A Value-Added Study of Math Teacher Effectiveness: A
Comparative Analysis of Principal Evaluations, Self-efficacy
Ratings, and Classroom Observations

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A Value-Added Study of Math Teacher Effectiveness:
A Comparative Analysis of Principal Evaluations, Self-efficacy Ratings, and Classroom Observations

A Dissertation Presented to
The Faculty of the School of Education
The College of William and Mary in Virginia

In Partial Fulfillment of the Requirements for the Degree of Doctor of Education

by
Shannon Schmidt Butler
February 2015
A Value-Added Study of Math Teacher Effectiveness:
A Comparative Analysis of Principal Evaluations, Self-efficacy Ratings, and Classroom Observations

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Dedication

This dissertation is dedicated to my wonderful family for allowing me to follow my dream and supporting me along the way. Spencer, you were the presence in our kids’ lives that allowed me the time it took for me to complete this journey. You are an unbelievable husband and father and I am eternally grateful for your support. Kase and Kendall, my greatest accomplishment in life is to be your mom. You two have been my greatest motivation and I hope that by walking through this journey with me, you see that with perseverance and the support of those around you, there is nothing that you can’t accomplish. I look forward to watching your every dream come true! Mom and dad, being the daughter of two incredible educators gave me the passion for such a wonderful profession. I thank you for your constant support, love and encouragement. To my sisters, in-laws, extended family and friends, thank you for your constant love, encouragement, and help in supporting me along with Spencer and the kids. Thank you all for believing in me! And to my sweet grandma, we often talked about how proud you were of my pursuit of this degree and my only regret is that you are no longer here to see its completion. I made a promise to you to complete this dream of both of ours and I know that you are smiling down on me with the utmost pride.
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A Value-Added Study of Math Teacher Effectiveness:
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Abstract

With recent global competition for innovation, job opportunities, and financial resources, it is more important than ever that United States develop and produce highly educated citizens for the future. Many researchers, policy makers and educators have wrestled with what variable has the largest impact on student achievement, and a large number have settled on teacher quality as that variable. Understanding what makes an effective teacher as well as how that translates into student learning is essential to giving students and our schools the greatest opportunity for success.

The purposes of this study were two-fold: 1) to explore the value-added impact of math teachers on their students' academic growth, and 2) to investigate selected teacher behaviors and dispositions that may be linked to teacher effectiveness. This was accomplished by a quantitative design that incorporated appropriate descriptive and inferential measures. Selected questions relied on correlational research which allowed for the analysis of relationships among multiple variables as well as the degree of these relationships in one study, making it possible to compare the relationships between teacher effectiveness as measured by value added statistics with teacher effectiveness qualities measured by classroom
observations, principal evaluations, and teachers' sense of self-efficacy in the area of elementary mathematics.

The results of this study found no significant relationship between a teacher's effectiveness as measured by value added statistics and their qualities as measured by principal evaluation ratings, classroom observation ratings, and teachers' sense of self-efficacy rating.

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CHAPTER 1
INTRODUCTION

"The success of U.S. public education depends upon the skills of the 3.1 million teachers managing classrooms in elementary and secondary schools around the country. Everything else – educational standards, testing, class size, greater accountability – is background, intended to support the crucial interactions between teachers and their students. Without the right people standing in front of the classroom, school reform is a futile exercise”

(Gordan, Kane & Staiger, 2006, p. 5).

Background of the Study

With recent global competition for innovation, job opportunities, and financial resources, it is more important than ever that United States develop and produce highly educated citizens for the future. Many researchers, policy makers and educators have wrestled with what variable has the largest impact on student achievement, and a large number have settled on teacher quality as that variable. Both the federal government and independent education organizations see teacher quality and effectiveness as “the crucial driving force for improving student achievement” and the only way in which the United States can promote its “economic competitiveness in a global society” (Akiba, LeTendre & Scribner, 2007, p. 369). Consequently, countless researchers have sought to create a knowledge base on
qualities of effective teachers and much of this research has focused specifically on qualities of effective mathematics teachers (Muijs & Reynolds, 2000).

Concern about U.S. students’ mathematics achievement is growing, and with each poor showing by American students on international math assessments, this concern continues to rise. In 2008, the United States (U.S.) Department of Education released the final report of the National Mathematics Advisory Panel which described American students’ math achievement as “mediocre” when compared with that of their peers throughout the world (Lewin, 2008). The performance of American students “makes it plain that the teaching and learning of mathematics needs improvement” (Ball, Hill & Bass, 2005, p. 14). Traditionally, improvement has been centered on curriculum and standards, but little improvement is actually possible without specific attention to the actual practice of teaching. Having strong math standards and quality curriculum are important, but “no curriculum teaches itself, and standards do not operate independently of professionals’ use of them” (Ball, et. al., 2005).

Mathematical knowledge and understanding is critical to a society for success in medicine, technology, finances, and many other fields. “This is as much a national priority as it is a practical necessity for the students themselves, because daily life involves math…” (Steedly, Dragoo, Araféh & Luke, 2008, p. 1). Because of the importance of this issue, educational leaders, researchers, and policy makers are faced with determining what the qualities of an effective math teacher are and what makes a math teacher effective. If these qualities are known, more can be done by instructors
and evaluators to ensure that teachers learn and possess these qualities at all levels of education.

Qualities of Effective Teachers

A consistent finding in educational research is that teachers are important for student learning. With that knowledge, it is evident that teacher effectiveness matters. This same educational research also has been consistent in reporting that great variation exists in teachers' levels of effectiveness. Because of this knowledge, it is critical to distinguish the factors that cause this variation. Understanding factors related to teacher effectiveness is a fundamental issue inherent to federal, state and local education policy discussions about qualities to promote in future teachers, whom to recruit and hire, and which qualities to base future pay scales on (Croniger, Rice, Rathbun & Nishio, 2007).

The difference between effective and non-effective teachers is not necessarily what they know, but what they do with that knowledge that truly makes a difference for students. In looking at research focused on identifying differences between more effective and less effective teachers, some behaviors such as taking attendance accurately or using technology appropriately, are present in both (Whitaker, 2004). It is what practices, characteristics and behaviors the best teachers do differently that set them apart. These qualities are often complex and hard to define; however, determining what these qualities are is crucial to teacher training and student achievement for the future.

Teacher quality is often difficult to measure, and as a result, most research studies focus on measurable teacher inputs such as years of experience, degree type,
and content knowledge. These studies often have produced mixed results, indicating that there is much more to be learned about what qualities are important to teacher effectiveness. In addition to these measurable qualities, it is important to look closely at other characteristics and behaviors found in the most competent and effective teachers. Stronge (2007) summarized decades of research on effective teaching and conceptualized key characteristics and behaviors using a framework with six domains, including: 1) prerequisites for effective teaching; 2) the teacher as a person; 3) classroom management and organization; 4) organizing for instruction; 5) implementing instruction; and, 6) monitoring student progress and potential. Within this framework, Stronge identified qualities (teacher characteristics and teacher behaviors) within each domain that have contributed to student achievement. It is important to examine these characteristics and behaviors identified by Stronge in order to develop a clear and deep understanding of how highly effective teachers manage the difficult and complex job of teaching while working with students to help them learn and achieve.

**Qualities of Effective Math Teachers**

The National Council of Teachers of Mathematics (NCTM) defined a highly qualified teacher as one who “understands how students learn mathematics, expects all students to learn mathematics, employs a wide range of teaching strategies, and is committed to lifelong professional learning” (NCTM, 2005). Numerous studies have concluded that the amount of knowledge that students learn can be traced to qualities and aspects of teachers and their instruction (Palardy & Rumberger, 2008). “To be effective, teachers must know and understand deeply the mathematics they are
teaching and be able to draw on that knowledge with flexibility in their teaching tasks” (NCTM, 2010, ¶4).

Background Characteristics.

While not the major determinant of teacher effectiveness, teacher qualifications and background characteristics do play a role in effectiveness in mathematics (Darling-Hammond & Ball, 1998). Background characteristics refer to factors such as a teacher’s certification and licensure, their mathematical subject matter knowledge (math content knowledge and pedagogical knowledge), their degree type and level, their verbal ability, and their experience. The federal government highlighted the importance of background characteristics such as these with the “highly qualified” provision found in No Child Left Behind (NCLB) (Palardy & Rumberger, 2008).

Instructional Practices

Instructional practices are often defined as teacher practice and students’ opportunity to learn including such things as student learning activities, questioning, student engagement, differentiation, technology integration and active learning. Instructional practices have the most direct influence on student learning. Muijs and Reynolds (2000) determined that specific individual practices and behaviors may only explain a small percentage of variance in pupil gains in mathematical achievement over time, but taking all of the practices or behaviors together as the definition of teacher effectiveness create a much more significant positive effect.
Self-efficacy

Teacher beliefs and their attitude toward mathematics play a key role in their effectiveness in teaching mathematics and their view of the definition of quality instructional practices. “Teacher efficacy has been defined as both context and subject matter specific” (Tschannen-Moran, Hoy & Hoy, 1998, p.215). This means that a teacher may feel competent with one particular subject or with one type of student but feel less competent with different subjects or different students (Tschannen-Moran, Hoy & Hoy, 1998). “There is a strong reason to believe that in mathematics, teachers’ conceptions (their beliefs, views, and preferences) about the subject and its teaching play an important role in affecting their effectiveness as the primary mediators between the subject and the learners” (Thompson, 1984, p. 105). Knowledge as well as attitudes and beliefs have a direct influence on instructional practice (Wilkins, 2008; Ingvarson et al., 2004). Studies have revealed that teachers with negative attitudes towards mathematics use more traditional teacher-directed instructional methods (Karp as discussed in Wilkins, 2008 and Swars, 2005a). These teachers with a lowered sense of self-efficacy are more likely to refrain from using innovative or exploratory instructional practices. In contrast, teachers who like mathematics, feel confident with it, and feel effective in teaching it are more willing to be creative and use inquiry-based methods of teaching mathematical concepts (Wilkins, 2008).

Rationale of the Study

Teachers are one of the most important factors in student learning and success. Stronge stated, "Among the factors within our control as educators, teachers
offer the greatest opportunity for improving the quality of life of our students" (2010, p. 1). Effective teachers motivate students to learn and encourage them to extend their experiences outside of the classroom (Hindman, 2008). Understanding what makes an effective teacher as well as how that translates into student learning is essential to giving students and our schools the greatest opportunity for success.

There has been a significant amount of research completed in recent years focusing on the impact of teacher effectiveness on student achievement. Research focusing on the value-added connection between teacher effectiveness and student learning has discovered that “teachers produce a strong cumulative effect on student achievement” (Stronge & Hindman, 2003, p. 48). Wright, Horn and Sanders (1997) summarized that "differences in teacher effectiveness were found to be the dominant factor affecting student academic gain" (p. 66). Thus, it is the role of administrators and policy makers to ensure that our students are being taught by the most effective teachers.

In order to ensure that students have the best chance of succeeding academically, schools and administrators must consistently do their part in putting effective teachers in the classroom. “The core of education is teaching and learning, and the teaching-learning connection works best when we have effective teachers working with every student everyday” (Stronge, 2006, p. 1). Thus, administrators need to use high quality teacher evaluations in order to determine the quality of teaching that is occurring in their schools. Evaluations must identify what good teaching looks like and translate that information to help all teachers get there (Stronge, 2006). “...teacher quality matters – and ... it matters a great deal. If we are
committed to this premise, then we must be committed to populating our schools with the highest quality teachers possible” (Stronge, Gareis, & Little, 2006, p. 2). Teacher effectiveness is the most important controllable factor in education, so being able to successfully evaluate teacher effectiveness is crucial to the growth and learning of students.

Statement of the Problem

It is more important than ever that math teachers be effective in the classroom in order to improve student achievement. The National Council of Teachers of Mathematics (2000) has presented a new vision for teaching mathematics and in this reformed vision; teachers are the most critical component. Improving teacher quality in mathematics is the most effective option for educational leaders seeking to improve student achievement in mathematics (Darling-Hammond & Ball, 1998).

More specifically, this study hoped to investigate the problem of what specific characteristics and behaviors make elementary teachers effective in teaching mathematics. The field of mathematics has gained importance over the past decade due to teacher shortages and the impact of accountability brought about by NCLB. Research has shown that elementary teachers generally have a command of the facts and basic procedures that encompass elementary level mathematics, but they often lack a conceptual understanding of this mathematics (Wilkins, 2008). Many new or aspiring elementary math teachers assume that memories of their school days and common sense is enough subject matter preparation needed to teach elementary math; however, research shows the importance of teachers’ knowledge of mathematics on their ability to teach it and which instructional strategies that they use (Ball, 1988).
This study was based on the fundamental premise that effective teaching by quality teachers truly makes a difference in student learning and achievement in mathematics. Finding the key qualities and characteristics of effective mathematics teaching required exploration and investigation of mathematics teachers' practices and behaviors. These findings were generated by observing classroom teaching and the practices of teachers, the experience of principal’s in their evaluation of teachers, and the professional thinking of teachers in their own ability.

**Statement of the Purpose**

The main purpose of this study was to build upon Stronge’s framework of teacher quality as it relates to math teacher effectiveness. Using educational research conducted throughout the past, Stronge (2002, 2007) chronicled the common background and identified common behaviors that often characterize teachers as effective and contribute to student achievement. Specifically, the purposes of this study were two-fold: 1) to explore the value-added impact of math teachers on their students’ academic growth, and 2) to investigate selected teacher behaviors and dispositions that may be linked to teacher effectiveness.

**Research Questions**

This study will address the following research questions:

1. What is the value-added effect of 4th and 5th grade math teachers on their students’ academic growth as measured by the Virginia Standards of Learning?

2. Are the value-added profiles in terms of distributions between the 4th and 5th grade teachers comparable?
3. To what extent do principals' evaluations of 4th and 5th grade math teachers correlate with teachers' level of math teaching effectiveness as measured by value-added student achievement scores?

4. To what extent do 4th and 5th grade math teachers' reported self-efficacy scores correlate with their level of math teaching effectiveness as measured by value-added student achievement scores?

5. How do 4th and 5th grade math teachers' effectiveness ratings as determined by value-added student achievement scores compare with their effectiveness ratings as determined by classroom observation on selected teacher effectiveness attributes?

Significance of the Study

Improvement in education is not possible without specific attention to the actual practice of teaching. If teachers truly offer the greatest opportunity for improving the quality of learning for students, then it is essential that policy makers and educators generate a more thorough understanding of what makes a teacher effective. This dissertation study, by closely observing mathematics classrooms, comparing principals' evaluations of teachers, and soliciting teachers' perceptions of their self-efficacy, can contribute to this specific understanding. Knowing which characteristics of teachers truly make a difference in their effectiveness can help create experiences and training opportunities for teachers that, in turn, can create enhanced learning opportunities and a better quality of education for students.
Definitions of Key Terms

The following definitions are offered to provide constitutive definitions for terms discussed during the context of this study:

Background characteristics: Background characteristics refer to factors such as a teacher's certification and licensure, their subject matter knowledge (math content and pedagogical content), their degree type or level of degree, their teaching experience, and their verbal ability. These are often referred to as prerequisites of teachers.

Classroom management: Classroom management is the practice that a teacher uses in order to create a well-ordered environment in which instruction and student learning can occur (Wong, 2009). This consists of the practices and procedures that can include rules, procedures, disciplinary interventions and teacher-student relationships.

Content knowledge: Content knowledge refers to the knowledge of a specific subject often gained through actual coursework. It includes the ability to understand the subject itself and use the that knowledge to carry out the task of teaching (Hill, Rowan & Ball, 2005)

Instructional delivery: Instructional delivery is the action of the teacher in providing instruction to students. This process involves the application of different instructional strategies and communication skills used to engage students in the content that they are learning.

Instructional practices: Instructional practices are defined as teacher practice paired with students' opportunity to learn including such things as student learning activities, questioning, student engagement, differentiation, technology integration and active
learning. Teachers’ instructional practices include their use of different teaching strategies and instructional materials.

**Pedagogical content knowledge:** Pedagogical content knowledge refers to a teacher’s knowledge of how to teach a subject rather than actual knowledge of the subject itself. This often includes the knowledge of using curriculum materials, using representations and tools, interpreting and responding to their student work and creating useful assignments for students (Ball, Lubienski, & Mewborn, 2001; Rowan, Chiang, & Miller, 1997).

**Planning for instruction:** Planning for instruction focuses on the actions of the teacher in preparing both short and long-term instructional lessons for students. This includes organizing time, preparing materials, selecting specific content, identifying learning objectives, selecting instructional strategies and designing learning and assessment activities.

**Self-efficacy:** Self-efficacy is a motivational construct. Self-efficacy beliefs are people’s judgments and perceptions of their own ability to perform an action (Pajares, 2002).

**Subject matter knowledge:** Subject matter knowledge refers to the pairing of content knowledge with pedagogical content knowledge. Subject matter knowledge bridges subject specific content knowledge and the practice of teaching and assures that discussions of the specific content are relevant to teaching and those discussions of teaching focus attention on the content (Ball, Thames & Phelps, 2007).

**Teacher self-efficacy:** Teacher self-efficacy is identified as a type of self-efficacy that focuses on the views of teachers and their beliefs in their ability to teach and be
effective in the classroom. Teacher self-efficacy can also be identified as a teachers’ belief that he or she can make a difference in how well a student learns or the extent to which they can affect a student’s achievement (Guskey & Passaro, 1994).

Value-added student achievement scores - Value-added student achievement scores are statistical measures of student achievement based on a growth model created by pre- and post-testing. This method of measuring student achievement removes the effects of many factors not controlled by the teacher and provides a more accurate estimate of teacher effectiveness on student academic growth.

Delimitations and Limitations of the Study

Limitations are restrictions of the study over which the researcher is able to exert no control (Rudestam & Newton, 2007). Although it is believed that the substantive understanding of the phenomenon (i.e., teacher effectiveness) that will be generated by this study should be replicable by other studies examining highly effective teachers, it is possible that the limitation of using one school division in one county of Virginia in this study limits the generalizability of the findings. In addition, focusing solely on math instruction may limit the ability to generalize these findings to other subjects. These factors limit the ability to generalize the results of this study beyond the school district or subject area participating in this study.

Delimitations are factors to the planned research design that have deliberately been imposed by the researcher (Rudestam & Newton, 2007). Data collection and analysis of this study was limited to all fourth and fifth grade teachers in one school district in Virginia. Due to the focus on one school district and on two elementary grade levels, the findings of this study may not be generalizable beyond the school
district studied and the corresponding grade levels. In addition, the total population of students found in the testing database was reduced to a smaller sample used for the study. Students were not included in the study if they did not have a score for both the 2009-2010 and 2010-2011 school years or if they took an alternative assessment other than the SOL test for that grade level. Due to these planned reductions in sample, the findings of this study may not be generalized to include true populations including transfer students and students with disabilities.

Assumptions

Certain data from this study were dependent on the self-reports of teachers and evaluative reports of administrators on the survey instruments. The responses of the teachers were assumed to accurately reflect their perceptions and beliefs of their own math teacher self-efficacy during the timeframe when the survey was administered. The responses of the administrators were assumed to accurately reflect their perceptions of teachers’ ability to be effective in teaching mathematics and to properly evaluate teachers in their respective schools.
CHAPTER 2
LITERATURE REVIEW

"The core of education is teaching and learning, and the teaching and learning connection works best when we have effective teachers working with every student every day" (Stronge, 2006, p. 1).

This chapter provides an in depth discussion of decades of research on teacher effectiveness beginning with why teaching matters to student learning. Qualities of effective teaching including prerequisites, teacher disposition, classroom management, planning, implementation of instruction and assessment are all examined. The researcher closely examines qualities related to math teacher effectiveness and past research focusing on the impact of background characteristics, instructional practices and teacher self-efficacy. In addition, this chapter discusses the impact and importance of teacher evaluation and its importance in creating a quality teaching force.

Why Do Teacher’s Matter?

In a review of state policy evidence, the states that repeatedly outperform the others in student achievement in both math and reading, have among the most highly qualified teachers in the country and have made huge investments in the quality of teaching (Darling-Hammond, 1999). Few could argue that teachers are the most important factor in student achievement and in determining whether students will learn (Polly, 2008). Research has even determined that quality teaching can eliminate
achievement deficits for even the lowest students. Getting rid of the bottom 6 to 10 percent of teachers and replacing them with just average teachers “would be enough to make U.S. students the leader in math and science” (Duffrin, 2011, p. 50). Without effective, high quality teachers in every classroom and in every school, no educational reform effort can properly succeed (Stronge, 2006).

