 2015).

Implication 2. Central office should match school needs with school administrators who have a positive attitude toward content areas of focus for schools. The elementary school administrators in this study had low levels of mathematics anxiety (92%) and positive attitudes toward mathematics (62%) as indicated by Findings 5 and 6. There was no relationship found between these variables and the frequency of classroom observations of mathematics lessons as indicated by Finding 8. Together, these findings support the notion that when positive attitudes toward a content area are present, avoidance behaviors are not necessarily exhibited by elementary school leaders. Different schools have different areas necessitating growth. Student achievement in schools could be impacted by matching school leaders possessing a positive attitude toward specific content areas and schools with deficits in the same area. This is supported by both Hembree (1990) and Hadley and Dorward (2011) who found that teachers with a more positive attitude toward mathematics were less mathematically anxious. Administrators with more positive attitudes toward subject areas may be less anxious about supporting instruction in these areas, such as mathematics.

Implication 3. School leaders should increase the number of classroom observations of mathematics instruction. The elementary school administrators in this study conducted classroom observations of mathematics lessons half as often as the number of English lessons, which was indicated in Finding 7. Whether internal or external, there are motivators for school administrators to conduct or not conduct observations in mathematics classrooms. Conducting classroom observations and providing teachers with specific feedback helps improve the instructional practices of teachers (Archer et al., 2016; Khachatryan, 2015). Feedback to improve instructional practices in mathematics cannot happen if school leaders are not conducting observations of mathematics lessons. The active participation of school leaders in teacher learning is crucial for student achievement (Robinson et al., 2008).

Implication 4. Central office should consider explicit expectations for observations in mathematics classrooms for school leaders. The number of classroom observations of mathematics lessons (25% of informal classroom walk-through observations) was less than the number of classroom observations of English lessons (50% of informal classroom walk-through observations) conducted by elementary school administrators as indicated by Finding 7. Virginia and other states and commonwealths continue to monitor mathematics achievement with standardized assessments, which intensifies the need for monitoring mathematics instruction. Research has found that observations with specific, appropriate feedback and coaching improve instruction (Archer et al., 2016; Khachatryan, 2015) thereby impacting student achievement. Explicit expectations for school leaders regarding the observation of mathematics classrooms can aid student achievement in mathematics.

Suggestions for Future Studies

The results of this study may not provide a clear indication of the connection that attitudes toward mathematics have with the instructional leadership role of conducting classroom observations and providing feedback to teachers. Future research would benefit from the following considerations.

1. This study could be replicated at the division, state, or national level.
2. This study could be replicated with both elementary and secondary school administrators.

3. This study could be replicated in an urban school division at the elementary school level.
4. Researchers could consider administering the components of the survey from this study in multiple settings, over time, to lessen the potential answer bias by participants.
5. Researchers could conduct a study where observation data can be recorded regarding curricular lessons observed from primary documents (i.e., reviewing observation forms or human resource reports). Primary source documents could increase the potential accuracy of the data to further investigate the possible relationship with attitude toward mathematics, including its related mathematics anxiety.
6. Researchers could conduct a study investigating the possible relationship between attitude toward mathematics (or mathematics anxiety) of school administrators and student achievement.
7. Researchers could examine the difference in attitude toward mathematics (or mathematics anxiety) of school administrators and schools with varying levels of student achievement in mathematics.
8. Researchers could examine the difference in the frequency of classroom observations of mathematics lessons in schools with varying levels of student achievement in mathematics.

To aid in reporting and analyzing data, future researchers using this survey tool should consider modifying it to allow respondents to explain the meaning of *Other* to the questions relating to high school mathematics courses, college mathematics courses, and teaching licensure endorsements. The researcher recognized that knowing what the course(s) or endorsement(s) the selection *other* represented in the survey would have added value in fully describing the sample population in this study.