**Teacher Effectiveness and Student Achievement**

Many studies have substantiated that an entire range of both personal and professional qualities are associated with high levels of student achievement (Tucker & Stronge, 2005). In 1997, using data from the Tennessee Value-Added Assessment System (TVAAS), Wright, Horn and Sanders conducted numerous studies that collectively found that teacher effectiveness "is the major determinant of student academic progress" (Stronge, 2010, p. 3). These multiple TVAAS studies found a direct link between the effectiveness of teachers and student achievement. They argued that teachers truly do make a significant difference for children. Good, McCaslin, Tsang, Zhang, Wiley and Bozack (2006) agreed in stating, “there is strong research evidence and social consensus that teachers make a difference in student achievement” (p. 412).

Two 1998 studies completed by Mendro, Jordan, Gomez, Anderson and Bembry found that teachers not only have large effects on student achievement, but also that these "measures of effectiveness are stable over time" (Stronge, 2010, p. 6). In an additional study, Rockoff (2004) found that "a one-standard-deviation increase in teacher quality raises student test scores by approximately 0.1 standard deviations in reading and math on nationally standardized distributions of achievement"
These particular studies illustrated the impact that teacher effectiveness has on student learning both immediately and over time. "Research consistently suggests that among the educational variables that can influence student achievement, the quality of the teaching is most important" (Good, et al., p. 412).

**Math Teacher Effectiveness and Student Achievement in Math**

In order to foster and support successful mathematical leaders of the future, mathematics teachers must be effective (U.S. Department of Education, 2008). Teachers are the critical piece to children's math learning, the conduits between the child and the math curriculum (Burns, 1999). Aaronson, Barrow, and Sanders (2007) found that having a teacher who was rated two standard deviations higher than other teachers in quality could add between 25 and 45 percent growth in a student's mathematics score in just one school year. Bill Sanders used the aforementioned data from TVASS to determine that when children were placed with three effective or high performing teachers in a row, they scored on average at the 96th percentile on Tennessee's statewide mathematics assessment after completing 5th grade. Children with comparable histories of math achievement that were placed with less effective teachers three years in a row had an average score in the 44th percentile on the same mathematics assessment. This significant 52-point percentile point difference reinforces the notion that math teacher effectiveness truly impacts student achievement in mathematics (Tucker & Stronge, 2005).

**Qualities of Effective Teachers**

As a strategy to improve U.S. education, No Child Left Behind (NCLB), added a highly qualified provision for teachers ensuring that teacher's defined as...
"highly qualified" would hold certain criteria and demonstrate competence in the subject that they were assigned to teach. Teacher effectiveness however, is defined by a much more complex set of qualities than just professional preparation (Tucker & Stronge, 2005). As Tucker and Stronge (2005) stated, “Effective teachers are able to envision instructional goals for their students, and then draw upon their knowledge and training to help students achieve success” (p. 6). Being “highly qualified” is certainly important and a great place to start, but planning, organizational, and instructional skills in the classroom are important to having a highly effective teacher whose teaching produces quality student learning (Tucker & Stronge, 2005).

Quite a significant amount of recent research has examined stakeholders’ perceptions of what makes a good teacher or what good teaching looks like. While instructional factors and management are keys to effectiveness, other more affective characteristics such as listening, understanding and other psychological factors have been linked to student achievement in a number of studies (Stronge, 2002). Stronge (2007) presented a framework for six teacher qualities based on a meta-review of a large amount of research on teacher effectiveness. These six qualities – prerequisites of effective teaching, teacher dispositions, classroom management, planning for instruction, implementing instruction, and assessing student progress – are all essential for teaching effectiveness in all subjects and grades.

**Prerequisites for Effective Teaching**

Prerequisites of teaching include the preparation made by the teacher prior to stepping into a classroom setting. These often include characteristics such as a teacher’s educational background, professional preparation, verbal ability, content
knowledge, educational coursework, and teacher certification. Often, these characteristics taken collectively can have a definite impact on teacher effectiveness and student learning. Teachers without proper preparation, including content specific coursework, a formal collegiate degree, and teaching certification, tend to be less effective and often struggle with overcoming barriers in teaching and student learning (Fetler, 2001).

Teacher Dispositions

Teacher dispositions are often based on a teacher’s nonacademic interactions with students and on their professional attitude towards their students and the profession of teaching itself. Effective teachers have high expectations for students but even greater expectations for themselves. Less effective teachers have high expectations for students but much lower expectations for themselves. In addition, these less effective teachers often have unrealistically high expectations for everyone else including parents, the school administration, and other teachers (Whitaker, 2004).

Highly effective teachers create a positive atmosphere in their classrooms at all times. They show respect to all of their students, all of the time and they understand the power of praise. An effective teacher looks for opportunities to find students doing the right thing and uses praise to ensure that they will continue to do the right things (Whitaker, 2004). In order to be effective, this praise must be authentic, specific, and immediate.

Classroom Management

A teacher’s classroom management sets the stage for student learning, and the most effective teachers are very clear about their approach to student behavior. Great
teachers set expectations from the first day of class and then build relationships with students so that students want to meet these expectations. Effective teachers are motivated to prevent misbehavior from occurring, while ineffective teachers are motivated to punish a student after that student misbehaves (Whitaker, 2004). In order to establish an effective classroom environment that is conducive to teaching and learning, a teacher must have a quality grasp of classroom management.

Most educators agree that one of the best ways to maintain good discipline is to conduct quality, highly engaging and motivational lessons (Posamentier, Jaye & Krulik, 2007). “Considerable evidence suggests that a teacher’s ability to allocate the appropriate time for instruction, to provide smooth transitions during the academic day, to generate and consistently apply rules and procedures in the classroom, and to pace instruction enhances the use of instructional time” (Jones, Palincsar, Ogle & Carr, 1987, p. 33). These classroom management activities serve as conduits in preparing a sound learning environment and a place where effective teaching can occur.

Planning for Instruction

Planning for instruction often includes the practices of maximizing the amount of time allocated for instruction, communicating expectations for student achievement, and planning for instructional purposes. Effective teachers have a plan for everything that they do and if things do not go well, they reflect on what they could have done differently and adjust accordingly (Whitaker, 2004). The plan itself often serves two purposes: to provide the teacher with a guide or notes to use in conducting the lesson and to give the teacher the opportunity to mentally rehearse the
lesson prior to delivering it (Posamentier, Jaye & Krulik, 2007). Effective teachers consistently and intentionally “arrange, rearrange, alter, and adjust the structures that frame their teaching. Their classroom set-up, their instructional approaches, their time management – all are carefully planned to promote a productive learning environment” (Whitaker, 2004, p. 85).

Implementing Instruction

Implementing instruction in the classroom involves the practices and strategies that a teacher uses to deliver instruction to students. It often includes using differentiated instructional strategies that meet the diverse needs of all students. Instructional strategies should include affective strategies that serve to focus attention and maintain motivation, strategies that serve to monitor learning such as self-questioning, and strategies that serve to organize information for students (Jones, Palincsar, Ogle & Carr, 1987). Using questioning techniques that support student engagement and learning are critical to quality implementation. Effective questioning clarifies and validates learning for the students and keeps them actively engaged. Effective teachers understand the complexities of teaching and implement lessons that make students active participants in the learning process (Posamentier, Jaye & Krulik, 2007).

Assessing Student Progress

Assessment is an essential element of the teaching process and should be used to determine the effectiveness of a lesson (Stronge, 2002). Assessing student progress often includes practices such as using homework and ongoing assessment to gain knowledge of student learning, providing meaningful feedback in a timely
fashion, and applying the findings of student assessment data to improve instruction. A quality formal assessment “should resemble the types of activities and thinking in which the students were engaged during the learning process and not merely be a forum for recalling facts without any application or reasoning and problem solving strategies” (Gilkey & Hunt, 1998, p. 4). Effective teachers use a variety of ways to monitor and assess student learning in order to make a positive impact on student achievement (Stronge, 2002).

**Qualities of Effective Math Teachers**

For mathematics teachers to be effective they must “embrace the goals of helping all students develop confidence in becoming mathematic problem solvers who value mathematics and are able to reason and to communicate mathematically” (Gilkey & Hunt, 1998, p. 4). Sutton and Krueger (2002) attempted to define the qualities of effective math teachers by stating the that “Highly effective mathematics teachers

- Have a deep knowledge of subject matter, which enables them to draw on that knowledge with flexibility
- Encourage all students to learn for understanding
- Foster healthy skepticism
- Allow for, recognize, and build on differences in learning styles, multiple intelligences, and abilities
- Carefully align curriculum, assessment, and high standards
- Conduct interim assessments of students’ progress and use the results to improve instruction
• Measure instructional effectiveness through student performance and achievement

• Use a problem solving approach” (p. 27).

The rapidly changing global workplace demands more quantitative and scientific knowledge and requires workers who can think creatively, collaborate together, and solve complex problems that may not even exist yet (Seeley, 2009). Knowing this, it is more important than ever that we recognize the growing importance of “providing students with a well-balanced mathematics program so that they can make sense of mathematics, based on conceptual understanding, perform appropriate computational procedures, and solve a variety of challenging problems…” (Seeley, p. 172). While all of the qualities of effective teachers mentioned in the previous section are important in the teaching of all subjects, recent research has suggested that three categories stand out as crucial to success in effective mathematics teaching. These three - background characteristics, instructional practices, and teacher self-efficacy – and the impact that they have on math teacher effectiveness are all discussed in depth in the sections that follow.

Impact of Background Characteristics on Math Teacher Effectiveness

Teacher qualifications and background characteristics play a key role in teacher effectiveness in mathematics (Darling-Hammond & Ball, 1998). Background characteristics refer to factors such as a teacher’s certification and licensure, their subject matter knowledge (math content and pedagogical content), their degree type or level of degree, their teaching experience, and their verbal ability. These are often referred to as prerequisites of effective teachers. The effects of these prerequisites for
well-prepared teachers on student achievement in mathematics can outweigh other important variables such as student background and school effects (Croninger, Rice, Rathbun, & Nishio, 2005). Often it is not the impact that each of these characteristics has individually on a teacher’s ability to be effective that matter significantly, but the collective impact of all of the background characteristics mentioned above that makes a huge difference.

During the 1999-2000 school year in the United States, 66.2% of middle school math teachers and 24.6% of high school math teachers did not have a certification or degree in mathematics. As a result, 23% of middle school students and 10% of high school students were taught by teachers without proper content knowledge and certification training in mathematics (U.S. Department of Education, 2003). The importance of background characteristics is highlighted within the “highly qualified” provision found in No Child Left Behind which focuses solely on such prerequisite characteristics (Palardy & Rumberger, 2008).

The National Council of Teachers of Mathematics (NCTM) defined a highly qualified mathematics teacher as one who “understands how students learn mathematics, expects all students to learn mathematics, employs a wide range of teaching strategies, and is committed to lifelong professional learning” (NCTM, 2005). Numerous studies have concluded that the amount of knowledge that students learn can be traced to qualities and aspects of teachers and their instruction (Palardy & Rumberger, 2008). “To be effective, teachers must know and understand deeply the mathematics they are teaching and be able to draw on that knowledge with flexibility in their teaching tasks” (NCTM, 2010, ¶4).
Although proper content knowledge, certification and experience are not the only qualities that impact math teacher effectiveness, educational research points to their importance. Multiple studies have connected the collection of background characteristics to teacher effectiveness as measured in terms of student achievement. Highlights of some of these studies are described below:

- Clotfelter, Ladd and Vigdor (2007) conducted a ten year longitudinal study throughout North Carolina. In this study, the researchers concluded that teacher experience, teacher test scores and teacher licensure all have positive effects on student achievement in math. They found that even when taking account for class size and student characteristics, the various teacher credentials had large effects on student achievement.

- In a study produced by the University of Washington Center for the Study of Teaching and Policy, results concluded that measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and mathematics (Darling-Hammond, 1999).

- Fetler (2001) found that teacher preparation and experience continued to demonstrate a significant association with student achievement in mathematics. The researcher concluded that better prepared teachers are more effective in their jobs and assist more students to reach their highest potential in math.

- Ingvarson, Beavis, Bishop, Peck, & Elsworth (2004) researched a number of different teacher effects on student achievement with a primary focus on what makes more or less effective teachers. When looking specifically at
background effects as defined in this paper, the researchers found that teacher knowledge and educational background are positively related to teacher effectiveness. The researchers further determined that the more this education includes mathematical content and pedagogy, the greater the likelihood that teachers will be effective.

Teachers without preparation, including subject matter knowledge and coursework, mathematics degree, and certification, struggle with anticipating and overcoming barriers in teaching and student learning (Fetler, 2001). "The effects of teachers with degrees in mathematics and appropriate certifications, and possible higher level mathematics courses, appear to be strongly and consistently related to student achievement in mathematics" (Goe, 2007, p. 3). This is true at all levels of secondary and elementary mathematics, but the effects are stronger at the secondary level (Goe, 2007). Background characteristics collectively impact teacher effectiveness and therefore, have an impact on student learning and achievement in mathematics.

Subject Matter Knowledge

In recent years, teachers’ knowledge of the subject matter that they teach has attracted increasing attention from policymakers at all levels of government in part because of evidence suggesting that U.S. teachers lack essential knowledge for teaching mathematics (Hill, Rowan & Ball, 2005). It is now more important than ever that mathematics teachers know the math content that they are teaching as well as how to teach it effectively (Cavanagh, 2009; Cavanagh, 2008; Hill, Rowan & Ball, 2005). Subject matter knowledge refers to the pairing of math content knowledge
(math content coursework and test scores) with pedagogical content knowledge (coursework in teaching methods courses and student teaching). This type of subject matter knowledge “bridges content knowledge and the practice of teaching, assuring that discussions of content are relevant to teaching and that discussions of teaching retain attention to content” (Ball, Thames & Phelps, 2007, p. 3).

The effects of a mathematics teachers’ content knowledge has a greater impact when that knowledge is paired with coursework in pedagogy (Ingvarson et al., 2004). Math teachers’ knowledge of their subject and how to make it accessible to their students relies on a deep understanding of both the math content and of the learning process of their students (Darling-Hammond & Baratz-Snowden, 2007). Without the pairing of this knowledge, teachers may lack the resources and abilities to solve problems of their work such as using curriculum materials, using representations and tools, interpreting and responding to their student’s work and creating useful assignments for students (Ball, Lubienski, & Mewborn, 2001; Rowan, Chiang, & Miller, 1997). Understanding the ideas connected to a particular mathematical topic matter with any approach to teaching that topic to students.

“Teachers not only need to acquire a set of skills; they also need to become adaptive experts who are able both to use efficient routines and to seek out and apply new strategies in situations where routines are not enough” (Darling-Hammond & Baratz-Snowden, p. 115). Appropriate knowledge of mathematics content and pedagogy is essential for teachers to effectively address the mathematical needs of all types of students (Sutton & Krueger, 2002).
Mathematics Content Knowledge and Coursework. Mathematics teachers’ content knowledge and knowledge about teaching the subject plays a significant role in the teaching of all levels of mathematics from early elementary to high school Advanced Placement (AP) courses. Mathematical content preparation has been found to be positively related to student achievement (Stronge, 2002). Teacher effects on student achievement in mathematics are often driven by teachers’ ability to understand and use mathematical knowledge to carry out the task of teaching (Hill, Rowan & Ball, 2005). “How well teachers know mathematics is central to their capacity to use instructional materials wisely, to assess students’ progress, and to make sound judgments about presentation, emphasis, and sequencing” (Ball, et. al., 2005, p. 14).

“Several studies have illustrated that teachers with greater subject matter knowledge tend to ask higher level questions, involve students in the lessons, and allow more student-directed activities” (Stronge, 2002, p. 9). Effective teachers must have a firm understanding of how students learn mathematics so that they can anticipate student misunderstandings and plan appropriate questions. “The foundation of good questioning is strong content knowledge, which is a critical factor in enabling teachers to understand and respond appropriately to students’ questions” (Sutton & Krueger, 2002, p. 17). Well-prepared and knowledgeable mathematics teachers produce more successful mathematics students (Wenglinsky, 2000). Teachers’ mathematical content knowledge plays a crucial role in their effectiveness and choice of instructional strategies (Wilkins, 2008). It is not unreasonable to
believe that more highly educated and experienced teachers possess greater skill and are therefore more effective (Fetler, 2001).

In order for teachers to become mathematically proficient, Hiebert, Morris and Glass (2003) argue that teachers must possess 1) conceptual understanding – the comprehension of math concepts, operations, and relations; 2) procedural fluency – the skill to carry out procedures flexibly, accurately, efficiently and appropriately; 3) strategic competence – the ability to formulate, represent and solve mathematical problems; 4) adaptive reasoning – the capacity for logical thought, reflection, explanation and justification; and 5) productive disposition – the habitual ability to see math as sensible and worthwhile while having a belief in one’s own ability.

Subject matter knowledge for mathematics goes beyond that taught in strict math content courses or basic math skills. “It is not only the knowledge of math content but also knowledge of how to teach math content that influences teachers’ effectiveness” (Hill, Rowan & Ball, p. 377). Teachers must know and be comfortable with the mathematical content they are responsible for teaching. They must be able to make connections with this math content and other important mathematical ideas, both prior to and beyond the level they teach (Cavanagh, 2008). Their coursework in both math content courses and math methods courses may all have an effect on their sense of self-efficacy in teaching math and thus their ability to teach math effectively (Wilkins, 2008).

Increased coursework in mathematics would hopefully lead to greater content knowledge which would seem to facilitate teachers’ ability to use a variety of successful instructional practices (Wilkins, 2008). It is not necessarily how many
courses that is important, but which courses have an “appreciable impact on a
teacher’s ability to teach specific subjects” (Allen, 2003, p. 4). What ultimately
matters most is whether and how teachers are able to use mathematical knowledge in
the course of their work (Ball, Lubienski & Mewborn, 2001).

**Pedagogical Content Knowledge and Coursework.** Both knowledge of
content and knowledge of pedagogical content have been shown by researchers to be
essential for teaching effectiveness (Glatthorn, 1997). Courses and training must be
instructionally relevant and not just focus on generic math content. “There is a
growing recognition of the need to give aspiring math teachers, particularly those
who will teach in the early grades, college coursework that is tailored more
specifically to working with students, rather simply piling on advanced math”
(Cavanagh, 2008, p. 3). Preparation and coursework in pedagogy can contribute
greatly to effective teaching (Allen, 2003). As teachers’ pedagogical content
knowledge increases, their ability to impact student learning also increases (Sutton &
Krueger, 2002).

Fully prepared mathematics teachers with coursework in pedagogy “are better
able to recognize student needs and customize instruction to increase overall student
achievement” (Stronge, 2002, p. 5). Additionally, math teachers without background
knowledge of pedagogy often have difficulty dealing with classroom management
and instructional delivery. They are less able to predict potential difficulties and
manage the learning environment so that students can succeed (Stronge, 2002).
Stronge (2002) stated, “a teacher’s formal pedagogical preparation has been shown to
have a positive effect on student achievement, especially in the areas of mathematics, science, and reading” (p. 6).

Research on the Impact of Subject Matter Knowledge and Coursework on Student Achievement. Studies have found a strong and consistent positive influence of education coursework (both content and pedagogy) on teachers’ effectiveness (Darling-Hammond, 1999). Rowan, Chiang & Miller (1997, p. 259) found “that teachers who have taken more courses in the subject matter that they are teaching tend to have students with higher levels of achievement.” Additionally, they determined that teachers’ knowledge of mathematics subject matter and expectancy motivation have direct effects on student math achievement. In separate studies, researchers found that teachers’ content preparation or coursework is positively related to student achievement in both mathematics and science, but this relationship levels off once a certain number of courses (e.g., five courses in mathematics) are taken (Darling-Hammond, 1999; Ingvarsen et. al., 2004).

Rice (2003) found that teacher coursework, whether subject specific or pedagogical in nature, appeared to have a positive impact on student learning at all grade levels. She also found that subject specific coursework mattered most in secondary education. Harris and Sass (2007) found that pedagogical content knowledge was positively associated with student test scores at both the elementary and middle school level in mathematics. In addition, Kukla-Acevado (2009) determined that a teacher’s preparation in terms of undergraduate GPA and math course hours is predictive of fifth grade math student achievement. Out of all of the teacher qualifications that were measured in this study, undergraduate GPA
consistently, positively impacted students’ math achievement across different student groups. The results varied with other factors including number of years of teaching experience and student characteristics, but overall emphasized the notion that teacher motivation, as measured by GPA and course hours, impacted student test scores.

Subject Matter Knowledge and Elementary Mathematics. Research on elementary teachers’ mathematical content knowledge suggests that elementary teachers generally have a command of the facts and basic procedures that encompass elementary level mathematics, but they often lack a conceptual understanding of this mathematics (Wilkins, 2008). More mathematics coursework has shown to increase content knowledge of the subject and has been reported to be related to increased student achievement (Wilkins, 2008). In fact, in one key study, “teachers’ mathematical knowledge for teaching positively predicted student gains in mathematics achievement during the first and third grades” (Hill, Rowan & Ball, 2005, p. 399). These results show that teachers’ mathematics content knowledge influences student achievement even in the earliest of elementary grades.

In another study of 700 first and third grade teachers and almost 3000 students, Ball, et.al. (2005) found that teachers’ performance on knowledge for teaching questions significantly predicted the size of student gain scores. These results were found even when controlling for student characteristics, absence rates, teacher credentials, teacher experience, and average length of mathematical lessons. These researchers found that mathematical knowledge for teaching does positively predict gains in student achievement at the elementary level.
Many new or aspiring elementary math teachers assume that memories of their school days and common sense is enough subject matter preparation needed to teach elementary math; however, research shows the importance of teachers’ knowledge of mathematics on their ability to teach it and which instructional strategies that they use (Ball, 1988). Knowledge of mathematics is fundamental to being able to teach it to someone else. In order to be successful in demonstrating concepts, selecting activities and understanding students’ struggles, “mathematics teachers must understand the mathematical concepts and ideas themselves” (Ball, 1988, p. 8).

Over the past 10 years, administrators of mathematics education reformed standards and curricula advocating for teaching and learning that emphasizes problem-solving and reasoning (Polly, 2008). With this change from the traditional approach of mastery of math facts and rote memorization of procedures, teachers had to adjust. Now, more than ever, “teachers are charged with creating rich mathematical experiences for students and must possess sufficient knowledge of mathematics and mathematical pedagogy, the skills to provide students with the opportunity to learn with hands-on materials (e.g., manipulatives, technologies), and be able to implement effective teaching practices in their classroom” (Polly, p. 247). Effective elementary math teachers need a specific skill set in how to explain mathematical concepts in different ways. They must be able to figure out what a student may be doing wrong, be able to decide when to use specific math vocabulary, and be able to make in-class adjustments when problems arise. All of this must be done while covering the grade level math content that includes numbers and
operations, geometry and measurement, probability and statistics, and patterns, functions and algebra (Cavanagh, 2009).

Researchers have found that managing the challenges of change, using new classroom materials, beginning new practices and teaching new content all depend on a teacher’s knowledge of mathematics (Ball, Lubienski & Mewborn, 2001). Teachers without this type of knowledge and preparation struggle with anticipating and overcoming challenges and barriers to student learning (Fetler, 2001). Thus, teachers’ exposure to and development of mathematical content is essential to equipping them with the resources that they will need to be effective teachers of mathematics. “Teacher’s knowledge provides the basis for his or her effectiveness, the most relevant knowledge will be that which concerns the particular topic being taught and the relevant pedagogical strategies for teaching it to the particular types of pupils to whom it will be taught” (Darling-Hammond, 1999, p. 8).

Certification

Most would agree that having an unlicensed doctor perform a surgical procedure would be out of the question; however, many of our nation’s children are being instructed by teachers with no license to teach. With the shortage of teachers that currently exists, many states and localities have issued emergency permits or waivers allowing many people with no professional training, no classroom experience, and little content knowledge to teach (Futernick, 2002; Darling-Hammond & Baratz-Snowden, 2007). As Futernick (2002) argues, having a proper teaching certification is no guarantee that a teacher will be effective just as having a medical license is no guarantee that a doctor won’t engage in malpractice; however
"in the vast majority of cases there is a much higher likelihood that a licensed physician or credentialed teacher will be effective in the classroom than one who is not" (p. 2). Licensure is at least a guarantee that a basic level or quality exists within the teacher in the classroom and that that teacher has cleared a series of hurdles to obtain that certificate (Goldhaber & Brewer, 2000).

Certification standards generally vary across states. Some states, such as New York and Connecticut, require a master's degree on top of a strong subject matter degree for full standard certifications. Other states, like Louisiana, do not even require a minor in the field that is being taught. All require certain scores on national tests such as the PRAXIS, but the passing scores needed for certification on these tests vary by state. Because of this variability, it is often difficult to generalize about certification standards at the national level (Darling-Hammond, Berry & Thoreson, 2001).

Research findings related specifically to math teacher certification have been mixed over the years. In a 2003 study, Rice found that teacher certification does matter for high school mathematics, but there is little evidence that it significantly matters to student achievement in lower grades. In addition, Rice determined that there was no difference in student outcomes for teachers who had traditional certification when compared with those with alternative certification.

Goldhaber and Brewer (1999) found that students with teachers who had a certification to teach mathematics – whether traditional or alternative – performed better than students whose teachers had no certification or were certified in a subject other than mathematics. In a second study related to math teacher certification,
Goldhaber and Brewer (2000) found that mathematics teachers who have a standard certification have a statistically significant positive impact on student test scores relative to teachers who either hold a private school certification or are not certified at all in mathematics. Contrary to many other studies, this study also found that students who have teachers with emergency credentials actually do no worse than students whose teachers have standard teaching credentials.

Like Goldhaber and Brewer, Wayne and Youngs (2003) found that math teachers with traditional mathematics certifications perform better than those with no mathematics certification. These researchers determined that students learn better from math teachers with a mathematics certification. Good, et. al. (2006) found that teachers who completed traditional preparation programs and received traditional certification were more skilled in classroom management. This finding points to the importance of pedagogical training in managing a classroom in order to create an environment conducive to learning. In a more recent study, Boyd, Lankford, Loeb, Rockoff, & Wyckoff (2007) examined student scores in grades 3 through 8 in New York City and found that the overall increase in hiring certified teachers has helped to narrow the achievement gap in schools since 2000.

"Content knowledge is a key component of both traditional and alternative pathways to teaching" (Kukla-Acevado, 2008). Research has shown that it is often difficult to gauge the effectiveness of alternative certification teachers because there are so many different alternative certification programs in existence and these programs take numerous forms (Good, et. al., 2006). These alternative routes vary widely, but in general, they allow those who wish to teach the ability to do so by
beginning in the classroom without having completed a formal teacher education program (Goldhaber & Brewer, 2000). The preparation that a teacher receives through an alternative certification program is often the determining factor in the success of that teacher. Additionally, teaching a grade level or subject other than the one that the teacher is certified for can turn an effective and highly capable teacher into an ineffective and struggling teacher (Stronge, 2002).

"Today, more than 15 percent of beginning teachers enter teaching through non-traditional pathways" (Darling-Hammond & Baratz-Snowden, 2007, p. 114). A large debate about teacher certification exists between whether alternative teacher education programs provide teachers with enough subject matter knowledge to be effective (Good, et. al., 2006). Teacher certification status is related to educational background and therefore important because of the level of preparation a teacher has received. Teacher impact on student achievement in mathematics is driven by the ability to understand and use mathematical knowledge to carry out the task of teaching, and certification ensures that this ability has at least been taught (Hill, Rowan, & Ball, 2005).

Degree

With mathematics teaching and learning, there appears to be a trend: teachers with mathematics or mathematics education degrees tend to produce students who demonstrate higher orders of achievement (Wilson and Floden, 2003; Haycock, 1998). Wayne and Youngs (2003) examined multiple studies and found that degrees and coursework appear to contribute to improved student achievement in
mathematics. Additionally, they found that certification truly matters when teaching mathematics and a mathematics credential truly matter to student learning.

Weglinsky (2000) used data from the U.S. National Assessment of Educational Progress (NAEP) program to determine that student achievement was higher when a student was taught by a teacher who had majored or minored in the subject that they were teaching. Students whose teachers majored in the relevant subject area were 39% of a grade level ahead of other students both in math and science. These teachers with mathematics degrees were more likely to attend professional development sessions and convey higher-order thinking skills to their students. In addition, the study found that math teachers with degrees in mathematics or math education were more likely to engage in hands-on learning with students (Weglinsky, 2000).

In two additional studies, both Rowan, Chiang and Miller (1997) and Goldhaber and Brewer (1999) found importance in math teachers having an actual degree in mathematics. Rowan, Chiang & Miller (1997) found that students who were taught by a math teacher with a degree in mathematics had higher achievement in their mathematics course. Goldhaber and Brewer (1999) found that students of teachers who had a degree in mathematics performed much better than students whose teachers did not have a degree in mathematics. In addition, teachers holding both an undergraduate and master’s degree in mathematics were found to be the most effective.

Strong content knowledge of mathematics as well as pedagogical knowledge in teaching it have already been discussed as being critical to effectiveness when
teaching mathematics. Teachers with degrees in mathematics or mathematics education have received significant coursework in mathematics content in order to help better prepare them to be effective. Teachers tend to perform better in the classroom when they have majored or minored in the subject that they teach, and are also associated with student achievement, especially in the area of secondary mathematics (Stronge, 2002).

Teaching Experience

There is a broad consensus by many in the field of education that practical mathematics teaching experience is important in learning to teach the subject effectively. “The idea is that experience, gained over time, enhances the knowledge, skills, and productivity of workers” (Rice, 2010, p. 1). Teachers with more teaching experience tend to produce larger learning gains in their students when compared with teachers with less experience (Fetler, 1999; Kukla-Acevado, 2008; Phillips, 2010). Brand math new teachers are often less effective than math teachers with some experience and students of first year teachers often learn less than those with more experienced teachers (Boyd, et. al., 2008). “Early career experience has a clear payoff in teacher effectiveness, and the impact is stronger than the effect of most other observable teacher related variables including advanced degrees, teacher licensure test scores, National Board certification at the elementary level, and class size” (Rice, 2010, p. 1).

Teachers with more experience tend to have better planning skills and are better able to apply a range of teaching strategies (Stronge, 2002). They have more flexibility and adaptability which is important to being able to meet the needs of all
students. “Novice teachers often hesitate to deviate from a plan, but the effective teacher can do it with ease and therefore capitalize on a teachable moment…” (Stronge, p. 10).

The effect of experience on math teacher effectiveness most likely varies with a teacher’s content preparation and other background characteristics. A first year teacher who has student taught and had the experience of running a math classroom has more experience then one who has received alternative certification or graduated from a program that does not require student teaching. Harris and Sass (2007) found that the impact of early teaching experience is most evident in mathematics and thus more experienced teachers are more effective in teaching elementary math and reading and middle school math. Additionally, Clotfelter, Ladd and Vigdor (2007) found that teachers with more experience were more effective in raising student achievement then those with less experience and this was most significant for math.

Previous research showed that the impacts of years of experience are likely to be the largest in the early years of teaching (Clotfelter, Ladd & Vigdor, 2007; Rice, 2010; Boyd, et. al., 2008). Rice (2010) found that the largest gains in student math achievement attributed to teacher experience were found between teachers progressing from their first year to year two. Boyd, et. al. (2008) found that when looking at math achievement of 4th and 5th graders, the differing effect of a teacher being completely inexperienced to having a full year of experience is about 0.06 standard deviations. Hanushek, Kain, O’Brien and Rivkin (2005) found that when using a value-added model, experience predicted higher student achievement gains but only for the first few years of teaching.
These studies are further emphasized by the fact that the positive effects of teacher experience on student achievement appear to be non-linear in nature as demonstrated by "substantial improvements in teaching skill during the first 3-5 years in the classroom with the effects generally tapering off around the 5th year" (Kukla-Acevedo, 2008, p. 49). Goe (2007) further argued that experience matters but it contributes to the gains in effectiveness only in the first four or five years. Teachers appear to gain in effectiveness as measured by student achievement scores during these first five years, but then level off after year five having little or no additional benefit in terms of student achievement (Goe, 2007).

Teachers with more than 20 years of teaching experience are often measured as more effective than those with no experience, but are not measured as significantly more effective than those with 5 years of teaching experience (Rice, 2010). Additionally, some research has suggested that high school math teachers with more than 25 years of experience may in fact be less effective than their less experienced co-workers. This can be explained by more experienced teachers perhaps not staying current with the latest technology, curricular and pedagogical advances (Rice, 2010).

Pedagogical content knowledge is often most affected by a math teacher’s experience. Bundles of such knowledge are built up over time by teachers as they teach the same topics to children …” (Ball, Lubienski & Mewborn, 2001, p. 448). Experienced math teachers differ from rookie math teachers in that they have practice and real-life experience in dealing with content pitfalls and classroom management. They have developed a “toolbox” from which they can pull in order to create flowing and meaningful lessons (Stronge, 2002). In the field of education, teacher
experience is often viewed as the key factor in personnel policies including salary schedules and transfer policies (Rice, 2010). This alone implies that teacher experience is closely tied to teacher effectiveness.

Verbal Ability

A number of studies have closely examined the relationship between teachers’ verbal ability and the impact on their ability to be effective. “It makes sense to view verbal ability as a general cognitive ability affecting the performance of teachers” (Rowan, Chiang & Miller, p. 258). Many studies have found a statistically significant, positive relationship between a teacher’s verbal ability and the achievement of their students (Rowan, Chiang & Miller, 1997; Stronge, 2002). Making use of one’s mathematical knowledge in teaching is highlighted by one’s verbal ability. A math teacher who fully understands the math concept himself but may have poor verbal ability is restricted in his capacity to express or discuss the ideas in language that makes sense to his students. Knowing how to do mathematics is not enough if a teacher cannot express that knowledge verbally to his or her students (Ball, Lubienski & Mewborn, 2001).

Rice (2003) found that tests that measured verbal ability appeared to correlate with both teacher performance and student learning outcomes. Additionally, these results were particularly important for student achievement in at-risk students. Wayne and Youngs (2003) determined that in most studies that they reviewed, students benefitted from having teachers with higher verbal scores. In a study comparing teacher performance on a basic literacy examination (the Texas Examination of Current Administrators and Teachers (TECAT)) with student
performance on the Iowa Test of Basic Skills (ITBS), researchers found a significant positive relationship between teacher test scores and students’ scores with higher-scoring teachers more likely to produce significant gains in student achievement than their lower-scoring counterparts (Ferguson, 1997 as discussed in Haycock, 1998).

Math teachers must constantly have to make judgments about how to define terms and whether to permit informal language or introduce and use technical vocabulary with teaching new math concepts or explaining the processes and reasoning while acquiring solutions (Ball, et. al., 2005). It is key that these math teachers have a specialized fluency with mathematical language. In addition, verbal ability is linked directly to communication skills and having good communication skills is critical to success in conveying mathematical concepts to students.

Summary: Background Characteristics

In the majority of studies mentioned throughout literature review, the impact of each single background characteristic may be seen as minor, but taken together these background characteristics are more positively related to teacher effectiveness. Kukla-Acevado (2008), for example, found that the number of math education hours has the largest effect of any teacher characteristic, but this effect is negative until teachers gain between 10 and 15 years of math teaching experience. The American Council on Education provides evidence that “earning a college degree in mathematics, being certified in mathematics, and being mathematically skillful” all contribute to the effective teaching of the subject (Ball, Lubienski & Mewborn, 2001, p. 441). One could then conclude, that taken as a whole, a teacher with greater subject matter knowledge, more experience, a degree in mathematics, proper
certification and strong verbal ability should be more effective and produce higher math achievement in students than someone without these characteristics.

A sampling of studies summarizing the effects of background characteristics on math teaching effectiveness and student learning is shown in Table 1 below.

Table 1. Summary Findings of Background Characteristics on Math Teacher Effectiveness & Student Learning from Selected Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Subject Matter Knowledge</th>
<th>Degree</th>
<th>Certification</th>
<th>Teaching Experience</th>
<th>Verbal Ability</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clotfelter, Ladd and Vigdor (2007)</td>
<td></td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
<td>• Researcher concluded that teacher test scores, licensure and experience all have positive effects of student achievement in math.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Even when taking account for class size and student characteristics, the various teacher credentials had large effects on student achievement.</td>
</tr>
<tr>
<td>University of Washington Center for the Study of Teaching and Policy (Darling-Hammond, 1999)</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
<td>• Measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and math.</td>
</tr>
<tr>
<td>Fetler (2001)</td>
<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
<td>• Teacher preparation and experience continued to demonstrate a significant association with student achievement in mathematics.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Better prepared teachers are more effective in their jobs and assist more students to reach their highest potential in math.</td>
</tr>
<tr>
<td>Ingvarson, Beavis, Bishop, Peck, &amp; Elsworth (2004)</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
<td></td>
<td>• Researchers found that teacher knowledge and educational background are positively related to teacher effectiveness.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Researchers determined that the more this education includes mathematical content and pedagogy, the greater the likelihood that teachers will be effective.</td>
</tr>
</tbody>
</table>
Goe (2007) • • • • The effects of teachers with degrees in mathematics and appropriate certifications, and possible higher level mathematics courses, appear to be strongly and consistently related to student achievement in mathematics.

- Further argued that experience matters but it contributes to the gains in effectiveness only in the first four or five years. Teachers appear to gain in effectiveness as measured by student achievement scores during these first five years, but then level off after year five having little or no additional benefit in terms of student achievement.

Rowan, Chiang & Miller (1997) • • The analysis of the results from this study suggests that teachers' knowledge of subject matter and expectancy motivation have direct effects on student achievement in mathematics.

- Found that students who were taught by a math teacher with a degree in mathematics had higher achievement in their mathematics course.

Rice (2003) • • • Found that tests that measured verbal ability appeared to correlate with both teacher performance and student learning outcomes.

- Found that teacher coursework appeared to have a positive impact on student learning at all grade levels.
- Found that teacher certification does matter for high school mathematics.

Rice (2010) • • • • Found that the largest learning gains in student math achievement attributed to teacher experience were found between teachers progressing from their first year to year two.

- Teachers with more than 20 years of teaching experience are often measured as more effective than those with no experience, but are not measured as significantly more effective than those with 5 years of teaching experience.

Harris & Sass (2007) • • • Found that pedagogical content knowledge was positively associated with student test scores at both the elementary and middle school level in mathematics.

- Found that the impact of early teaching experience is most evident in mathematics and thus more experienced teachers are more effective in teaching
Goldhaber & Brewer (1999) | • | • | - Found that students with teachers who had a certification to teach mathematics – whether traditional or alternative – performed better than students whose teachers had no certification or were certified in a subject other than mathematics.  
- Found that students of teachers who had a degree in mathematics performed much better than students whose teachers did not have a degree in mathematics.

Wayne & Youngs (2003) | • | • | • | • | - Found that degrees and coursework appear to contribute to improved student achievement in math.  
- Found that certification truly matters when teaching mathematics and a mathematics credential truly matter to student learning.  
- Determined that in most studies that they reviewed, students benefited from having teachers with higher verbal scores.

Boyd, Grossman, Lankford, Loeb & Wycoff (2008) | • | • | • | - Found that first year math teachers are often less effective than math teachers with some experience and students of first year teachers often learn less than those with more experienced teachers.

Hanushek, Kain, O’Brien & Rivkin (2005) | • | • | • | - Found that when using a value-added model, experience predicted higher student achievement gains but only for the first few years of teaching.

**Impact of Instructional Practices on Math Teacher Effectiveness**

The practices that teachers use in their classrooms are extremely important and can be more important than their certification, degree, and other background characteristics (Palardy & Rumberger, 2008). The biggest difference between effective math teachers and their ineffective counterparts is not what they know, but
what they do (Whitaker, 2004). "The most important influence on what students learn is what their teachers do" (Ingvarson et al., p. 18). Effective math teachers actively engage all students with "challenging mathematical tasks that help them understand concepts, learn skills and solve problems" (NCTM, 2010, ¶5). These tasks need to support students' conceptual understanding of mathematics by being mathematically challenging and significant. "Students should be exposed to numerous and varied interrelated experiences that encourage them to value mathematical enterprise, to develop the mathematical enterprise, to develop mathematical habits of mind, and to understand and appreciate the role of mathematics in human affairs" (Gilkey & Hunt, 1998, p. 2).

Effective mathematics teachers "run lively and effective classroom discussion, in which they respond to and build on students' ideas, and provide timely and appropriate feedback..." (Ingvarson et al., p. 6). These discussions can be further developed by an effective math teacher's ability to select tasks that have different solutions or that allow students to defend different methods and solutions. Polly (2008) found that having students explain their approach to solving problems significantly improves student learning in mathematics. Teachers should encourage students "to explore, to guess, and even to make and correct errors so that they gain confidence in their ability to solve complex problems" (Gilkey & Hunt, 1998, p. 2).

In a study by Palardy and Rumberger (2008), the researchers "found significant effects for many measures of instructional practices on student learning across one or more grades" at both the elementary and secondary level (p. 114). What a student learns often is contingent upon how he or she was taught it (Gilkey &
Effective, student-centered math instruction includes effective instructional practices that engage students in interesting and meaningful problems.

The National Council of Teachers of Mathematics (NCTM) illustrated the importance of a shift in instructional practices in order to meet the needs of changing mathematics students. In the *Professional Standards for Teaching Mathematics* (NCTM, 1991, p. 3), the NCTM stated a “need to shift

- toward classrooms as mathematical communities – away from classrooms as simply a collection of individuals;
- toward logic and mathematical evidence as verification – away from the teacher as the sole authority for right answers;
- toward mathematical reasoning – away from merely memorizing procedures;
- toward conjecturing mathematics, inventing, and problem solving – away from an emphasis on mechanistic answer-finding;
- toward connecting mathematics, its ideas, and its applications – away from treating mathematics as a body of isolated concepts and procedures.”