Findings Summary

Based on prior research and professional experiences, the researcher anticipated a relationship between an elementary school administrators' attitude toward mathematics and the frequency of classroom observations of mathematics lessons. It has often been acceptable to say "I'm not good at math," and that attitude can carry throughout life. Both Brush (1981) and

Hembree (1990) had found that elementary school teachers have some of the highest levels of mathematics anxiety or less positive attitudes toward mathematics. This study found that elementary school administrators lacked exposure to higher level mathematics coursework and teaching licensure endorsements. It did not find a statistically significant relationship between their attitude toward mathematics and the frequency of classroom observations of mathematics lessons when seeking to answer the research questions guiding the study.

Conclusions

The purpose of this study was to explore the relationship between the attitude toward mathematics, including related mathematics anxiety, and the frequency of classroom observations of mathematics lessons by elementary school administrators. Although data in this study did not support a relationship between attitude toward mathematics and the frequency of classroom observations of elementary school administrators, the prevalence of mathematics anxiety in students and teachers (especially connected to content knowledge) supports the need for further examination of the topic. The relationship between mathematics anxiety and instructional leadership practices warrants further examinations as well. Additionally, the connection between curricular attitudes and the frequency of classroom observations in content areas has the potential to influence student achievement. Educational leadership practices would benefit from research investigating the relationship between attitude toward different content subjects and classroom observations.

Upon reflection of this process, the researcher would make the following adjustments if completing the study again.

1. Investigate a larger population of participants.
2. Chose a different timeframe for the data collection; November and December were very busy months for elementary school administrators.
3. Gather data relating to the frequency of classroom observations of mathematics lessons at a separate time from the administration of the FSMAS-T instrument for measuring attitude toward mathematics, including its related mathematics anxiety.

This entire process has benefited my growth as an education professional and leader, as well as a researcher. My eyes have been opened to processes and thinking that I had not considered prior to this program. I look forward to utilizing the experiences and knowledge gained in this program and through this study to continue to contribute to the body of knowledge in education. I'm very interested in continuing to examine the topic of mathematics attitude and anxiety and classroom observations by school administrators.

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APPENDIX A
SURVEY INSTRUMENT

Participant Information Questionnaire

Directions: Answer the following questions by selecting the appropriate description, checking the appropriate box(es), and entering information where space is provided.

What is your current position?

❍ Elementary school principal
❍ Elementary school assistant principal
❍ Other

What was your position during the 2015-2016 school year?

❍ Elementary school principal
❍ Elementary school assistant principal
❍ Other

How many years have you served in an administrative position in education?

Did your school meet all benchmarks for accreditation in mathematics for the 2014-2015 school year?

❍ Yes
❍ No

Did your school meet all benchmarks for accreditation in mathematics last year (2015-2016)?

❍ Yes
❍ No

Which of the following mathematics courses did you complete during high school? (Select all that apply)

- ❑ Algebra I
- ❑ Geometry
- ❑ Algebra II
- ❑ Mathematical Analysis
- ❑ Probability & Statistics
- ❑ Trigonometry
- ❑ Calculus
- ❑ Other

Which of the following mathematics courses did you complete during college? (Select all that apply)

- ❑ College Algebra
- ❑ College Geometry
- ❑ Probability & Statistics
- ❑ Mathematics for Elementary Teachers
- ❑ Mathematics for Business
- ❑ Applied Mathematics
- ❑ Calculus I
- ❑ Calculus II
- ❑ Calculus III
- ❑ Other

Which of the following Virginia license endorsements do you have? (Select all that apply)

- ❑ Early/Primary Education PreK-3
- ❑ Early Education NK-4
- ❑ Elementary Education PreK-6
- ❑ Elementary Grades 4-7
- ❑ Middle Education Grades 4-8
- ❑ Middle Ed. 6-8 Mathematics
- ❑ Math Specialist for Elem & Middle Ed.
- ❑ Mathematics-Algebra I
- ❑ Mathematics
- ❑ Other

How many years teaching experience do you have (excluding administrative experience)?