**Planning for Instruction**

Effective mathematics teachers know and understand that mathematical success in the classroom depends upon the thought process that occurs prior to the bell ringing. The many hours of work and thought that take place prior to the start of the lesson and in the planning phases of instruction are crucial to student learning. Not only do teachers need to plan what is to be taught, but they must determine how it is to be taught. A well-designed and thought out lesson plan is the main ingredient in a successful math lesson. In reviewing the professional practices of effective math
teachers, it is clear that great organizational skills and thoughtful design of lesson plans are two commonalities that exist (Posamentier, Jaye & Krulik, 2007). In a study of school improvement in the 1980s, Pollock (2007) found that high levels of student achievement were associated “with effective instructional planning and delivery” (p. 60).

Determining appropriate strategies and activities is key to ensuring that students become active learners and that the learning is retained (Gilkey & Hunt, 1998). Effective teachers plan lessons that include a variety of instructional strategies that meet the needs of all types of learners. “Effective teachers know their students well – their strengths and their weaknesses, their interests and preferences – and plan instruction to challenge all learners to meet high standards” (Sutton & Krueger, 2002, p. 20).

Implementing Instruction

Teachers’ decisions and actions in the mathematics classroom directly affect how well students learn mathematics and their level of retention for the future. Teachers need to be able to represent mathematics using a range of different teaching strategies and instructional materials. It is not enough for teachers to just know math and math content; they must be able to understand how the minds of young people work and how to diagnose the kinds of tangles kids get into when trying to solve a mathematics problem. Effective teachers are not ruffled by student questions and difficulties; instead, they are prepared to contend with these difficulties with alternative methods or mental strategies.
Real student engagement depends primarily on the choices that a teacher makes about the task or activity that students work on. “Students become engaged in mathematics when they are drawn in to what they are doing because it is interesting, or when something about the task intrigues them or stretches them to think” (Seeley, p. 178). Effective math teachers keep student engaged by valuing their thinking, their questioning and their ability to communicate with one another to solve problems. It is crucial for teachers to use a repertoire of instructional strategies and vary their instruction in order to keep the students’ interest and accommodate different learning styles within the classroom.

*Meaningful Discussion and Vocabulary.* The National Council of Teachers of Mathematics maintains that it is vitally important to give students a variety of experiences that assist them in appreciating the power and precision of mathematical language. This mathematical language is as important in learning mathematics as it is in learning to read (Murray, 2004). As Pat Wingert stated, “It boils down to this – if you can’t talk about math, you are unlikely to do it well” (Murray, 2004, p. 35). By communicating their understanding of mathematics and trying to make their ideas understood by others, students refine their ideas and develop a deeper understanding. This type of communication can include reading, writing and using multiple representations in order to discover and develop connections between different ways in which an idea can be represented (Sutton & Krueger, 2002).

Math teachers play a crucial role in a student’s ability to learn the language of mathematics. Deliberate and careful attention must be paid to acquiring and using the vocabulary of mathematics (Murray, 2004). Technical math terminology is not a part
of everyday language for most students, so effective math teachers must ensure that mathematical communication requires more than just an understanding of numbers and symbols, but the development of a common language using vocabulary that is understood by all.

Effective math teachers orchestrate productive discussions within the classroom and engage students in discussion so that they are better able to make sense of ideas and reflect on their thinking. These effective teachers continuously pose questions to students and ask questions that require higher cognitive demand. They use questioning and follow-up discussions as an effective learning tool. Better teacher questioning practices and better classroom discussions lead to better mathematical learning by all students (Sutton & Krueger, 2002).

**Problem-Solving.** The National Council of Teachers of Mathematics advocates mathematics instruction that focuses on problem solving and reasoning rather than on traditional approaches that emphasize the teaching of algorithms and mastery of static information and rote procedures (Polly, 2008; Posamentier, Jaye & Krulik, 2007). As Sutton and Krueger (2002) stated, “Mathematical reasoning and problem solving requires teachers to teach mathematics as the power of thought rather than the power of discrete facts” (p. 12). Effective teachers question students about problem-solving processes and listen to their explanations in order to truly understand their learning. They see the subject of mathematics as “richly connected” and consistently use strategies that help students connect the links within the subject (Ingvarsen, et al., p. 14). As students become more interested in problem solving and
more comfortable with it, they often become more interested in the subject of mathematics altogether (Posamentier, Jaye & Krulik, 2007).

Classroom observations conducted during the Third International Mathematics and Science Study (TIMSS) revealed that mathematics teachers in Japan and other parts of the world customarily present students with a problem without first telling them all of the steps they should follow in order to solve it. In the United States, math teachers tend to spoon-feed students by telling them how to solve a problem, by giving them the steps they should follow in order to solve it, and by giving them similar problems to solve repeatedly (Seeley, 2009). Effective mathematics teachers understand that they can guide student learning of a math concept without doing all of the work for their students. This approach provides students with more of an opportunity for critical thinking and working collaboratively with others to solve a problem. Effective mathematics instruction occurs in community settings in which teachers use methods that promote and support student sharing and active listening in order to enhance student reasoning and problem solving skills (Sutton & Krueger, 2002).

As students increasingly are educated with the goal of becoming lifelong learners, they must develop skills to manage and use knowledge to solve problems in the real-world, not just in textbooks. Knowing how to access, evaluate, and use information is a major component of mathematics literacy that is necessary for twenty-first century careers. As Sutton and Krueger stated (2002), “Teachers who orchestrate the integration among conceptual, procedural, and factual knowledge provide the ‘sense making’ that is necessary if students are to develop confidence in
their ability to reason and solve problems” (p. 12). Mathematics instruction should focus on using mathematics appropriately for problem-solving in the future as enhanced career opportunities will exist for those who understand mathematics and solve mathematical problems (Sutton & Krueger, 2002). Because of these enhanced careers, there is a growing need for major emphases on reasoning, thinking and problem solving in mathematics classrooms (Posamentier, Jaye & Krulik, 2007).

*Visual Representations.* Instructional practice should support a wide variety of tools and representations that are designed to support exploration. These tools often influence the kind of learning and understanding that occur (Sutton & Krueger, 2002). Visual representations make mathematics come to life for many students and connect a concrete image to an important concept. They “bring research-based options, tools, and alternatives to bear in meeting the instructional challenge of mathematics education” (Steedly, Dragoo, Arafeh & Luke, p. 8). The most common visual representations used in mathematics teaching are concrete materials or manipulatives. Educators believe that using manipulatives to explore and visualize concepts is a key factor in understanding mathematics content and not just process (Swars, 2005a; Swars, 2005b; Hart, Smith, Smith, & Swars, 2007).

In mathematics, using concrete materials as part of a well-designed task can be a valuable tool that supports the conceptual understanding of a math concept (Seeley, 2009). The manipulatives themselves do not provide meaning, but help students make connections in order to build understanding. Effective math teachers often use manipulatives as part of the teaching process while less effective teachers are often hesitant to use manipulatives while explaining concepts (Swars, 2005b).
Most importantly, manipulative use often helps students move from the concrete to the representational to the abstract and works well individually with students, in small groups, or for whole class instruction at both the elementary and secondary level (Steedly et al., 2008). Teachers who use these resources with students are more likely to produce students with higher mathematical literacy (Sutton & Krueger, 2002).

Use of Technology. Researchers, scholars and national organizations all advocate for the use of technology in the mathematics classroom. “The increased diversity of learners, students’ familiarity and attraction to technology, and the improved availability of technology in education have made it increasingly possible for teachers to use various forms of technology in instruction” (DePeau & Kalder, 2010, p. 268). Technology in the math classroom is a powerful new tool that supports student collaboration, inquiry and communication, and it gives students the opportunity to be involved in their learning (Gilkey & Hunt, 1998). Math teachers should use technology to “help students learn content, develop their conceptual understanding and enrich their higher-order thinking skills” (Polly, 2008, p. 247).

Recent studies focused on mathematics education have determined that students should be exposed to a variety of representations have the ability to draw meaning from these different representations of the same mathematical concept (DePeau & Kalder, 2010). Presenting material in these multiple representations can easily be accomplished by integrating technology into a math lesson. “Technology use in mathematics often involves either exploratory or expressive modeling. When using exploratory models, students use technology to investigate a premade expert model of some phenomena. When creating expressive models, students have greater
flexibility for constructing their own model for investigation using objects and mechanisms available to them in the technological environment” (Madden, 2010, p. 276).

Calculators, with their ever growing technology and capabilities, are necessary and effective technological tools that should be used often in mathematics classrooms. A basic calculator can do the same things more efficiently and far more in depth than the slide rule and logarithms did in the past. The graphing calculator allows students to graph more efficiently so that they can spend more time exploring other aspects of functions and how they behave (Posamentier, Jaye & Krulik, 2007). Polly (2008) used data from the Early Childhood Longitudinal Study to research the effects of calculator use on first grade math student achievement and determined that the use of calculators had a positive influence on student achievement. Additionally, in 2003, Interactive Educational Systems found that “the use of graphing calculators in a variety of instructional situations leads to improved student achievement in specific middle and high school skills” (Posamentier, Jaye & Krulik, 2007, p. 28).

Making decisions about when and how to use technology are like all other instructional decisions for math teachers, they call for the teacher to have a solid knowledge of the mathematics that they are teaching as well as a working knowledge of the available technological tools (Seeley, 2009). “Even the simplest uses of technology can add a new dimension to a lesson, but like everything else in the classroom, these uses require careful planning” (Posamentier, Jaye & Krulik, 2007, p. 25). Effective math teachers understand how to use technology for concept demonstration and exploration while ineffective math teachers tend to use no
technology or just use it for simple computation or drill-and-practice (Polly, 2008). Ineffective math teachers are typically unprepared and unwilling to use technology in meaningful ways as part of their instruction. There is nothing wrong with a student knowing more about some features of certain pieces of technology, but there is something wrong with a teacher not allowing the use of technological tools because of their own discomfort (Seeley, 2009). Effective teachers take responsibility for ensuring that students have access to technological tools, and “they take full advantage of these tools to help students learn the complex quantitative and thinking skills they will need as they enter our technology-driven workforce” (Seeley, 2009, p. 27).

Summary: Instructional Practices

Instructional practice includes the selection of worthwhile mathematical tasks that engage students, develop mathematical understandings, emphasize connections and coherence, call for problem solving and reasoning, promote communication, and use both visual representations and technology to investigate and explore (Sutton & Krueger, 2002). The instructional practices that a mathematics teacher chooses to use in both the planning and delivery process of instruction can be the major determinant of student learning. Students who gain mathematical knowledge and understanding through meaningful activities and problems are far more likely to have the ability to apply their learning (Gilkey & Hunt, 1998). The National Council of Teachers of Mathematics (1989) stated that “a variety of instructional methods should be used in classrooms in order to cultivate students’ abilities to investigate, to make sense of, and to construct meanings from new situations; to make and provide arguments for
conjectures; and to use a flexible set of strategies to solve problems from both within and outside mathematics” (Gilkey & Hunt, 1998, p. 37). Classrooms that allow students to approach mathematics in multiple ways using manipulatives, technological tools, or hands-on activities engage students and motivate them toward the learning of mathematics.

A sampling of studies summarizing the effects of instructional practices on math teaching effectiveness and student learning is shown in Table 2 below.

**Table 2. Summary Findings of Instructional Practices on Math Teacher Effectiveness & Student learning from Selected Studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>Key Findings</th>
</tr>
</thead>
</table>
| Polly (2008)                                    | - Found that having students explain their approach to solving problems significantly improves student learning in mathematics.  
- Used data from the Early Childhood Longitudinal Study to research the effects of calculator use on first grade math student achievement and determined that the use of calculators had a positive influence on student achievement |
| Palardy and Rumberger (2008)                    | - Found significant effects for many measures of instructional practices on student learning across one or more grades at both the elementary and secondary level. |
| Pollock (2007)                                  | - Found that high levels of student achievement were associated with effective instructional planning and delivery.                             |
| Interactive Educational Systems in 2003 (Posamentier, Jaye & Krulik, 2007) | - Found that “the use of graphing calculators in a variety of instructional situations leads to improved student achievement in specific middle and high school skills. |
Impact of Teacher Self-Efficacy on Math Teacher Effectiveness

In recent years, educational researchers have closely studied teachers' self-efficacy beliefs and the impact of these beliefs on teacher effectiveness and student learning (Guskey & Passaro, 1994). Such researchers have framed their theories of this powerful variable around the self-efficacy component of social cognitive theory. As Hart, Smith, Smith and Swars (2007, p. 239) stated, “The relationship between teachers’ beliefs and teaching is well-established. Beliefs influence teacher behavior and decision-making and change in beliefs is a crucial precursor to real change in teaching.”

Self-efficacy is a motivational construct and self-efficacy beliefs are people’s judgments and perceptions of their own ability to perform an action (Pajares, 2002). Self-efficacy beliefs are related to expected outcomes because beliefs contribute, in part, to outcomes (Pajares, 1996). For example, if a teacher is confident in his/her lesson planning skills, than the teacher will have high expectations for the success of the lesson. The converse is also true of those who lack such confidence. Teaching attitudes and practices tend to be more difficult to measure and quantify which is why they have received less attention from educational researchers, but studies that have looked closely at these factors have found significant effects on students’ achievement (Palardy & Rumberger, 2008). “Teacher efficacy is a significant predictor of mathematics instructional strategies, and highly efficacious teachers are more effective math teachers than teachers with a lower sense of efficacy” (Swarz, 2005b, 139).
Teacher Self-Efficacy

Teacher self-efficacy is identified as a type of self-efficacy that focuses on the views of teachers and their beliefs in their ability to teach and be effective in the classroom. Teacher self-efficacy can also be identified as a teachers' belief that he or she can make a difference in how well a student learns or the extent to which they can affect a student's achievement (Guskey & Passaro, 1994). Teacher self-efficacy has been related to "teachers' classroom behaviors, their openness to new ideas, and their attitudes towards teaching" (Tschanen-Moran, Hoy & Hoy, 2001, p. 215). Teacher self-efficacy can influence student performance, student attitudes towards learning and student growth. Tschanen-Moran and Hoy (2001) stated, "Teacher efficacy has proved to be powerfully related to many meaningful educational outcomes such as teachers' persistence, enthusiasm, commitment and instructional behavior, as well as student outcomes such as achievement, motivation, and self-efficacy beliefs" (p. 783).

With all of these crucial and important factors related to teacher self-efficacy, educational researchers have focused a lot of time to understanding teacher self-efficacy, its relationship to student learning and how it can be improved.

When discussing teacher self-efficacy, educators are often confused by the distinction between beliefs and knowledge (Pajares, 1992). Knowledge of the subject is different than a feeling about teaching it, yet often the knowledge that one has impacts this feeling about teaching. Pajares (1992) summarized the two when he stated, "Knowledge is the cognitive outcome of thought and belief the affective outcome" (p. 310). A 1989 study by Ernest, concluded that teachers may have similar knowledge but teach in different ways; therefore, their beliefs about teaching

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are more useful in understanding and predicting their effectiveness than their actual knowledge (Pajares, 1992).

Social cognitive theorists propose that behavior and environment interact to influence the beliefs of a person. Both student effects and school-level effects have been identified as environmental factors that can influence a teacher’s self-efficacy. Student effects have been shown to include the type of students that make up a class and their abilities and behavior while school-level effects have been shown to include the climate of a school, the relationship that a teacher has with the principal, and the way in which decisions are made in the school. Depending on these external factors, researchers have found that teacher self-efficacy can be similar across an entire school and this collective efficacy can be very powerful in its effect on student achievement (Tschannen-Moran, Hoy & Hoy, 1998).

As Tschannen-Moran, Hoy & Hoy (1998) stated, “Teacher efficacy is the teacher’s belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context” (p. 233). The level of self-efficacy that a teacher has changes as he or she is faced with new challenges. For example, a new content or grade level may create uneasiness and impact a person’s level of teacher self-efficacy. Teacher self-efficacy is very cyclical in nature which is one of the main reasons it is so important to educational research. Higher self-efficacy leads to greater effort, motivation and ability to instruct, which often leads to better student and teacher performance, which in turn leads to higher self-efficacy for the teacher. The reverse is also true. Lower self-efficacy leads to less persistence and motivation, which often leads to less effort
and poor outcomes, which in turn leads to a lower sense of teacher self-efficacy (Tschannen-Moran, Hoy & Hoy, 1998). This cyclical pattern is consistent unless broken with new experiences, confidence, training or some other critical factor.

Self-Efficacy As It Relates To Teacher Effectiveness

Researchers have found that teacher self-efficacy can be directly correlated to a teacher’s willingness to embrace new ideas and to their use of varying instructional strategies (Turner, Cruz & Papakonstantinou, 2004). Individual’s with a high sense of teacher self-efficacy “are more likely to use inquiry and student-centered teaching strategies, while teachers with a low sense of self-efficacy are more likely to use teacher-directed strategies such as lecture and reading from the text” (Swars, 2005a, p.2). Teachers with low self-efficacy tend to lecture and use traditional methods while those with high self-efficacy will often group students together and allow students to explore and guide their own learning. This communication and group work is critical as students often learn best by communicating with one another and by being exposed to a variety of models (Turner, Cruz & Papakonstantinou, 2004). Additionally, teachers with a high sense of self-efficacy are more likely to try new strategies that may be risky or hard to implement.

In addition to instructional strategies, teachers with a higher sense of self-efficacy are less likely to be custodial and rigid in their approach with discipline (Rimm-Kaufman & Sawyer, 2004; Woolfolk & Hoy, 1990; Woolfolk, Rosoff & Hoy, 1990). These researchers found that these teachers with a higher sense of self-efficacy were more capable with their ability to control classroom behavior and
influence decisions made by the administrators in the school. Both of these factors are essential to effectiveness in the classroom and school as a whole.

Teacher self-efficacy is a powerful construct that can influence student achievement as well as student motivation and student attitude towards learning (Rimm-Kaufman, 2004). A teacher’s effort, goals and aspirations can all be affected by their level of self-efficacy. Their beliefs, attitudes and priorities are closely related to their classroom behavior and practices as well as improved student performance (Rimm-Kaufman, 2004). Pajares (1992) stated “…that understanding the belief structures of teachers and teacher candidates is essential to improving their professional preparation and teaching practices” (p. 307). For all of these reasons, it is crucial that educational researchers further study the factors that influence teacher self-efficacy in order to determine what educators, colleges and others can do to help teachers gain a higher sense of teacher self-efficacy. Educational research in this field is not complete or as useful unless it provides insights into the relationship between teacher beliefs, teacher practices, teacher knowledge and student performance (Pajares, 1992).

Math Teacher Self-Efficacy as It Relates To Effectiveness

In the past three decades educational researchers have looked at the impact of teacher self-efficacy on teacher effectiveness, but few researchers have focused on the specific impact of math teacher self-efficacy. Teacher self-efficacy is often dependent upon the comfort level of the content, grade level of the students or specific topic being taught. For example, a teacher with high self-efficacy while teaching reading could in fact have low self-efficacy about teaching mathematics.
Specific research regarding math teacher self-efficacy is needed in order to fully understand the connection between math teacher self-efficacy and student achievement in mathematics.

Math teacher self-efficacy may be an indicator of math teacher effectiveness and therefore a variable to strengthen and develop effective mathematics teachers. "Teacher attitudes impact their daily choices of activities, the amount of effort expended on each, and their expectations of students' abilities to perform" (Sutton & Krueger, 2002, p. 28). Because teachers' beliefs influence their instructional decisions, the result is often varied student achievement results. Individual student attitudes towards mathematics often reflect the attitude of their teacher and students who have positive interactions with their mathematics teacher tend to have high confidence in their own mathematics ability (Sutton & Krueger, 2002).

A substantial amount of research with regards to mathematics instruction pointed to manipulative use as a crucial part of quality instruction. Educators believe that using manipulatives to explore and visualize concepts is a key factor in understanding mathematics content and not just process (Swar, 2005a; Swars, 2005b; Hart, Smith, Smith, & Swars, 2007). Teachers with high self-efficacy often use manipulatives as part of the teaching process while teachers with a lower sense of self-efficacy are often hesitant to use manipulatives while explaining concepts (Swar, 2005b). The importance of comfort and belief in using materials associated with mathematics is highlighted as one way in which math teacher self-efficacy is important to mathematics teaching and learning.
The attitude and beliefs of a mathematics teacher is a crucial ingredient in creating a positive learning environment that promotes problem solving and makes students feel comfortable talking about mathematics. Teachers who believe in their own abilities and in the importance of providing all students the opportunity to learn mathematics with understanding employ strategies that promote student engagement and discussion as part of problem solving (Sutton & Krueger, 2002).

In one study of math teaching effectiveness among pre-service elementary teachers with varying levels of mathematics teacher self-efficacy, it was discovered that teachers with a high sense of self-efficacy were more effective mathematics teachers than those teachers with a low sense of self-efficacy (Swars, 2005b). The teachers’ self-efficacy levels also had a direct impact on their willingness to embrace new instructional strategies and which classroom strategies that they chose to use (Swars, 2005b). The importance of comfort and belief in using materials associated with mathematics is highlighted as one way in which math teacher self-efficacy is important to mathematics teaching and learning.

**Math Anxiety.** At the elementary level, researchers have begun to also look at the impact of math anxiety on math teacher self-efficacy. Math anxiety is often defined as being a severe discomfort or uneasiness that occurs when a person is asked to perform mathematically or required to manipulate numbers. Teachers with a high level of math anxiety often possess a low level of teacher self-efficacy. They sometimes avoid teaching mathematics altogether and pass their fear of the subject onto their students. Their effectiveness in teaching mathematics is directly impacted by this math anxiety and low sense of math teacher self-efficacy (Swars, 2005a).
Among pre-service teachers, those with a low level of math anxiety had strong beliefs in their ability to be an effective math teacher, while those with a high level of math anxiety had less confident views of their ability to teach math effectively (Swars, 2005a).

Summary: Teacher Beliefs

The field of mathematics has gained importance over the past decade due to teacher shortages and the impact of accountability brought about by No Child Left Behind. It is more important than ever that math teachers be effective in the classroom in order to improve student achievement. The National Council of Teachers of Mathematics (2000) has presented a new vision for teaching mathematics and in this reformed vision; teachers are the most critical component. Teacher implementation of effective instructional practices is impacted by their level of math teacher self-efficacy and therefore, the importance of this construct is evident to the success of teachers and students.

Using the theories brought about in cognitive psychology and with social cognitive theory, self-efficacy as it relates to teacher self-efficacy has been placed at the forefront of educational research. The Rand Corporation conducted one of the earliest studies in which they found that teacher self-efficacy was the most important and powerful variable in predicting program success (Guskey & Passaro, 1994). Similarly, a 1979 study by Brookover and Lezotte found that “those in more effective schools had a stronger sense of efficacy and tended to feel more responsible for the learning of their students then did those in less effective schools” (Guskey & Passaro, p. 628). Because teacher effectiveness “is the major determinant of student
academic progress" (Stronge, 2010, p. 1), researchers have since focused much of
their attention on the impact of teacher self-efficacy on teacher effectiveness.

Educators and educational researchers should continue to spend both time and
resources in order to continue to research ways to improve teacher self-efficacy.
This improvement in teacher self-efficacy can have a direct impact on teacher
effectiveness in mathematics teaching and as Wright, Horn and Sanders (1997)
summarized “differences in teacher effectiveness were found to be the dominant
factor affecting student academic gain” (p. 66). Teachers truly do make a significant
difference for children and thus teacher self-efficacy is an important construct in the
field of education.

A sampling of studies summarizing the effects of math teacher self-efficacy
on math teaching effectiveness and student learning is shown in Table 3 below.

Table 3. Summary Findings of Math Teacher Self-Efficacy on Math Teacher
Effectiveness & Student Learning from Selected Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Key Findings</th>
</tr>
</thead>
</table>
| Swars (2005b)                | • Found that teacher efficacy is a significant predictor of mathematics instructional strategies, and highly efficacious teachers are more effective math teachers than teachers with a lower sense of efficacy.  
• Found that teachers with a high sense of self-efficacy were more effective mathematics teachers than those teachers with a low sense of self-efficacy. |
| Ernest (1989) discussed in (Pajares, 1992) | • Found that teachers may have similar knowledge but teach in different ways; therefore, their beliefs about teaching are more useful in understanding and predicting their effectiveness than their actual knowledge. |
| Tschannen-Moran, Hoy & Hoy (1998) | • Found that teacher self-efficacy can be similar across an entire school and this collective efficacy can be very powerful in its effect on student achievement. |
| Turner, Cruz &               | • Found that teacher self-efficacy can be directly                                                                                                                                 |

80
Papakonstantinou (2004) correlated to a teacher’s willingness to embrace new ideas and to their use of varying instructional strategies.

Swar (2005a)  
- Found that among pre-service teachers, those with a low level of math anxiety had strong beliefs in their ability to be an effective math teacher, while those with a high level of math anxiety had less confident views of their ability to teach math effectively.

Rand Corporation Study discussed in (Guskey & Passaro, 1994)  
- Found that teacher self-efficacy was the most important and powerful variable in predicting program success.

Brookeover and Lezotte (1979) discussed in (Guskey & Passaro, 1994)  
- Found that those in more effective schools had a stronger sense of efficacy and tended to feel more responsible for the learning of their students than those in less effective schools.

**Why Does Teacher Evaluation Matter?**

If, as previously discussed, teachers truly matter, than a high quality system for evaluation also matters. “The basic needs in a quality teacher evaluation system are for a fair and effective evaluation based on performance and designed to encourage improvement in both the teacher being evaluated and the school” (Stronge, 2010, p.2). Most educators agree that the general purpose for evaluating teachers is to protect and improve the quality of instruction for students. Peterson and Kauchak (1982) further explained that “the purpose of teacher evaluation is not to determine the question of what makes an ideal teacher (a question for research), but how good a given performance, product or person has been in an actual situation” (p. 7).

Although most educators agree on the purpose of teacher evaluations, difficulties do exist with the process by which the evaluation system is carried out (McGreal, 1983). Often the failure to properly evaluate teachers does not exist because of a poor instrument, but because it is not always implemented correctly
(Stronge, 2006). As Wright, Horn and Sanders (1997) stated, teachers often argue that equity issues exist in “the fair application of teacher evaluation instruments and procedures…” (p. 57). They find issues in the diversity and ability levels of their students and with how these factors are accounted for in the evaluation process (Wright et al., 1997). It is crucial that teacher evaluation systems are used and implemented correctly in order to provide “feedback for change and improvement” (Peterson, 1982, p. 9) and in some cases provide the basis for employment decisions.

Many researchers agree that the traditional teacher evaluation systems used in many school districts are seriously flawed. Most teachers, even in their first and second years of teaching, are being told that they are doing a good job regardless of whether they actually are being effective. Many districts are even using criteria that is irrelevant to student learning such as bulletin board appearance to evaluate teachers on their level of effectiveness. In 2009, a national non-profit organization called The New Teacher Project (TNTP) released a study that “revealed that only 1 percent of teachers in 12 cities, including Chicago and Denver, received unsatisfactory ratings” (Duffrin, 2011, p. 50).

Quality teacher evaluation is critical to the improvement of teachers and schools. Evaluation has “implications for quality, accountability, training, and the well-being of teachers” (Peterson, 1982, p. 5). “Teacher evaluation is one of the primary means of improving educational instruction, enhancing educational services, and justifying the removal of substandard teachers” (Veir & Dagley, 2002, p. 2). In the current state of accountability brought about by the federal legislation of the No Child Left Behind Act, it is now more important than ever that a mechanism exist to
measure teacher quality and performance fairly and accurately. Teacher effectiveness is the most important controllable factor in education, so being able to successfully evaluate teacher effectiveness is crucial to the growth and learning of students.

*Using Value-Added Measures to Evaluate Teacher Effectiveness*

Teacher evaluation traditionally has focused on the act of teaching and been documented almost exclusively through classroom observations completed by administrators (Tucker & Stronge, 2005). A growing number of school divisions across the country are using value-added measures of teacher quality to evaluate teaching effectiveness. The measures, which are actually value-added student achievement scores, are even being used in some school divisions to determine tenure or bonuses. Value-added student achievement scores are statistical measures of student achievement based on a growth model created by pre- and post-testing. This method of measuring student achievement removes the effects of many factors not controlled by the teacher and provides a more accurate estimate of teacher effectiveness on student academic growth. “To measure a teacher’s effectiveness, value-added models find the difference between students’ expected and actual test score growth, considering that students learn at different rates” (Duffrin, 2011, p. 50).

Value-added measure alone cannot compensate for an otherwise weak evaluation system, but they do use a statistical method to determine a teacher’s contribution to their students learning. Being able to successfully identify the most effective and least effective teachers “with an objective measure like their value-added ratings is valuable information that is difficult to get any other way…” (Duffrin, p. 50). An outside crisis or random event could skew the statistical results
of the measures; however, as long as they are combined with other quality judgments made in a quality teacher evaluation, using value-added measures can truly help determine teacher effectiveness (Duffrin, 2011). While there are concerns about the quality of test data available to school divisions, “properly constructed tests, better databases, improved methodologies for analyzing test data, proper administrative use, and a climate of trust have the potential to maximize the benefits and minimize the liabilities in the connection of student learning and teaching effectiveness” (Stronge, 2006, p. 163).

Beginning in 2007, the Houston Independent School District began using value-added student achievement scores from the results of state tests to award annual bonuses to teachers. The results have been encouraging thus far in terms of retention. “Within two years, the retention rate for awarded teachers rose from 84 percent to 92 percent. Meanwhile, retention of the bottom performers, who received no award, shrank from 13 percent to 2 percent” (Duffrin, 2011, p. 52). In addition, New York City has seen positive results in terms of using value-added measures as a criteria for tenure. Since they began using these value-added measure in 2010, school principals have denied tenure to a larger number of teachers.

Proponents of using value-added measures for teacher evaluation believe that “teacher effectiveness can be reliably estimated by gauging student’s progress on standardized tests” (Duffrin, 2011, p. 48). For this reason, value-added assessment models have been embraced by many researchers and school divisions as being a potential means for assessing teacher quality and effectiveness (Tucker & Stronge, 2005). Measurable evidence of student learning, such as value-added student
achievement scores, must be an important component upon which teachers are
evaluated. The essential issue is that we have the most effective teachers guiding
student learning, but "without high quality evaluation systems, we cannot know if we
have high quality teachers" (Stronge, 2006, p. 1).

With the recent shift in teacher evaluation practices by the state and federal
governments, value-added models are being examined more often as a method for
determining the correlation between teacher effectiveness and student academic
growth. Opponents of these models fear that if these value-added models are used for
high stakes purposes such as merit pay and formal teacher evaluation much more
attention will need to be paid to ensure fair and ethical treatment. Opponents also
argue that one single year's worth of data would not be sufficient when making such
high stakes decisions (Stronge, Ward & Grant, 2011). In addition, Stronge, Ward and
Grant (2011) argue that if value-added model evidence is to be used in high stakes
decisions, it should be used as only one source in a multi-faceted review of teacher
effectiveness.

Summary

"The quality of an education system cannot exceed the quality of its teachers"
(Barber & Moursheed, 2007, p. iii). To date, research has begun to examine which
qualities of effective teachers are critical to producing the highest student
achievement. Background characteristics, instructional practices and teacher self-
efficacy are all elements that have proven to be important, but more research is
needed with respect to the effect of these qualities on specific subjects and student
populations. A better understanding of what truly makes an effective teacher has
significant implications for hiring and evaluating teachers in the future. “Although various educational policy initiatives may offer the promise of improving education, nothing is more fundamentally important to improving our schools than improving the teaching that occurs every day in every classroom” (Stronge, Ward, & Grant, 2011, p. 351).
CHAPTER 3

METHODS

This chapter presents the research design for the study, addressing its paradigm, research strategy, sampling method, data generation and collection, data analysis, and study quality indicators. This study employed a quantitative design that incorporated appropriate descriptive and inferential measures to answer the research questions studied. Selected questions relied on correlational research which allowed for the analysis of relationships among multiple variables as well as the degree of these relationships in one study. The design of the study made it possible to compare the relationships between teacher effectiveness as measured by value added statistics with teacher effectiveness qualities measured by classroom observations, principal evaluations, and teachers’ sense of self-efficacy in the area of elementary mathematics. This study addressed the following research questions:

1. What is the value-added effect of 4th and 5th grade math teachers on their students’ academic growth as measured by the Virginia Standards of Learning?

2. Are the value-added profiles in terms of distributions between the 4th and 5th grade teachers comparable?

3. To what extent do principals’ evaluations of 4th and 5th grade math teachers correlate with teachers’ level of math teaching effectiveness as measured by value-added student achievement scores?
4. To what extent do 4th and 5th grade math teachers' reported self-efficacy scores correlate with their level of math teaching effectiveness as measured by value-added student achievement scores?

5. How do 4th and 5th grade math teachers' effectiveness ratings as determined by value-added student achievement scores compare with their effectiveness ratings as determined by classroom observation on selected teacher effectiveness attributes?

**Perspective**

This study built upon Stronge’s (2007) teacher effectiveness framework which had closely studied the qualities of effective teachers and was grounded in an in depth review of research on teacher quality. Stronge (2007) summarized decades of research on effective teaching and conceptualized key characteristics and behaviors using a framework with six domains, including: 1) prerequisites for effective teaching; 2) the teacher as a person; 3) classroom management and organization; 4) organizing for instruction; 5) implementing instruction; and, 6) monitoring student progress and potential. Within this framework, Stronge identified qualities (teacher characteristics and teacher behaviors) within each domain that have contributed to student achievement. In this study, Stronge’s framework served as a gauge in comparing teacher effectiveness measured by principals’ evaluations, classroom observations, and self-efficacy ratings with teacher effectiveness as measured by value-added statistics.

This theoretical framework linked the different parts of this study’s design and guided the selection of an appropriate classroom observation instrument and principal
evaluation instrument. It was also used to interpret data and generalize results. Because Stronge's framework was based on a broad review of extant literature and research which examined what constitutes teacher effectiveness, this framework had solid construct validity (i.e., the framework is a valid measure of an intended hypothetical construct – teacher effectiveness) and sound content validity (i.e., the elements in Stronge's framework are consistent with existing literature examining qualities of effective teachers) (Xu, 2011). Research studies using classroom observation have shown that teachers possessing the qualities in Stronge's (2007) framework are closely connected to student learning in different subject areas. This past research demonstrates that Stronge's framework also possessed substantial criterion validity (i.e., a consistency with performance on another criterion) (Xu, 2011). In addition, Williams (2010) found that teachers and administrator's perceptions of what defines teacher effectiveness are in agreement with Stronge's model. The combination of all of these findings suggests Stronge's teacher effectiveness framework has strong concurrent validity (i.e., consistency of results by assessments that are administered at the same time but taken by different groups of people) (Xu, 2011).

Sample and Participant Selection

This convenience sample was comprised of 4th and 5th grade teachers from the 10 elementary schools found in one suburban school district in the Commonwealth of Virginia. This school district serves more than 12,000 students in grades K-12 and in both 2009-2010 and 2010-2011, all 10 elementary schools met the state criteria to be Fully Accredited. The sample of 58 teachers included 32 teachers teaching grade 4
mathematics and 27 teachers teaching grade 5 mathematics (1 teacher taught both 4th and 5th grade mathematics) for the 2010-2011 school year. Approximately 875 4th grade students and 954 5th grade students were instructed in mathematics by this sample of teachers, with some of the teachers teaching multiple math classes of students and others teaching just one math class of students.

This sample was chosen for several reasons. First, the Virginia Standard of Learning (SOL) data were accessible, making it possible to determine value-added measures for the 58 teachers. Secondly, the school division is located within close proximity to The College of William and Mary, making it possible for the researcher to conduct the multiple classroom observations. Thirdly, the number of 4th and 5th grade teachers in this school district totaled 58, which exceeds the 30 participant minimum recommended for correlational research. All student results from the 2009-2010 and 2010-2011 Standards of Learning (SOL) mathematics assessments were used to determine a value-added measure for each of the 58 teachers. To ensure that the students included in the calculation of the teacher effectiveness ratings could be properly matched to the correct mathematics teacher, student growth scores were only included when they were found on that teacher’s math class rosters for the 2010-2011 school year. In addition, students had to have SOL math scores for both the 2009-2010 (pre-test data) and 2010-2011 school year in order to measure growth. Table 4 below shows the sample by school and grade level for the 2010-2011 school year.
Table 4. Sample Participants – Teacher and Student – per School for the 2010-2011 School Year

<table>
<thead>
<tr>
<th>School</th>
<th>Number of 4th Grade Math Teachers</th>
<th>Number of 4th Grade Math Classes</th>
<th>Number of 4th Grade Students</th>
<th>Number of 5th Grade Math Teachers</th>
<th>Number of 5th Grade Math Classes</th>
<th>Number of 5th Grade Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td>45</td>
<td>1</td>
<td>3</td>
<td>57</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>5</td>
<td>111</td>
<td>2</td>
<td>5</td>
<td>111</td>
</tr>
<tr>
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<td>3</td>
<td>3</td>
<td>67</td>
<td>4</td>
<td>4</td>
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</tr>
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<td>5</td>
<td>5</td>
<td>110</td>
<td>2</td>
<td>5</td>
<td>105</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
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<td>5</td>
<td>5</td>
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</tr>
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<td>8</td>
<td>3</td>
<td>6</td>
<td>113</td>
<td>3</td>
<td>5</td>
<td>114</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>2</td>
<td>51</td>
<td>3</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>5</td>
<td>97</td>
<td>3</td>
<td>5</td>
<td>103</td>
</tr>
<tr>
<td><strong>Total Sample</strong></td>
<td><strong>32</strong></td>
<td><strong>43</strong></td>
<td><strong>875</strong></td>
<td><strong>27</strong></td>
<td><strong>44</strong></td>
<td><strong>954</strong></td>
</tr>
</tbody>
</table>

The maximum sample for the principal evaluation measures was 58 as all 10 school principals were given an evaluation instrument for every one of the 4<sup>th</sup> and 5<sup>th</sup> grade math teachers in their respective schools. The maximum sample for the teacher efficacy ratings was 46 as 12 teachers left the school division prior to the survey distribution in April 2013. For the classrooms observations, the 58 teachers were divided into quartiles using the value-added results as measured by the SOL results.
The results of these value-added scores were used to identify the teachers in the highest and lowest quartiles based on their student academic growth. The 15 teachers in the highest quartile and 15 teachers in the lowest quartile became the sample for the classroom observations, making the original sample for the classroom observations 30. Five of these 30 teachers left the school division before observations were completed in 2013 and 4 no longer taught mathematics making the maximum sample for classroom observations 21.

**Instrumentation**

A variety of data collection instruments were used or adapted for use in this study. Specifically, the following instruments were used: (a) Teachers' Sense of Efficacy Scale, (b) Teacher Effectiveness Scale.

**Teacher Self-efficacy**

All 46 remaining participants were given the *Teachers' Sense of Efficacy Scale* short form created by Dr. Megan Tschannen-Moran of the College of William and Mary and Dr. Anita Woolfolk Hoy of the Ohio State University. Because this instrument was developed at the Ohio State University, it is sometimes referred to as the *Ohio State Teacher Efficacy Scale*. There were 12 questions in this survey and the responses were based on a nine-point Likert scale. They included questions found in the following 3 categories: Efficacy in Student Engagement (question numbers 2, 4, 7 and 11), Efficacy in Instructional Strategies (question numbers 5, 9, 10 and 12) and Efficacy in Classroom Management (question numbers 1, 3, 6 and 8). The survey also included demographic questions related to gender, race, subject matter, grade level, years of experience, level, context of the school, and socio-economic
status of the school. Instructions for completing the survey were sent via e-mail prior to the survey being sent by mail and were also attached to the survey itself. The participants were directed in the instructions to answer the questions reflecting on their math teaching only. The researcher made the assumption that participants could isolate their math teaching from their teaching of other subjects.

Although the make-up of these scales has varied slightly, Tschannen-Moran and Hoy used factor analysis to test this instrument and have consistently found three moderately correlated factors: Efficacy in Student Engagement, Efficacy in Instructional Practices, and Efficacy in Classroom Management. In a study reported by Tschannen-Moran and Hoy (2001), reliabilities were found and are shown in Table 5 below.

Table 5. Reliabilities for Teachers' Sense of Efficacy Scale (Tschannen-Moran and Hoy, 2001).

<table>
<thead>
<tr>
<th>Short Form</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Sense of Efficacy</td>
<td>7.1</td>
<td>.98</td>
<td>.90</td>
</tr>
<tr>
<td>Engagement</td>
<td>7.2</td>
<td>1.2</td>
<td>.81</td>
</tr>
<tr>
<td>Instruction</td>
<td>7.3</td>
<td>1.2</td>
<td>.86</td>
</tr>
<tr>
<td>Management</td>
<td>6.7</td>
<td>1.2</td>
<td>.86</td>
</tr>
</tbody>
</table>

A validation study for this short form instrument was conducted in 2001 by Tschannen-Moran and Hoy. In this study, the researchers confirmed the validity of this instrument and found that the strongest correlations between the instrument and
other measures are with scales that assess personal teaching efficacy (Stronge, Ward, & Grant, 2011).