______

How many years teaching experience do you have in a mathematics classroom? ______

Classroom Observations Questionnaire

Directions: Use the following definitions for *formal classroom observation* and *informal classroom walk-through observation* to answer the questions below.

Definitions:

Formal classroom observation – The observation of teaching as it is taking place in a classroom or other learning environment. *Formal classroom observations* are usually conducted by administrators or instructional specialists to provide teachers with constructive, critical feedback intended to assist the improvement of classroom management and instructional techniques. School administrators also conduct *formal classroom observations* regularly as an extension of job-performance evaluations (Hidden Curriculum, 2014).

Informal classroom walk-through observation – Classroom visit wherein principals or other administrators collect information about teaching practices or implementation of school initiatives to learn about teacher needs but not intended as an evaluation (David, 2007).

During the 2015-2016 school year, what was the total number of formal classroom observations (including resource classes) you conducted? ______

During the 2015-2016 school year, what was the total number of formal classroom observations you conducted for mathematics lessons? ______

If known, what was the total number of informal classroom walk-through observations (including resource classes) you conducted in each of the following areas during the 2015-2016 school year?

______ English lessons

______ Mathematics lessons

______ Science lessons

______ Social Studies/Social Sciences lessons

______ Resource class lessons

If the number of informal classroom walk-through observations conducted in the previous question is not known, please provide an estimate of the percentage of informal classroom walk-through observations you conducted in each of the following areas. (The total must equal 100)

______ English lessons

______ Mathematics lessons

______ Science lessons

______ Social Studies/Social Sciences lessons

______ Resource class lessons

_100__

Fennema-Sherman Mathematics Attitude Scales-Teacher (Ren et al., 2016) was adapted from the original instrument developed by Fennema and Sherman (1976).

Fennema-Sherman Mathematics Attitude Scales-Teacher

Directions: Rate how strongly you agree or disagree with each of the following statements by marking the appropriate field for each statement.

Most subjects I can handle O.K., but I have a tendency to mess up math.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I almost never get nervous during a math test.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

When a question is left unanswered in math class, I continue to think about it afterward.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Mathematics is enjoyable and stimulating to me.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

My mind goes blank and I am unable to think clearly when doing mathematics.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I am sure that I can learn mathematics.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I don't understand how some people can spend so much time on math and seem to enjoy it.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I'm not the type to do well in math.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Generally, I have felt secure about attempting mathematics.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

I usually have been at ease during math tests.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

I am challenged by math problems I can't understand immediately.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Math was my worst subject.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I have lots of self-confidence when it comes to math.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

The challenge of math problems does not appeal to me.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I think I could handle more difficult mathematics.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Mathematics makes me feel uncomfortable, restless, irritable, or impatient.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I don't usually worry about being able to solve math problems.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I usually have been at ease in math classes.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I get a sinking feeling when I think of trying hard math problems.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

A math test would scare me.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I'm no good at math.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Mathematics usually makes me feel uncomfortable and nervous.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Math puzzles are boring.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I can get good grades in mathematics.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

It wouldn't bother me at all to take more math courses.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Once I start trying to work on a math puzzle, I find it hard to stop.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Figuring out mathematical problems does not appeal to me.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Mathematics makes me feel uneasy or confused.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

Math doesn't scare me at all.

- ❍ Strongly agree
- ❍ Somewhat agree
- ❍ Neither agree nor disagree
- ❍ Somewhat disagree
- ❍ Strongly disagree

For some reason even though I study, math seems unusually hard for me.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

I do as little work in math as possible.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

APPENDIX B

PERMISSION TO USE FSMAS-T IN STUDY

Hi Molly,

Please see the forwarded email. Please let me know if you have any question regarding the measurement. Thanks!

Lixin

Sent from my iPhone

Begin forwarded message:

From: Wendy Smith <wsmith5@unl.edu>

Date: September 19, 2016 at 3:49:57 PM GMT+2

To: "lixin.ren@huskers.unl.edu" <lixin.ren@huskers.unl.edu>

Subject: Re: Permission to Use FSMAS-T

Reply-To: <wsmith5@unl.edu>

Lixin,

Yes, we can reply to her to say she is free to use FSMAS-T in her study (with a citation acknowledging us).