**Observed Teacher Effectiveness**

Each of the remaining 21 participants found to be in the top- and bottom-quartile were observed within their authentic math teaching environment during the spring of 2013. The Teacher Effectiveness Scale (Stronge, 2003) was used as the instrument for collecting observation data. The Teacher Effectiveness Scale is a valuable tool for examining instructional practices used by teachers. This instrument is a behaviorally-anchored rating scale that is designed to record and document effective teacher qualities and behavior in the classroom. It was created to capture both the types of behaviors observed and the degree to which the teacher exhibits these behaviors. Content validation of the Teacher Effectiveness Scale was achieved using a comparison of extent research on teacher effectiveness discussed in Stronge’s (2002, 2007) meta-review of qualities of effective teachers. A field test by Stronge, comparing actual teaching practices with the instrument’s intended content design was used to ensure concurrent validity.

**Principal Evaluations**

For principal evaluation of the selected teachers, again Stronge’s (2003) Teacher Effectiveness Scale was used to collect principal evaluations’ of the 4th and 5th grade math teachers in their building during the 2010-2011 school year. The principals determined ratings for each of their teachers in fifteen separate items divided into four major categories: Instructional Skills, Assessment Skills, Classroom Management and Personal Qualities.
Data Collection

Value-Added Ratings

Without meaningful pre-test data, achievement test scores at the end of a given year are not necessarily valid measures of a teacher’s influence. A more accurate measure of what a student has learned is achieved when a curriculum-aligned assessment is administered at the start of the year and then again at the end of a year. In addition, when learning gains are averaged over a whole class of students, there is a greater indication of the magnitude of learning that took place (Tucker & Stronge, 2005). With this in mind, the methodology for determining teacher effectiveness ratings based on growth measures is based on the Virginia SOL math tests for grades 3, 4 and 5. The tests are given in late May or early June of each year and the previous year’s assessment acts as a pre-test for the following school year. These tests are designed to measure student performance on grade-level math competencies specified in the state of Virginia’s curriculum standards. Therefore, these SOL math tests are criterion-referenced assessments. Criterion-referenced tests are designed to test whether a student has “reached an established criterion in a clearly defined domain” (Tucker & Stronge, 2005, p. 19).

All of the teachers were coded so that only the researcher knew the identities of the teachers. Teachers were matched with their students using class rosters provided by the school division’s student data system. Growth measures for each student were determined by the rate of change from their previous year’s scores (i.e. growth of 4th grade students was determined using their 3rd grade scores from the previous year). Any student who did not have scores for both the 2009-2010 and
2010-2011 school year or could not be matched to a teacher was not used in determining growth. Descriptive statistics including mean and standard deviation were used to determine each teacher’s value-added growth score. The difference scores of the students were standardized, aggregated, and averaged to determine a composite score for each of the 59 teachers.

Teacher Efficacy

The Teachers' Sense of Efficacy Scale was sent to each teacher in April 2013. The researcher sent the survey to each of the 58 teachers by inner school division mail in April 2013. Included in the envelope were instructions on completing the survey and on basing all answers specifically on their math teaching. Consent forms for each teacher were also included. An e-mail was sent to all participants explaining the project and the survey directions the day before all surveys were mailed. Two reminder e-mails were all sent to all participants. A minimum of 45 responses was desired to have a response rate of at least 75%.

Observations

Observations were conducted by the researcher and another trained observer. Data was collected using the Teacher Effectiveness Scale (Stronge, 2003). The researcher targeted the 15 teachers in the top quartile and 15 teachers in the bottom quartile as determine by their value-added scores from the HLM analysis. In order to maintain unbiased scoring, the observers did not know which quartile (highest or lowest) each teacher was categorized in prior to conducting the observation. The observer determined ratings for each of the teachers in fifteen separate items divided
into the four major categories: Instructional Skills, Assessment Skills, Classroom Management and Personal Qualities.

The participants found to be in the top- and bottom-quartile were observed within their authentic math teaching environment during the spring of 2013. The observations were all pre-arranged with the teacher and the school principal with the teacher picking the date and time for the observation. Each observation lasted approximately 60-75 minutes and was conducted in the teacher's classroom at their normal math class time. At the conclusion of the observations, the observer(s) determined the best value for each item based on the classroom observation and lesson just observed. Ratings were determined using the rubric with Level 4 = most effective, Level 1 = least effective. For each observed teacher, means were determined for each of the four categories – Instructional Skills, Assessment Skills, Classroom Management and Student Engagement.

Principal Evaluations

Principals were asked to complete teacher evaluations at the conclusion of 2010-2011 school year. Evaluations were done at this time to ensure that all principals completing the evaluations did so at the conclusion of the school year from which the SOL data used was retrieved. In addition, this prevented any administrative retirements or moves to impact the evaluation data. Each of the 10 elementary principals was given the Teacher Effectiveness Scale ratings form for each of the teachers in their school building. The researcher met with each principal in person to deliver the rating forms and explain the purpose of the educational project. The principals were instructed to complete the scale for each teacher.
honestly, as these would not be placed in a teacher’s record or be shown to the teacher. As stated above, the teachers would be coded so that only the researcher knew the identity of each teacher. The principals were asked to complete the Teacher Effectiveness Scale evaluations from May 2011-August 2011. Those that did not complete the evaluations at this time were asked again at the conclusion of the 2013-2014 school year to complete the TES for each of their teachers. For this study, these evaluation results were coded and used to compare these principal evaluations of their teachers’ effectiveness with teacher effectiveness as determined by the value-added growth measures.

**Data Analysis**

In order to explore the phenomenon of effective teaching, a quantitative approach centered on descriptive statistics was used to determine the correlations between all parts of the study. Data analysis in phenomenological inquiry is a process intended to “grasp and elucidate the meaning, structures, and essence of the lived experience of a phenomenon for a person or group of people” (Patton, 2001, p. 482). This section explains the methods of data analysis the researcher will use to convert the raw data from the study into interpretations of the larger construct of teacher effectiveness.

**Value-Added Model**

Hierarchical linear modeling (HLM) is a regression-based methodology that can account for the influence of variables on an outcome such as student achievement. HLM can be used to predict student achievement within schools and classrooms by blocking out the impact exerted by non-teacher-level factors allowing
for a more precise examination on the effect of teachers on student progress and
achievement (Stronge, Ward & Grant, 2011). Hierarchical linear modeling was used
in this study to estimate the growth in mathematics achievement for all students in the
sample. These values were standardized for ease of interpretation and then used to
calculate a composite number and rank the individual teachers. Once the individual
teachers were ranked, they were divided into quartiles in order to identify the 15 top-
and 15 bottom-quartile teachers for the observation phase of the study.

Descriptive Statistics

Descriptive statistics are mathematical analyses used primarily for organizing,
summarizing, and displaying a set of numerical data (Gall, Gall, & Borg, 2007). For
the classroom observations, means will be calculated in order to summarize and
compare the categories including Instructional Skills, Assessment Skills, Classroom
Learning Environment and Personal Qualities. The means will be compared with the
composite scores of each teacher based on student learning to determine if any type of
correlation exists. In a similar process, the principal evaluation data will also be
summarized and the means calculated to determine scores for each teacher.

In order to analyze and compare the data collected from the TSES, means and
standard deviations were calculated for each of the four categories: Teacher Sense of
Efficacy, Engagement, Instruction, and Management. In order to obtain teacher
efficacy significance, the means will be compared with the composite scores of each
teacher based on student learning to determine if any type of correlation exists. A
summary of data collection and analysis is shown in Table 6 below by research
question.
**Table 6. Data Collection and Analysis by Research Question**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Collection Method/Instrumentation</th>
<th>Descriptive and/or Inferential Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is the value-added effect of 4th and 5th grade math teachers on their students’ academic growth as measured by the Virginia Standards of Learning?</td>
<td>2009-2010 and 2010-2011 Virginia Standards of Learning Math Assessments (Grades 3, 4 and 5)</td>
<td>Hierarchical linear modeling (HLM)</td>
</tr>
<tr>
<td>2. Are the value-added profiles in terms of distributions between the 4th and 5th grade teachers comparable?</td>
<td>2009-2010 and 2010-2011 Virginia Standards of Learning Math Assessments (Grades 3, 4 and 5)</td>
<td>Hierarchical linear modeling (HLM)</td>
</tr>
<tr>
<td>3. To what extent do principals’ evaluations of 4th and 5th grade math teachers correlate with teachers’ level of math teaching effectiveness as measured by value-added student achievement scores?</td>
<td>Principal Evaluations Teacher Effectiveness Scale</td>
<td>Means</td>
</tr>
<tr>
<td>4. To what extent do 4th and 5th grade math teachers’ reported self-efficacy scores correlate with their level of math teaching effectiveness as measured by value-added student achievement scores?</td>
<td>Survey Teachers’ Sense of Efficacy Scale</td>
<td>Means</td>
</tr>
<tr>
<td>5. How do 4th and 5th grade math teachers’ effectiveness ratings as determined by value-added student achievement scores compare with their effectiveness ratings as determined by classroom observation on selected teacher effectiveness attributes?</td>
<td>Observations Teacher Effectiveness Scale</td>
<td>Means</td>
</tr>
</tbody>
</table>
**Ethical Safeguards**

In February 2012, prior to conducting the complete study, permission was obtained through the College of William and Mary's Protection of Human Subjects Committee. The student assessment data from the Virginia Standards of Learning assessments which was used for this study was collected prior to the initiation of this study by the school district in both the 2009-2010 and 2010-2011 school years. The principal evaluation data for this study was gathered as part of an earlier educational project to ensure that the teachers were evaluated by the principals that were tasked with evaluating them during the 2010-2011 school year when the SOL data was collected.

Additional safeguards provided by the researcher follow. Teacher participants were asked by the researcher to complete these surveys anonymously with their identity only known by the researcher for matching purposes. This allowed for confidentiality of the respondents as they will only be identified as a specific teacher number and by school for the purpose of this study. Participation in this study was voluntary. Completion of the survey by teachers indicated their consent to participate in the teacher efficacy portion of this study. Selected teachers in the highest and lowest quartiles were asked to participate in the observation portion of the study. Again, this participation was voluntary and the observation time was arranged between the teacher and researcher prior to the observation. Principal participants were asked to complete the teacher evaluations for each of the teachers in their respective building. They were informed that these evaluations would be kept confidential and only matched to the specific teacher using their assigned anonymous...
teacher number known only by the researcher. Executive summaries of these research results will be provided to the participating school division to be shared with the administration, teachers, and parents.
CHAPTER 4
DATA ANALYSIS

The purpose of this study was to determine if the practices of highly effective and less effective mathematics teachers differ in their teaching, the ways in which they view themselves as mathematics teachers, and how they are evaluated as mathematics teachers by their administrators. Further, this study sought to examine the relationship between the highest and lowest quartile of teachers (determined by value-added measure of student growth) and the teacher effectiveness variables of classroom management, personal qualities, instructional strategies, and student assessment as measured by both classroom observations and principal evaluation. Additionally, the self-efficacy measures of classroom management, instructional strategies, and student engagement as determined by the teachers themselves were investigated by comparing them to the value-added teacher effectiveness levels. The results obtained from analyzing these data for each of the five research questions are addressed in this chapter.

This convenience sample was comprised of 4th and 5th grade teachers from the 10 elementary schools found in one suburban school district in the Commonwealth of Virginia. This school division has a very stable population and serves more than 12,000 students in grades K-12. In both 2009-2010 and 2010-2011, all 10 elementary schools met the state criteria to be Fully Accredited. The sample of 58 teachers included 32 teachers teaching grade 4 mathematics and 27 teachers teaching grade 5 mathematics (1 teacher taught both 4th and 5th grade mathematics) for the 2010-2011 school year. Approximately 875 4th grade students and 954 5th grade students were
instructed in mathematics by this sample of teachers, with some of the teachers teaching multiple math classes of students and others teaching just one math class of students.

To ensure that the students included in the calculation of the teacher effectiveness ratings could be properly matched to the correct mathematics teacher, student growth scores were only included when they were found on that teacher's math class rosters for the 2010-2011 school year. In addition, students had to have Virginia Standards of Learning (SOL) math scores for both the 2009-2010 (pre-test data) and 2010-2011 (post-test data) school year in order to measure growth. Students who were not tested in both years or who took an alternate test were not included in this sample. Table 7 below shows the sample by grade level for the 2010-2011 school year.

Table 7. Sample Participants – Teacher and Student – for the 2010-2011 School Year

<table>
<thead>
<tr>
<th>Number of 4th Grade Math Teachers</th>
<th>Number of 4th Grade Math Classes</th>
<th>Number of 4th Grade Students</th>
<th>Number of 5th Grade Math Teachers</th>
<th>Number of 5th Grade Math Classes</th>
<th>Number of 5th Grade Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>43</td>
<td>875</td>
<td>27</td>
<td>44</td>
<td>954</td>
</tr>
</tbody>
</table>

Principal Evaluations

As part of an earlier educational project completed by the researcher in June 2011, the principals at each of the 10 elementary schools used in this study were given the Teacher Effectiveness Scale (TES) for each of their 4th and 5th grade math teachers in this study. The Teacher Effectiveness Scale was the tool of choice for examining instructional practices used by teachers. This instrument has a
behaviorally-anchored rating scale that is designed to record and document effective teacher qualities and behavior in the classroom. It was created to capture both the types of behaviors observed and the degree to which the teachers exhibit these behaviors. The principals determined ratings for each of their teachers in 15 separate items divided into four major categories: Instructional Skills, Assessment Skills, Classroom Management and Personal Qualities. The category of Instructional Skills includes rating for six items: Instructional Differentiation, Instructional Focus on Learning, Instructional Clarity, Instructional Complexity, Expectations for Students Learning, and Use of Technology. The category of Assessment Skills includes ratings for two items: Assessment for Understanding and Quality of Verbal Feedback to Students. The category of Classroom Management includes ratings for two items: Classroom Management and Classroom Organization. The category of Personal Qualities includes ratings for 5 items: Caring, Fairness & Respect, Positive Relationships, Encouragement of Responsibility, and Enthusiasm.

The principals were requested to determine the best value for each item based on their classroom observations and knowledge of the individual teachers’ abilities to teach math throughout the 2010-2011 school year using the rubric for each item: Level 4 = most effective, Level 1 = least effective. When the observed behavior throughout the school year in a given teacher effectiveness item crossed more than one level on the scoring rubric, principals were asked to score the item on the scale of 1 to 4 in which the preponderance of evidence or witnessed behavior fell. In order to determine an overall principal evaluation rating, the mean of the 15 separate items for each teacher were calculated. Although the expected sample was 58, the 10
principals completed evaluations for 54 teachers. One principal did not submit evaluations for four fourth grade teachers.

The results from the TES instrument ratings showed that principals rated teachers with values on the scale between 2 and 4 in the categories of Assessment Skills, Classroom Management, and Personal Qualities with no teacher receiving the lowest mark of 1 on a single question. For Instructional Skills, principals rated their teachers in each value from 1 to 4. The mean was highest in the category of Personal Qualities. Overall, the principal rating means were between 3.35 and 3.52 for the four categories, illustrating that principals rated their teachers in the highest two values on the 1-4 scaled rubric. The results from the principal evaluations by category are shown below in Table 8.

Table 8. Principal Evaluation Ratings for both 4th and 5th Grade Teachers

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>Minimum Principal Rating</th>
<th>Maximum Principal Rating</th>
<th>Mean for All Teachers</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Skills</td>
<td>54</td>
<td>1.67</td>
<td>4.0</td>
<td>3.35</td>
<td>.47</td>
</tr>
<tr>
<td>Assessment Skills</td>
<td>54</td>
<td>2.0</td>
<td>4.0</td>
<td>3.45</td>
<td>.50</td>
</tr>
<tr>
<td>Classroom Management</td>
<td>54</td>
<td>2.0</td>
<td>4.0</td>
<td>3.40</td>
<td>.55</td>
</tr>
<tr>
<td>Personal Qualities</td>
<td>54</td>
<td>2.0</td>
<td>4.0</td>
<td>3.52</td>
<td>.57</td>
</tr>
</tbody>
</table>
Teacher Sense of Self-Efficacy

The original sample size used to determine the value-added scores consisted of 58 4th and 5th grade teachers. In the time between the end of the 2010-2011 school year and May 2013 when the Teachers’ Sense of Self-Efficacy Scales (TSES) were administered, 12 of the sample of 58 teachers left the school division, leaving a sample of 46 teachers.

All 46 remaining participants were given the Teachers’ Sense of Efficacy Scale short form created by Dr. Megan Tschannen-Moran of the College of William and Mary and Dr. Anita Woolfolk Hoy of the Ohio State University. One of the remaining 46 teachers was on maternity leave at the time of the delivery and collection of survey data (May 2013-June 2013) making a final sample size for this research question of 45 teachers. There were 12 questions in this survey and the responses were based on a nine-point Likert scale. They included questions found in the following 3 categories: Efficacy in Student Engagement (question numbers 2, 4, 7 and 11), Efficacy in Instructional Strategies (question numbers 5, 9, 10 and 12) and Efficacy in Classroom Management (question numbers 1, 3, 6 and 8). In early May of 2013, the researcher sent an e-mail to all participants giving a brief explanation of the study and the survey. The researcher then sent each teacher a manila envelope containing the TSES short form, a Participant Informed Consent Form and a letter with directions and explanations. This envelope was sent via the school division’s internal mail system (the pony). Participants were told in both the e-mail and the letter that participation was voluntary and that their responses would not be identified with them personally. The participants were directed in the instructions to answer the
questions reflecting on their math teaching only. The researcher made the assumption that participants could isolate their math teaching from their teaching of other subjects. Teachers were asked to return the completed instrument with the signed Participant Informed Consent Form by May 31, 2013. A reminder e-mail was sent on two different occasions in May 2013. After the May 31, 2013 deadline passed, the researcher sent an additional request and extended the completion deadline to June 14, 2013. Of the 45 teachers, 31 teachers completed the TSES instrument for a participation rate of 68.9%.

In order to answer research question 4, means were calculated for each teacher participant for each of the three categories of efficacy: Efficacy in Student Engagement, Efficacy in Instructional Practices, and Efficacy in Classroom Management. Items 2, 4, 7 and 11 were used to determine an unweighted mean for Efficacy in Student Engagement. Of the 31 teachers who completed the instrument, the average minimum score was 4.25 while the average maximum score was 9.00. The mean score for student engagement for was 6.86 with a standard deviation of 1.12. While the mean of 6.86 was the lowest for the three categories, the standard deviation was the highest, showing that although teachers rated their confidence in their ability to engage students the lowest, they had the most inconsistency in their scores.

Items 5, 9, 10 and 12 were used to determine an unweighted mean for Efficacy in Instructional Practices. When analyzing the results of the 31 responses, the minimum average value was 5.25 while the maximum average value was 9.00. The mean of responses was 7.40 and the standard deviation was 1.07.
Items 1, 3, 6 and 8 were used to determine an unweighted mean for Efficacy in Classroom Management. Once analyzed, the range of scores for classroom management was 5.50 to 9.00. The mean score was 7.42 while the standard deviation was .85. Of the three separate categories, Classroom Management had the highest mean score and the lowest standard deviation suggesting that overall the teachers completing the survey felt they were most effective in managing their classrooms while the lowest variability between them existed.

In order to determine an overall self-efficacy score, the twelve questions were averaged for each teacher. The minimum overall score for each individual teacher was 6.00 while the maximum was 9.00. The overall mean of the 31 teachers was 7.24 while the standard deviation was .86. All minimum and maximum responses as well as the means and standard deviations from each category and overall self-efficacy are displayed in Table 9 below.

Table 9. Teacher Sense of Self-Efficacy Ratings

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum Individual Teacher Rating</th>
<th>Maximum Individual Teacher Rating</th>
<th>Mean for All Teacher Respondents</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey – Total Responses</td>
<td>31</td>
<td>6.00</td>
<td>9.00</td>
<td>7.24</td>
<td>.86</td>
</tr>
<tr>
<td>Survey – Student Engagement</td>
<td>31</td>
<td>4.25</td>
<td>9.00</td>
<td>6.86</td>
<td>1.12</td>
</tr>
<tr>
<td>Survey – Instructional Practices</td>
<td>31</td>
<td>5.25</td>
<td>9.00</td>
<td>7.40</td>
<td>1.07</td>
</tr>
</tbody>
</table>
Although the make-up of these scales has varied slightly, Tschannen-Moran and Hoy used factor analysis to test this instrument and have consistently found three moderately correlated factors: Efficacy in Student Engagement, Efficacy in Instructional Practices, and Efficacy in Classroom Management. In a study reported by Tschannen-Moran and Hoy (2001), reliabilities were found and are shown in Table 10 below.

Table 10. Reliabilities for Teachers' Sense of Efficacy Scale (Tschannen-Moran and Hoy, 2001).

<table>
<thead>
<tr>
<th>Short Form</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Sense of Efficacy</td>
<td>7.1</td>
<td>.98</td>
<td>.90</td>
</tr>
<tr>
<td>Engagement</td>
<td>7.2</td>
<td>1.2</td>
<td>.81</td>
</tr>
<tr>
<td>Instruction</td>
<td>7.3</td>
<td>1.2</td>
<td>.86</td>
</tr>
<tr>
<td>Management</td>
<td>6.7</td>
<td>1.2</td>
<td>.86</td>
</tr>
</tbody>
</table>

When comparing the means of this study to that of Tschannen-Moran and Hoy, the results for Instructional Practices are typical, 7.4 for this study and 7.3 for the instrument. For Student Engagement, the results of this study showed that the mean was found to be 6.86 which is lower than the instrument value of 7.2; however, it was less than half of a standard deviation lower. The mean for Classroom Management for this study was 7.42 which was more than half a standard deviation lower.
above the instrument mean of 6.7. For the overall survey, the mean for this study was 7.24 which is typical to that of the instrument mean of 7.1.

*Classroom Observations*

The researcher targeted the 15 teachers in the top quartile and 15 teachers in the bottom quartile as determined by their value-added scores from the HLM analysis. (Note: Since there were 58 teachers in the study, quartiles were rounded to 15.) Only 7 teachers in the top quartile and 7 teachers in the bottom quartile were able to be observed because 5 left the division, 4 were no longer teaching math, 6 did not agree to being observed during this timeframe, and 1 was on maternity leave. In order to maintain unbiased scoring, the observers did not know which quartile (highest or lowest) each teacher was categorized in prior to conducting the observation. The Teacher Effectiveness Scale was used as the evaluation instrument for each of the 14 observations conducted. As in Research Question 3, the observer determined ratings for each of the teachers in 15 separate items divided into the four major categories: Instructional Skills, Assessment Skills, Classroom Management and Personal Qualities.

Each of the remaining 21 participants found to be in the top- and bottom-quartile were observed within their authentic math teaching environment during the spring of 2013. The Teacher Effectiveness Scale (Stronge, 2003) was again used as the instrument for collecting observation data. Content validation of the Teacher Effectiveness Scale was achieved using a comparison of extent research on teacher effectiveness discussed in Stronge’s (2002, 2007) meta-review of qualities of
effective teachers. A field test by Stronge, comparing actual teaching practices with
the instrument's intended content design was used to ensure concurrent validity.

The observations were all pre-arranged with the teacher and the school
principal with the teacher picking the date and time for the observation. Teachers did
not know why they were selected – that is, they did not know they were in the top 15
or bottom 15 as determined by their value-added ratings. Each observation lasted
approximately 60-75 minutes and was conducted in the teacher's classroom at their
normal math class time. Prior to the first observation, the project observer met with a
well-trained and highly experienced user of the TES instrument in order to ensure that
the instrument would be used properly and that the scores from the observations
would be both valid and reliable. As part of this training, the project observer and
experienced observer used the TES with a classroom teacher video and matched their
scores. Matches between the project observer and the experienced observer were
above 90% using the video, so the observations began on May 1, 2013. For the first,
third and fourth observations, the experienced observer accompanied the project
observer and also completed her own independent TES instrument for each of these
three observations. At the conclusion of the observations, the two observers
compared their scoring and determined that matched in categorical analysis by greater
than 90%. Because of the high consistency and reliability between the two observers,
the project observer conducted observation 2 and observations 5 through 14 without
the expert observer.

At the conclusion of the observations, the observer(s) determined the best
value for each item based on the classroom observation and lesson just observed.
Ratings were determined using the rubric with Level 4 = most effective, Level 1 = least effective. For each observed teacher, means were determined for each of the four categories – Instructional Skills, Assessment Skills, Classroom Management and Student Engagement. Note: Regression analyses were not calculated due to the small sample size.

**Findings for Research Question 1: What is the value-added effect of 4th and 5th grade math teachers on their students’ academic growth as measured by the Virginia Standards of Learning?**

HLM 7 is a program that can fit models to outcome variables that generate a linear model with explanatory variables that account for variations at each level, utilizing variables specified at each level. Using this HLM 7 software, the data were analyzed in order to determine the relationship between 2010 and 2011 student test scores by teacher. In this analysis, the student was the first level factor and the teacher was the second level. In order to ensure that all data were entered correctly in the original Excel spreadsheet of student Standards of Learning (SOL) Virginia criterion-referenced state assessment scores from 2010 and 2011, a systematic spot check was conducted first by the researcher and then by an outside non-participant in the study. This systematic spot check was intended to ensure that all data points were accurate before conducting the analysis thus ensuring validity in the results of the HLM analysis.

The Standards of Learning assessments used in this study have a scale score ranging from 200 to 600. A score of 400 represents a proficient passing score, and a score of 600 is a perfect score. The value-added scores for each of the 58 teachers
included in this study were determined by the students enrolled in their math classes during the 2010-2011 school year. Some teachers taught multiple math classes while others just taught one class of math. Each student’s previous year’s (May 2010) SOL score was used as their pre-assessment score and the end of the school year (May 2011) SOL score was used as their post-assessment score. Thus, for a student to be included in the analysis, she or he had to have both a 2010 and 2011 SOL score.

A value-added negative score for a student indicates that the student performed below expectation. A value-added negative score for a teacher means that, on average, the students in that class or classes performed below expectations. The value-added scores for teachers in this analysis range from -62.01 to 34.68. Twenty-seven teachers (46.55%) had a value-added score that was negative while thirty-one teachers (53.45%) had a value-added score that was positive. The mean value-added score of the 58 teachers was -2.13 with a standard deviation of 19.49. Figure 1 displays the distribution of teacher value-added scores.
The graph suggests that two teachers had a relatively large negative impact on their students' mathematics achievement as measured by these 2010 and 2011 SOL assessments. With the exception of these two lower outliers, the value-added results are quite close to a normal distribution. The average value-added score is slightly negative which is attributable to the two extreme teachers.

Findings for Research Question 2: Are the value-added profiles in terms of distributions between the 4th and 5th grade teachers comparable?

To answer this question, the 4th and 5th grade outcomes on the value-added measure need to be compared. In order to get a fair comparison of results for 4th and 5th grade teachers, one teacher, who taught both 4th and 5th grade math classes was
removed from the sample. Using the value-added score for each individual teacher, a t-test was conducted to determine if a difference between 4th and 5th grade mean value-added scores for the teachers was significant. The mean value-added score for 4th grade teachers was -2.67 while the mean for 5th grade teachers was -0.26. Both means are slightly negative, suggesting that for both 4th and 5th grade teachers, average student performance was slightly less than expected. The standard deviation for fourth grade was 17.80 while the standard deviation for 5th grade was 21.00. In both cases, the standard deviations are high suggesting a large amount of variability exists within the value-added scores of each grade level. Table 11 shows the means and standard deviations for both the 4th and 5th grade teachers.

Table 11. 4th and 5th Grade Value-Added Ratings

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>31</td>
<td>-2.67</td>
<td>17.80</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>-.26</td>
<td>21.00</td>
</tr>
</tbody>
</table>

The results of the Independent Samples t-test found no significant difference between 4th and 5th grade teachers (t (55) = -0.468, p = .64) -tailed).

Findings for Research Question 3: To what extent do principals’ evaluations of 4th and 5th grade math teachers correlate with teachers’ level of math teaching effectiveness as measured by value-added student achievement scores?

Principals completed evaluations for 54 of the 58 teachers. One principal did not submit evaluations for four fourth grade teachers. For each teacher, category values were computed as the mean of the relevant questions and the total was
represented by the overall average. These values were then used in separate regression analyses by category to determine whether the principal evaluation scores were predictive of the teachers’ value-added score. Table 12 shows the results of the regressions that were calculated. In each instance the coefficient for the predictor was not significant, indicating that none of the principal rating components were related to the value added scores.

Table 12. Regression Analysis for Principal Ratings

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Standard Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>Instructional Skills</td>
<td>11.55</td>
<td>9.06</td>
<td>.27</td>
<td>1.28</td>
</tr>
<tr>
<td>Assessment Skills</td>
<td>6.25</td>
<td>8.62</td>
<td>.16</td>
<td>.73</td>
</tr>
<tr>
<td>Classroom Management Skills</td>
<td>4.15</td>
<td>6.58</td>
<td>.12</td>
<td>.63</td>
</tr>
<tr>
<td>Personal Qualities</td>
<td>-9.90</td>
<td>6.82</td>
<td>-.28</td>
<td>-1.45</td>
</tr>
<tr>
<td>Overall Principal Evaluation</td>
<td>10.24</td>
<td>6.12</td>
<td>.23</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Comparison of Top and Bottom Quartile Teacher Principal Evaluation Results

Because the results of the correlational analysis did not show a relationship, it was decided to examine the discrimination of principals between the top and bottom quartile teachers. Table 13 shows the means for the top and bottom quartile teachers.
on the principal ratings. The largest difference was in Classroom Management where the teachers in the top quartile were rated an average of .32 higher than the bottom quartile. The smallest difference was in Personal Qualities where the top quartile teachers were rated just .06 higher than those in the bottom quartile. In all categories combined, the overall ratings for the teachers in the top quartile were .21 higher than the in the bottom quartile. Each value and the comparison values are shown below in Table 13 while a graphical comparison of the data is shown in Figure 2. Using a t-test to compare, none of these values are significant.

*Table 13. Principal Ratings between Top and Bottom Quartile Teachers*

<table>
<thead>
<tr>
<th></th>
<th>Instructional Skills Mean</th>
<th>Assessment Skills Mean</th>
<th>Classroom Management Mean</th>
<th>Personal Qualities Mean</th>
<th>Principal Evaluation Total Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Quartile Teachers</td>
<td>3.48</td>
<td>3.53</td>
<td>3.57</td>
<td>3.57</td>
<td>3.54</td>
</tr>
<tr>
<td>Bottom Quartile Teachers</td>
<td>3.21</td>
<td>3.32</td>
<td>3.25</td>
<td>3.51</td>
<td>3.33</td>
</tr>
<tr>
<td>Top Quartile Compared with Bottom Quartile Means</td>
<td>+.26</td>
<td>+.21</td>
<td>+.32</td>
<td>+.06</td>
<td>+.21</td>
</tr>
<tr>
<td>t-test*</td>
<td>-1.39</td>
<td>-1.42</td>
<td>-1.14</td>
<td>-.09</td>
<td>-1.31</td>
</tr>
</tbody>
</table>

*All t-tests have 27 degrees of freedom and none were significant at the level of p < .05.*
Findings for Research Question 4: To what extent do 4th and 5th grade math teachers’ reported self-efficacy scores correlate with their level of math teaching effectiveness as measured by value-added student achievement scores?

Of the 45 teachers in the final sample size for this research question, 31 teachers completed the TSES instrument. For each teacher, category values were computed as the mean of the relevant questions and the total was represented by the overall average. These values were then used in separate regression analyses to determine whether the math teachers’ reported self-efficacy scores were predictive of their value-added scores. Table 14 shows the results of the regressions that were run. In each instance the coefficient for the predictor was not significant indicating that none of the reported self-efficacy scores were related to the value added scores.
Table 14. Regression Analysis for Teacher Self-Efficacy Survey Ratings

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Standard Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>Total Self-Efficacy</td>
<td>-6.67</td>
<td>4.35</td>
<td>-.27</td>
<td>-1.54</td>
</tr>
<tr>
<td>Instructional Skills</td>
<td>-6.62</td>
<td>4.29</td>
<td>-.35</td>
<td>-1.54</td>
</tr>
<tr>
<td>Student Engagement</td>
<td>2.29</td>
<td>5.86</td>
<td>.13</td>
<td>.39</td>
</tr>
<tr>
<td>Classroom Management</td>
<td>-2.37</td>
<td>6.78</td>
<td>-.10</td>
<td>-.35</td>
</tr>
</tbody>
</table>

Comparison of Means between Top and Bottom Quartile Teachers

Of the 15 teachers determined to be in the top quartile based on their value-added scores, nine completed and returned the TSES instrument while ten of the fifteen in the bottom quartile completed the survey. The results of the TSES instrument showed that in each category: Student Engagement, Instructional Practices, Classroom Management and overall Self-Efficacy the mean score of the ten teachers in the bottom quartile was greater than the mean score of the nine teachers in the top quartile. The largest disparity was in Classroom Management where the bottom quartile teachers rated themselves .69 higher than the top quartile teachers. The smallest disparity was in Student Engagement where the bottom quartile teachers rated themselves an average of .11 higher than the higher quartile teachers. The disparity between Instructional Practices and Overall Self-Efficacy was .17 and .36.
respectively against the bottom quartile teachers rating themselves higher than the top quartile teachers. These results suggest that the teachers in the bottom quartile feel better about their own abilities to teach than the teachers in the top quartile.

However, using a t-test to examine significance found that none of these values are significant. These results and comparisons are shown below in Table 15 and graphically in Figure 3.

*Table 15. Teacher Self-Efficacy Survey Ratings between Top and Bottom Quartile Teachers*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top Quartile Teachers</strong></td>
<td>9</td>
<td>7.416667</td>
<td>6.694444</td>
<td>6.888889</td>
<td>7</td>
</tr>
<tr>
<td><strong>Bottom Quartile Teachers</strong></td>
<td>10</td>
<td>7.525</td>
<td>6.861111</td>
<td>7.575</td>
<td>7.358333</td>
</tr>
<tr>
<td><strong>Top Quartile Compared with Bottom Quartile Means</strong></td>
<td></td>
<td>-.108333</td>
<td>-.166667</td>
<td>-.686111</td>
<td>-.358333</td>
</tr>
<tr>
<td><strong>t-test</strong></td>
<td></td>
<td>.248</td>
<td>.282</td>
<td>1.69</td>
<td>.901</td>
</tr>
</tbody>
</table>

* All t-tests have 17 degrees of freedom and none were significant at the level of p < .05
Figure 3. Comparison of Teacher Self-Efficacy Survey Ratings between Top and Bottom quartile Teachers

Comparison of Self-Efficacy Ratings

- Student Engagement Means
- Instructional Practices Means
- Classroom Management Means
- Overall Self-Efficacy Rating Means

Findings for Research Question 5: How do 4th and 5th grade math teachers’ effectiveness ratings as determined by value-added student achievement scores compare with their effectiveness ratings as determined by classroom observation on selected teacher effectiveness attributes?

Seven teachers in the top quartile and seven teachers in the bottom quartile were observed. When comparing the mean scores in each of the four categories: Instructional Skills, Assessment Skills, Classroom Management and Personal Qualities and in the overall mean score, the teachers in the bottom quartile were actually rated slightly higher in Instructional Skills, Classroom Management, Personal Qualities and Overall Total. Teachers in the top quartile were only rated slightly higher in the category of Assessment Skills. After using a t-test to check for significance, none of these values were found to be significant. Each value and the
comparison values are shown below in Table 16 while a graphical comparison of the data is shown in Figure 4.

Table 16. Classroom Observation Ratings between Top and Bottom Quartile Teachers

<table>
<thead>
<tr>
<th></th>
<th>Instructional Skills Mean</th>
<th>Assessment Skills Mean</th>
<th>Classroom Management Mean</th>
<th>Personal Qualities Mean</th>
<th>Observation Total Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Quartile Teachers</td>
<td>2.88</td>
<td>3</td>
<td>3.07</td>
<td>3</td>
<td>2.99</td>
</tr>
<tr>
<td>Bottom Quartile Teachers</td>
<td>3</td>
<td>2.86</td>
<td>3.21</td>
<td>3.14</td>
<td>3.05</td>
</tr>
<tr>
<td>Top Quartile Compared with Bottom Quartile Means</td>
<td>-.12</td>
<td>+.14</td>
<td>-.14</td>
<td>-.14</td>
<td>-.07</td>
</tr>
<tr>
<td>t-test</td>
<td>-.54</td>
<td>-.35</td>
<td>.35</td>
<td>.03</td>
<td>.32</td>
</tr>
</tbody>
</table>

* All t-test have 12 degrees of freedom and none have p < .05.
Figure 4. Comparison of Classroom Observation Ratings between Top and Bottom quartile Teachers

Classroom Observations

(top quartile teachers) vs. (bottom quartile teachers)

Summary

The overall results of this study suggest that with the exception of two lower outliers, the value-added results are fairly close to a normal distribution. The average value-added score is slightly negative which is attributable to the extreme two teachers. In addition, the results of the Independent Samples t-test found no significant difference between 4th and 5th grade teachers. In order to determine whether the math teachers’ principal ratings, reported self-efficacy scores and classroom observation ratings were predictive of their value-added scores separate regression analyses were conducted and in each instance, the coefficient for the predictor was not significant indicating that none were related to the value added scores of the teachers. When comparing bottom and top-quartile teachers results suggest that the teachers in the bottom quartile and teachers in the top quartile have some differences in how they are rated by principals, how they view their own
teaching and how others observe them; however, using multiple t-tests for each variable, none of these differences are significant. All of these results will be discussed further in chapter 5.
CHAPTER V  
SUMMARY, DISCUSSION, AND IMPLICATIONS

While educators today continue to strive to reach our nation's goal of helping every child reach academic success, research has emerged showing that the most important aspect of student success is the teacher providing the instruction. The intent of the present study was to shed further light on the practice of effective teaching by looking closely at key elements of successful elementary math teaching. Using data on student learning to determine growth in the teacher evaluation process offers a potential tool for improvement of the teacher evaluation process and the practice of teaching in general (Tucker & Stronge, 2005). This study combined the teacher effectiveness measures of value-added student learning with principal evaluations, classroom observations and teachers' own self-evaluation of their level of self-efficacy.

Most existing research of teacher effectiveness thus far has examined only isolated aspects of teachers' practices. This study provided a more descriptive picture into teacher effectiveness, approaching it from many levels. Although it would be premature to conclude what makes a teacher effective based on the findings of this one study, I trust that this study's results will contribute to a deeper understanding of a crucial issue in education: teacher effectiveness.

This study examined the effectiveness of 58 fourth and fifth grade teachers in one suburban school division in Virginia in teaching math using value-added scores from Virginia's Standards of Learning (SOL) assessments. The relationship between
these scores and principal evaluations, classroom observations and teachers’ own self-efficacy beliefs were investigated. All of the data were collected and analyzed to answer the following questions:

1. What is the value-added effect of 4th and 5th grade math teachers on their students’ academic growth as measured by the Virginia Standards of Learning?

2. Are the value-added profiles in terms of distributions between the 4th and 5th grade teachers comparable?

3. To what extent do principals’ evaluations of 4th and 5th grade math teachers correlate with teachers’ level of math teaching effectiveness as measured by value-added student achievement scores?

4. To what extent do 4th and 5th grade math teachers’ reported self-efficacy scores correlate with their level of math teaching effectiveness as measured by value-added student achievement scores?

5. How do 4th and 5th grade math teachers’ effectiveness ratings as determined by value-added student achievement scores compare with their effectiveness ratings as determined by classroom observation on selected teacher effectiveness attributes?

Summary and Discussion of Findings

Value-Added Measures

The heightened focus on increasing teacher effectiveness requires more quality data than ever on educators and their impact on the students that they teach. Having a quality teacher-student data link is essential to using student growth
measures to improve teaching. By 2014, 16 states have implemented a system incorporating a teacher of record definition along with a class roster verification process and structures for governing such a teacher-student data link (Data Quality Campaign, n.d.). Student growth cannot be an effective measure for teacher evaluation without considering ways to ensure that quality data are available and used to meet stakeholder information needs (Data Quality Campaign, n.d.).

This study used data from the Virginia Standards of Learning for mathematics with students in a suburban Virginia school division. Virginia is one of the 16 states mentioned above that has a teacher-student data link and has provided funding in the state budget for a longitudinal data system. In addition, Virginia has current policies in place that support the development of longitudinal data systems. However, at this time Virginia does not share teacher performance data with educator preparation programs in order for them to better prepare teachers for the future (Data Quality Campaign, n.d.).

For this study, the school division used had a huge database of SOL scores but the database itself was somewhat unuseful because of the way in which teachers were identified. In many cases, the students were listed by homeroom teacher rather than their math teacher. In order to assign the students to their proper teacher for this study, class rosters had to be used to identify the actual math teacher of each student. By identifying the correct teacher, an accurate student-teacher data link was created. This was an extremely long and tedious process that could only be done by hand which further highlighted the lack of usefulness of the large database currently in use by the division.
For the purpose of this study, effectiveness was tied directly to how well teachers prepared students for the SOL exam and how well they performed on the exam. A value-added negative score for a student indicated that the student performed below expectations while a value-added negative score for a teacher meant that, on average, the students in that class or classes performed below expectations. The value-added scores for teachers in this study ranged from -62.01 to 34.68 with 27 teachers having a negative value-added score and 31 teachers having a positive value-added score. Two teachers had a relatively large negative impact on their students’ mathematics achievement which skewed the overall data. Value-added data is often prone to extreme values which can reflect factors other than the quality of instruction. Without these two lower outliers, the value-added teacher results quite closely resembled a normal distribution which would indicate that there were similar numbers and levels of effective and ineffective teachers as measured by their ability to prepare students for the SOL exam.