Thanks

Wendy

On Tue, Sep 13, 2016 at 7:33 PM, lixin.ren@huskers.unl.edu <lixin.ren@huskers.unl.edu> wrote:

Hi Wendy,

Please see the forwarded email. I guess there is no restriction in using the FSMAS-T, right? Thanks!

Lixin

Begin forwarded message:

From: Molly Sullivan <mlsull10@vt.edu>

Date: September 14, 2016 at 4:30:45 AM GMT+8

To: <lixin.ren@huskers.unl.edu>

Cc: Carol Cash <ccash48@vt.edu>

Subject: Permission to Use FSMAS-T

Ms. Ren,

I am writing to request permission to use the modified version of the Fennema-Sherman Mathematics Attitude Scales (FSMAS), the Fennema-Sherman Mathematics Attitude Scales for Teachers (FSMAS-T) in a research study I will be conducting.

I look forward to hearing from you.

Molly L. Sullivan
Doctoral Candidate
Virginia Polytechnic Institute and State University

APPENDIX C

INSTITUTIONAL REVIEW BOARD (IRB) TRAINING CERTIFICATE

Certificate of Completion

This certifies that

Molly Lynn Sullivan

Has completed

Training in Human Subjects Protection

On the following topics:

Historical Basis for Regulating Human Subjects Research

The Belmont Report

Federal and Virginia Tech Regulatory Entities, Policies and Procedures

on

September 3, 2014

David Moore, IRB Chair

APPENDIX D

VT IRB APPROVAL

VirginiaTech

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: October 18, 2016

TO: Carol S Cash, Molly Lynn Sullivan

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)

PROTOCOL TITLE: The Relationship between the Attitude toward Mathematics and the Frequency of Classroom Observations of Mathematics Lessons by Elementary School Administrators

IRB NUMBER: **16-934**

Effective October 18, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2,4**
Protocol Approval Date:	**October 18, 2016**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

APPENDIX E

DIVISION APPROVAL TO CONDUCT RESEARCH

October 25, 2016

Dear Ms. Molly Sullivan:

Your request to conduct research for your doctoral dissertation focused on *The Relationship between Attitude toward Mathematics and the Frequency of Classroom Observations of Mathematics Lessons by Elementary Administrators* at Virginia Polytechnic Institute and State University is approved. The approval is granted with the understanding that the following conditions will apply:

- Participation of administrators, counselors, and teachers is strictly voluntary.
- Parent permission must be obtained for student participation (if applicable).
- Names of individuals, school names or the name of the school division cannot be used in the reporting of the results of your findings without prior permission from the Department of Staff Development.
- All copies, distribution, retrieval of materials and arrangement of interviews/collections will be your responsibility.
- Questions/procedures must be limited to those detailed in your prospectus.

You may use this letter as a cover letter when contacting administrators and teachers. Should you have further questions, please feel free to contact me at

Sincerely,

(Research Approval)

APPENDIX F

REQUEST FOR PARTICIPATION

Dear Participant,

My name is Molly Sullivan, and I am a doctoral candidate at Virginia Polytechnic Institute and State University. I am requesting your help in my doctoral dissertation research by completing the survey linked below. My study aims to explore the relationship between curricular attitude and classroom observations. The population for participation in my study is elementary school principals and assistant principals in one Virginia school division.

The survey should take less than 20 minutes to complete. Please note that the survey will request data relating to the number of *formal classroom observations* and *informal classroom walk-through observations* conducted in different curricular areas last school year (2015-2016). You may wish to have information related to the number of these evaluations/observations conducted available when you begin the survey. If exact numbers for informal classroom walk-through observations are not known, the survey provides an opportunity for an approximation. I appreciate you being as accurate as possible in your answers.