Comparability of 4th and 5th Grade Teachers. For both 4th and 5th grade teachers, the mean value-added scores were slightly negative, suggesting that for both 4th and 5th grade teachers, average student performance on the mathematics SOL assessments was slightly less than expected. For both grades, one key finding was that the standard deviations were high (4th grade was 17.80 and 5th grade was 21.00) suggesting that a large amount of variability existed within the value-added scores for each grade level. This finding of high variability within the grades themselves rather than between the grades is consistent with prior findings that similarly showed greater variability within schools than between schools. Again, the two outliers that had such
a negative impact on their students' achievement added to this variability. Overall, when looking at the comparison between 4th and 5th grade teachers, these findings suggest that there are both highly effective and less effective teachers within both of these grades (4th and 5th). This finding also suggests that as research has suggested, it is the quality of the teacher, not the grade level, curriculum of that grade level, or assessment of that grade level, that is the biggest influence on student growth.

**Principal Evaluation of Teacher Effectiveness**

The results from the principal evaluations of teachers in this study showed that not only did the principals fail to distinguish the effective from less effective teachers overall, they also failed to do so in each of the four domains – instructional skills, assessment skills, classroom management skills, and personal qualities. In each instance, the coefficient for the predictor was not significant, indicating that none of the principal rating components were related to the value-added scores. This result confirms prior research that suggests that principals' ratings are often grossly inflated and not reliable (Stronge and Ostrander, 2006).

Principals are often faced with a number of daily tasks that require a large amount of time with teacher evaluation being only one such task. One explanation for their reluctance to criticize teachers is that they are unable to spend the amount of time observing teachers and providing feedback that is needed for a quality evaluation. Some principals have personal connections to their teachers and bias and prejudice can be factors in their evaluation ratings. In addition, principals are often reluctant to give poor ratings for fear of repercussions or in order to avoid unwanted conflict with teachers themselves (Stronge and Ostrander, 2006). The results from
This study further supports research (Scriven, 1981) that personal relationships, time and other factors can cause principals to make generalizations about their teachers that are inadequate. In turn, teachers are often rated on their perceived performance of what the principal thinks they know about them then their actual teaching performance (Stronge and Ostrander, 2006).

When comparing the bottom quartile teachers to those in the top quartile, the principals did rate the top quartile teachers higher than those in the bottom quartile in each separate category and in overall rating. Despite these higher ratings, none of the values were significant further supporting the earlier discussion about the reliability of principal ratings as accurate measures of teacher effectiveness. This slightly higher ratings suggest that principals can differentiate but not enough possibly because they do not want to rate any teacher too low. The variability of principal ratings was small, further suggesting that there was not a lot of discrimination.

This finding of the study is perhaps the most intriguing and could have the biggest implications for current teacher evaluation practices. The table below shows the principal ratings of the two outliers mentioned earlier.

*Table 17. Principal Ratings of Outlier Teachers*

<table>
<thead>
<tr>
<th>Outlier Teacher</th>
<th>Value-Added Score</th>
<th>Instruction</th>
<th>Assessment</th>
<th>Management</th>
<th>Personal Qualities</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>427</td>
<td>-53.02</td>
<td>2.67</td>
<td>3.5</td>
<td>3</td>
<td>3.6</td>
<td>3.19</td>
</tr>
<tr>
<td>518</td>
<td>-62.01</td>
<td>3</td>
<td>3</td>
<td>3.5</td>
<td>3.4</td>
<td>3.23</td>
</tr>
</tbody>
</table>
Although these two teachers had value added ratings significantly lower than the other teachers in the study, they still maintained relatively high marks on a scale of 1 to 4. The teacher with the absolute lowest value added was rated by their respective principal with all ratings of 3 and 4 and an overall average of 3.23. There is an obvious inconsistency in how the students of these two teachers performed and how their principals’ rated them.

In order to look more closely into the lack of discrimination of the principal ratings the ratings of the 12 lowest scoring teachers with regards to their value added scores are shown in the table below.

*Table 18. Principal Ratings of Bottom Twelve Teachers as Measured by Value Added Scores*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Value-Added Score</th>
<th>Instruction</th>
<th>Assessment</th>
<th>Management</th>
<th>Personal Qualities</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>504</td>
<td>-20.03</td>
<td>2.67</td>
<td>3</td>
<td>2.5</td>
<td>3.6</td>
<td>2.94</td>
</tr>
<tr>
<td>523</td>
<td>-20.52</td>
<td>3.83</td>
<td>4</td>
<td>3.5</td>
<td>4</td>
<td>3.83</td>
</tr>
<tr>
<td>503</td>
<td>-20.61</td>
<td>3</td>
<td>3</td>
<td>3.5</td>
<td>3</td>
<td>3.13</td>
</tr>
<tr>
<td>404</td>
<td>-22.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>417</td>
<td>-22.28</td>
<td>3.5</td>
<td>3</td>
<td>3.5</td>
<td>3.4</td>
<td>3.48</td>
</tr>
<tr>
<td>507</td>
<td>-26.77</td>
<td>3.33</td>
<td>3.5</td>
<td>4</td>
<td>4</td>
<td>3.71</td>
</tr>
<tr>
<td>420</td>
<td>-27.79</td>
<td>1.67</td>
<td>2</td>
<td>2</td>
<td>2.2</td>
<td>1.97</td>
</tr>
<tr>
<td>431</td>
<td>-29.03</td>
<td>3.17</td>
<td>3.5</td>
<td>3</td>
<td>3.6</td>
<td>3.32</td>
</tr>
<tr>
<td>601</td>
<td>-34.19</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>415</td>
<td>-35.99</td>
<td>3</td>
<td>2.5</td>
<td>2.5</td>
<td>2.6</td>
<td>2.65</td>
</tr>
</tbody>
</table>
Of the twelve teachers with the lowest student success, only three were rated on an average below a 3 and only one teacher was rated poorly with an average of 1.97. Three of the twelve were even rated with category averages of the highest possible score of four and one teacher was given all perfect 4s in every category. This data opens up many questions about principals’ abilities to truly evaluate the teaching that is occurring in their buildings. Are the ratings inflated because of lack or time, lack of knowledge, lack of effort, fear of conflict, personal relationships, or some other variable? The implications of these results suggest that the issue of teacher evaluation by principals needs to be more closely examined.

**Teacher Sense of Self-Efficacy**

Many studies (Palardy & Rumberger, 2008; Swars, 2005b; Turner, Cruz & Papakonstantinou, 2004; Wright, Horn and Sanders, 1997) determined that self-efficacy ratings and a teacher’s sense of self-efficacy had an impact on student achievement. However, when looking at the results of this study, the coefficient for the predictor was not significant, indicating that none of the reported self-efficacy scores were related to the value-added scores. This could be due in part to the loss of power from the small sample size of just 31.

When comparing the lower quartile teachers (10 of the identified 15 responded) to the higher quartile teachers (9 of the identified 15 responded), the results showed that teachers in the bottom quartile rated themselves higher in each of
the three categories and in overall scores. This could be interpreted many ways. Some might suggest that these results are an example of false confidence by the bottom quartile teachers (lowest 15 teachers as rated by their value-added scores). This could also suggest a lack of knowledge about what skills are important for good teaching and the teachers’ ability to demonstrate these skills. The results from this portion of the study might also suggest that more effective teachers are harder on themselves and are continually striving to be better at their craft knowing that there is room for growth. Additionally, these comparison results could be seen as an example of more effective teachers (top quartile – highest 15 as rated by their value-added scores) being more reflective and more aware of what is needed to be an effective teacher.

There were no specific math items on the TSES; however, teachers were asked to answer these questions with regards to their math teaching where applicable. It is a possibility that teachers could not differentiate their instruction to be math subject specific. Another possibility for the results of this portion of the study could be the fact that they truly believe that they are better than they actually are. Elementary teachers do not often have the opportunity to interact with each other or observe each other in the classroom in an instructional setting. This lack of degree to which they can observe different levels of teaching could influence their lack of knowledge about their own level of teaching effectiveness.

Classroom Observation

The results of observations should capture consistent qualities of teacher performance and a teacher’s rating should “be due to the quality of the lesson and not
the quality of the observer" (Kane and Staiger, 2012, p. 17). Inter-rater reliability was an important factor to consider with this study. The observer in this study met with a well-trained and highly experienced user of the TES instrument in order to ensure that the instrument would be used properly and that the scores from the observations would be both valid and reliable. As part of this training, the project observer and experienced observer used the TES with a classroom teacher video and matched their scores. Matches between the project observer and the experienced observer were above 90% using the video. In addition, the experienced observer accompanied the observer for this study on three classroom observations and also completed her own independent TES instrument for each. The two observers compared their scoring and determined that matched in categorical analysis by greater than 90%.

Even with this check to ensure inter-rater reliability, the results of these observations could be misleading because only a single observation of each teacher was conducted. Kane and Staiger (2012) found that one observation score is substantially driven by factors other than consistent characteristics of a teacher’s normal behavior. A single observation, the content of that particular lesson, or the make-up of that particular group of students that day could all influence ratings or be a misleading indicator of a particular teacher’s actual practice (Kane and Staiger, 2012). Scriven (1981) further highlighted the low reliability of ratings made by classroom visits by explaining that “the number and length of observations are almost always inadequate for making generalizations” (Stronge and Ostrander, p. 129).

The analysis of results for this research question show that the lower quartile teachers observed were slightly superior on classroom management, personal
qualities and instructional skills, and the higher quartile teachers were only superior in assessment skills. Even though significance was not found with the classroom observations of this study, this result is surprising. This lack of significance and surprising results could be explained by observing only one lesson for each teacher. In addition to observing only one lesson, the lesson itself was selected by the teacher and the date and time were also selected by the teacher in advance. Most importantly, only 7 of the 15 teachers (less than 50%) in each of the top and bottom quartile were actually observed. This small sample size coupled with the factors mentioned above, could explain the surprising results of this portion of the study and one could generalize that with these factors, the results of this portion of the study are unreliable.

In addition to the small sample size, these results suggest that it is possible that there is misalignment between the curriculum, assessment and instruction with regards to the teaching of math within the elementary classroom. The instructional piece is what was observed during these observations and this instruction did not match the assessment as measured by the SOL tests. The curriculum for the school division is closely aligned with the assessment, so the issue appears to be that the lack of alignment is between the instruction and the assessment used to measure in this particular study. Another possible impact on the classroom observation results is the ability of teachers to “play act” during a pre-arranged observations. Many teachers have the ability to “put on a show” that is not typical of their everyday classroom instruction or behavior. This ability to portray something different then what is the
regular in the classroom could easily have impacted the results of this portion of the study.

**Implications for Practice**

Improving the quality of teaching at all levels and in all subjects is critical to student success and thus the success of the system of education today. For decades, researchers have been trying to answer the all-important question of what makes teachers effective. An answer to this question has major implications for K-12 and higher education decisions regarding hiring practices, college preparation programs, compensation, teacher evaluation, and professional development (Stronge, Ward & Grant, 2011). The evaluation of teaching in order to determine these factors and others such as budget allocations for teacher salaries and size of a particular teaching force is critical and deserves high priority (Stronge and Ostrander, 2006).

*Using Observations for Teacher Evaluation*

The ultimate goal of classroom observations is to help teachers improve their practice, making them more effective so that they can have a positive impact on student learning. Inaccurate or unfair classroom observations can lead to mistrust and more importantly to bad decisions involving staffing. Although classroom observations can be a useful tool in assessing a teacher’s performance, they are often just a snapshot of what a teacher does on a day to day basis. Stronge and Ostrander (2006) stated, “If the purpose of a teacher evaluation system is to provide a comprehensive picture of performance in order to guide professional growth, then classroom observations should be only one piece of the information collected (p. 128).
Classroom observations give the evaluator the opportunity to see a teacher in action and assess multiple factors such as classroom management, relationships with students, instructional delivery and assessment. Most practitioners agree that they are a valuable piece to the teacher evaluation system; however, they are just one piece and should not be the only tool for evaluation. Often, the visits themselves are scheduled and thus alter the normal behavior of both teacher and students. This reduces the reliability of ratings made during classroom visits by narrowing the opportunity to see an actual representation of what the daily instruction and classroom climate looks like (Stronge and Ostrander, 2006).

*Training the Observer.* Training of observers is extremely important; however, “ensuring accuracy is not just a matter of training. It requires assessing observers’ ability to use the instrument at the end of the training” (Kane and Staiger, p. 14). Frequently, instructional quality is a matter of opinion and there is often “little agreement among evaluators in assessing classroom performance” (Stronge and Ostrander, p. 5). A system for assessing the accuracy of observers and creating a process where training can be continually revisited is important to ensuring quality and has implications for future practice.

*Instrumentation.* In developing an instrument for measuring teacher effectiveness through observation, school systems must look to develop and adopt an instrument that matches their theory of instruction. The better the instrument, the more likely that it is to capture the vision of a school system on what makes an effective teacher (Kane and Staiger, 2012). Using a quality instrument that
encompasses all of the components of effectiveness is crucial to ensuring that the observation itself is successful.

Frequency. Most school systems need to increase the overall number of observations that an observer performs each year in order to ensure that the observations which lead to evaluations achieve the most reliable results. When it comes to current practice, Stronge and Ostrander (2006) state that “the number and length of observations are almost always inadequate for making generalizations” (p. 129). The realization that current practice is lacking could significantly impact how administrators are trained to perform observations and how they allocate time. In addition it may have an impact on training additional personnel (curriculum specialists, teacher leaders and instructional coaches) to share in the responsibility of observing. One example of this is in Washington, D.C. where the district has trained more than 45 “Master Educators” who go from school to school observing teachers, conferencing with them and communicated the results of these observations to principals so that they are able to check reliability (Kane and Staiger, 2012).

Although classroom observation can be a valuable and meaningful component of a larger and more comprehensive teacher evaluation system, it cannot be utilized as the single source of information regarding a teacher’s performance and level of effectiveness (Stronge and Ostrander, 2006). Kane and Staiger (2012) further summarized that “Classroom observations provide a wealth of information that could support teachers in improving their practice. But, by themselves, these measures are not highly reliable, and they are only modestly related to student achievement gains” (p. 29).
Using Principal Ratings for Teacher Evaluation

In current teacher evaluation practices, one single administrator is often the sole evaluator for a teacher. Because these administrators often have personal relationships with the teachers that they are evaluating, the reliability of the ratings they provide is low. In a study by Frase and Streshly (1994), independent auditors brought in to conduct classroom observations described many instances of poor instructional practices in classrooms where administrators rated the teachers with high marks. The results of this study further support that an issue in reliability of principal ratings is most evident. More often than not, teachers do not receive valuable feedback from administrators on their performance which makes the teachers themselves view the process as useless (Stronge and Ostrander, 2006).

For principal evaluation to be successful as a tool for teacher evaluation, principals must assist teachers in using data collected and feedback provided to make meaningful changes to classroom practice. In addition, principals themselves need to focus on utilizing evaluation data to make decisions on needed teacher professional development, on plans for improvement for teachers, and on personnel matters (Stronge and Ostrander, 2006). Like classroom observation, principal evaluation alone should not be the single tool in determining teacher effectiveness; however, with proper training, more time, and use of valuable feedback, principal evaluations can be a valuable tool for teacher performance improvement.

Using Student Growth Measures and Student Feedback for Teacher Evaluation

"Teacher evaluation should improve teaching practice in ways that help teachers achieve greater success with their students. For that to happen, the measures
must be related to student outcomes” (Kane and Staiger, p. 28). The implications for using student outcomes leave many open questions about how to include this component with teachers who teach subjects and grades that are not included in state testing. Kane and Staiger (2012) further pointed out that “value-added is the best predictor of a teacher’s student achievement gains in the future. However, value-added is often not as reliable as some other measures and it does not point a teacher to specific areas needing improvement” (p. 29).

In this study, Standards of Learning (SOL) data were used as the student growth measure. This SOL data itself may not have been a reliable and valid measure which could have impacted the results of this study. The state of Virginia uses SOL data to determine accreditation of schools; however, it does not use this data as a single method of teacher evaluation. Kane and Staiger (2012) discuss one example in practice in Tennessee where the department of education developed a system for comparing observation results with teacher value-added scores in order to identify misalignment and work with school divisions to address such issues. This system combines the two allowing for a more accurate depiction of actual effectiveness in teacher evaluation. This could possibly be a more effective way that using SOL scores in Virginia.

In addition to just student growth measures, student feedback may also have implications for future practice for teacher evaluation. Wilkerson, Manatt, Rogers, and Maughan (2000) examined the validity of ratings by students, principals and teachers themselves and found that of the three sources of feedback, the ratings by students were best predictor of student achievement (Stronge and Ostrander, 2006). If
classroom observations, principal evaluations and student feedback are all shown to
be related to student outcomes than these measures can be a valid measure of teacher
performance (Kane and Staiger, 2012).

Implications for Research and Limitations of the Study

This value-added teacher effectiveness study explored the relationships
between teacher effectiveness ratings as determined by value-added data and teacher
observations, principal evaluations and teachers’ own sense of self-efficacy while
looking closely at specific characteristics known to be related to teacher effectiveness.
There is an abundance of research supporting the importance of teacher effectiveness
at all levels and in all subjects. There is also compelling research that shows that
there is a large variation among teachers in terms of their effectiveness (Xu, 2012).
Recent federal and state mandates are forcing local school divisions all over the
country to develop methods of teacher evaluation that include student growth
achievement and measure teacher effectiveness accurately. For this reason, it is more
important than ever for educational policy makers to determine what factors are most
important in determining teacher effectiveness in order to find accurate methods to
judge teacher effectiveness.

A convenience sample was used in this study based on location and
availability of student growth data. The method for which the school division itself
set up its database for this data made the time that it took to assign value-added scores
to teachers themselves longer than anticipated. For future research, it may be
suggested to use a more diverse sample and one in which the database for student
growth data is more defined.
One definite limitation of this study was in the smaller sample size that continued to get smaller as the study progressed. The original sample of 58 teachers was a good size for obtaining value-added measures and comparing them. One principal failed to complete evaluations for her 4th grade teachers, reducing the sample to 54 teachers for that portion of the study. For the teacher self-efficacy portion of the study, the sample was reduced to 45 (12 teachers left the division and 1 was on maternity leave) with 31 teachers completing the survey. For the classroom observation portion of this study, the researcher targeted the 15 teachers in the top quartile and 15 teachers in the bottom quartile as determined by their value-added scores from the HLM analysis. Only 7 teachers in the top quartile and 7 teachers in the bottom quartile were able to be observed because 5 left the division, 4 were no longer teaching math, 6 did not agree to being observed during this timeframe, and 1 was on maternity leave. A larger initial sample size would be helpful for future research because of the loss of teachers that may occur overtime and because of outside factors (timing, change of grade level, teachers no longer teaching math, etc.). In order to get the best results for a comparative study, a larger sample size for each portion would be recommended.

Another limitation of this study was in the instrumentation itself at each level—value-added teacher effects, classroom observation, and teacher’s sense of self-efficacy. As discussed earlier in this chapter, using the SOL scores as the student growth data may not be the most reliable and valid measure to determine teacher impact over just one year’s time. Perhaps a multiple year study would be better for determining a true value for a teacher’s value-added score. The classroom
observation instrument (TSES) is a valid and reliable measure for observing teacher behavior in the classroom; however, only one scheduled observation may have not been enough to show a true picture of each teacher's abilities. A suggestion for future research would be that multiple observations for each teacher be done in order to ensure that a true picture of the teacher's ability is obtained. With determining teacher self-efficacy, the issue with the instrument itself is mostly related to teachers self-reporting. With self-reporting, there is always some questions as to whether or not the participants are being completely honest and thoughtful in the answers that they provide.

This study used quantitative principal evaluation data and classroom observation data focused on instructional skills, assessment skills, classroom management and personal qualities to identify the practices of great teachers and compare those with the results of their value-added ratings. In addition, the study used quantitative self-efficacy data focused efficacy in student engagement, efficacy in instructional strategies and efficacy in classroom management in order to determine teachers' own perceptions of their teaching as it relates to their effectiveness as determined by their value-added ratings. Comparing the teacher effectiveness ratings as determined by their value-added scores with principal evaluation ratings, classroom observation measures and their own belief measures is what makes this study different from the prominent data available based on identified teacher effectiveness characteristics. For future research on this topic to be meaningful, careful attention should be made to sample size, type of sample and the instrumentation itself.
Conclusion

Improvement in education is not possible without specific attention to the actual practice of teaching. To develop, retain and reward outstanding teachers, school divisions must be able to recognize effective teaching. Teachers, administrators and providers of professional development are in search of a common vision of effective instruction to work toward (Kane and Staiger, 2012). Although this study does not answer the entire question of what makes an effective teacher, it does contribute into further understanding of this important issue.
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Improvement.


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