Participation in this research is completely voluntary, and all responses will be anonymous. The survey data I receive will have no identifiers attached to it. This research will be used in my dissertation and possible publication when completed. Should you have any questions or concerns about the study's conduct or your rights as a research subject, or need to report a research-related injury or event, you may contact the VT IRB Chair, Dr. David M. Moore at moored@vt.edu or (540) 231-4991. The decision to participate will not have any effect on employment within the school division.

Thank you in advance for your support and assistance in completing my dissertation study. Once you have completed the survey, please disregard any reminder emails you may receive as I strive to complete the data collection process.

Please click the link below to complete the survey for my study. Your consent to participate in this study is indicated with the submission of the survey.

With Gratitude,

Molly Sullivan
Phone: (757) 270-5509
Email: mlsull10@vt.edu or mollylsullivan@yahoo.com

Follow this link to the Survey:

Take the survey

Or copy and paste the URL below into your internet browser:

https://virginiatech.qualtrics.com/SE?Q_DL=e55RdMi9gBGbEvX_ehaZj8RMyR8GhO5_MLRP_0fbRSpcKMdbQvHL&Q_CHL=email

Follow the link to opt out of future emails:

Click here to unsubscribe

APPENDIX G

FSMAS SCALE ITEMS AND CODING

Item #	Question/Statement by Scale	Positive/ Negative Statement	Reverse Coding
	Confidence in Learning Mathematics Scale		
1	Most subjects I can handle O.K., but I have a tendency to mess up math.	-	Reverse
6	I am sure that I can learn mathematics.	+	No
8	I'm not the type to do well in math.	-	Reverse
9	Generally, I have felt secure about attempting mathematics.	+	No
12	Math was my worst subject.	-	Reverse
13	I have a lot of self-confidence when it comes to math.	+	No
15	I think I could handle more difficult mathematics.	+	No
21	I'm no good at math.	-	Reverse
24	I can get good grade in mathematics.	+	No
32	For some reason even though I study, math seems unusually hard for me.	-	Reverse
	Effectance Motivation in Mathematics Scale		
3	When a question is left unanswered in math class, I continue to think about it afterward.	+	No
4	Mathematics is enjoyable and stimulating to me.	+	No
7	I don't understand how some people can spend so much time on math and seem to enjoy it.	-	Reverse
11	I am challenged by math problems I can't understand immediately.	+	No
14	The challenge of math problems does not appeal to me.	-	Reverse
23	Math puzzles are boring.	-	Reverse
26	Once I start trying to work on a math puzzle, I find it hard to stop.	+	No
27	Figuring out mathematical problems does not appeal to me.	-	Reverse

28	When a math problem arises that I can't immediately solve, I stick with it until I have the solution.	+	No
30	I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.	-	Reverse
33	I do as little work in math as possible.	-	Reverse
	Mathematics Anxiety Scale		
2	I almost never get nervous during a math test.	+	No
5	My mind goes blank and I am unable to think clearly when doing mathematics.	-	Reverse
10	I usually have been at ease during math tests.	+	No
16	Mathematics makes me feel uncomfortable, restless, irritable, or impatient.	-	Reverse
17	I don't usually worry about being able to solve math problems.	+	No
18	I usually have been at ease in math classes.	+	No
19	I get a sinking feeling when I think of trying hard math problems.	-	Reverse
20	A math test would scare me.	-	Reverse
22	Mathematics usually makes me feel uncomfortable or nervous.	-	Reverse
25	It wouldn't bother me at all to take more math courses.	+	No
29	Mathematics makes me feel uneasy or confused.	-	Reverse
31	Math doesn't scare me at all.	+	No

Ren, L., Green, J. L., & Smith, W. M. (2016). Using the Fennema-Sherman Mathematics Attitude Scales with lower-primary teachers. *Mathematics Education Research Journal*, *28*, 303-326.

Mulhern, F., & Rae, G. (1998). Development of a shortened form of the Fennema-Sherman Mathematics Attitudes Scales. *Educational and psychological Measurement*, *58*(2), 295-306.