THE MATH TEACHING GAP: A STUDY OF THE RELATIONSHIP BETWEEN DIFFERENT LEVELS OF MATHEMATICS TEACHER EFFECTIVENESS AND STUDENT ACHIEVEMENT

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ABSTRACT

Jennifer Persson: The Math Teaching Gap: A Study of the relationship between different levels of mathematics teacher effectiveness and student achievement
(Under the direction of Dr. Catherine Scott and Dr. Jocelyn Glazier)

Findings from previous studies suggest that the effectiveness of students’ teachers can have a significant impact on student achievement outcomes. However, scholars have not updated research on the short- and long-term effects of this experience, nor have they tied the information to highly effective and highly ineffective teachers’ beliefs on teaching and learning. Using mixed research methods, I sought answers to the following research questions:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

I first employed quantitative methods to assess the effects of spending three years in a row with highly effective or highly ineffective teachers. When I looked for the short-term effects of these three years that the students experienced, there was a statistically significant difference between entering & exiting achievement across teacher assignment group, with a large effect size. Additionally, there were statistically significant differences of entering & exiting achievement across teacher assignment group for students of differing achievement levels, with large effect sizes. There was no statistically significant effect of teacher assignment group on the change in achievement by entering achievement level. When I looked for the long-term effects of these three years, there were statistically significant differences in students’ Algebra I projections by
teacher assignment group, as well as statistically significant differences in students’ SAT Math projections by teacher assignment group.

I then utilized blind, semi-structured interviews with five highly effective teachers and five highly ineffective teachers to compare their views on teaching and learning to (1) the prevailing views of effective teaching in the math wars, and (2) to each other. I found that the highly effective teachers expressed more constructivist views of teaching and learning and the highly ineffective teachers expressed more traditional views. I also found there were distinct characteristics between highly effective and highly ineffective teachers’ beliefs, specifically around beliefs on student engagement and responsibility for learning. The quantitative and qualitative results of this study have many implications for policy makers, K-12 teacher professional development and support programs, and teacher preparation programs.
This dissertation is dedicated to

my parents, Debbie and Benn Vennesland,

who convinced me I could do anything I put my mind to,

my children, Shane Hudson Persson and Alana Debra Persson,

who inspire me to be a better person,

and my husband, Kenny,

who offered guidance and encouragement every step of the way.
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CHAPTER 1
INTRODUCTION

Major examinations of K-12 curriculum and instruction were undertaken during the last two decades. Beginning decades ago with the publication of A Nation at Risk (NCEE, 1983), the public has become more concerned about the quality of education in America’s schools and our competitiveness in the global economy. Since that time, several publications such as the Report of the Academic Competitiveness Council (U.S. Department of Education, 2007) and Before It’s Too Late (Glenn, 2000) have further focused attention on the United States’ education program, especially on the achievement gaps that exist between white students and students from minority groups.

The election of President George W. Bush brought a renewed focus on education to the political landscape and galvanized political support for sweeping changes to federal education policy. The No Child Left Behind Act (NCLB) of 2001 (U.S. Department of Education) is federal legislation that enacted the theories of standards-based education reform, which is based on the belief that setting high standards and establishing measurable goals can improve individual outcomes in education. The Act required states to develop assessments for specific content areas to be given to all students in certain grades, if those states are to receive federal funding for schools (U.S. Department of Education, 2001). The NCLB legislation was followed up by the Race to the Top (RtT) initiative designed to assist states in improving student achievement through the implementation of comprehensive reforms, including raising educational standards (The White House, 2009).
As in many other states, the North Carolina State Board of Education saw a need to increase the rigor of the academic content standards taught to students; this increased rigor would better prepare students for success in post-secondary education and the. More rigorous content standards result in a higher bar for the state’s for the state’s graduation requirements. Failure to meet these graduation requirements in a timely manner can have severe consequences for the students including course repetition and grade retention, potentially leading to long term consequences such as high school dropout and other adverse outcomes.

The State Board of Education in North Carolina revised its policies to create a system in which Algebra I serves as a “gateway course” to higher level mathematics courses now required for high school graduation (State Board of Education, 2009). The term “gateway course” captures the fact that Algebra I is the first math course in a series of math graduation requirements; students cannot advance to the next course until they have demonstrated proficiency in Algebra I as measured by the state’s standardized Algebra I End of Course (EOC) exam. Prior to 2009, the policy stated that students could receive a high school diploma by passing Algebra I and any two other math courses which could be taken non-sequentially. After 2009, a new policy (State Board of Education, 2009) went into effect requiring students to pass Algebra I, Geometry, Algebra II, and a 4th math course in order to graduate, which epitomizes the reality of high stakes consequences. In previous years, students could take courses in whichever sequences they wanted. Under the new policy, these courses had to be taken in the specific order listed above.

In high schools without block scheduling, it is typical for students to take only one math course per year. Those students must pass Algebra I by the end of 9th grade in order to have enough time to complete the remaining three math courses and stay on track for a timely high
school graduation. One of the consequences of the new mandate is that students who do not successfully complete Algebra I in middle school and fail it in the 9th grade will need to take summer classes in order to catch up or accept a longer tenure in high school. For some students this reality results in a failure to graduate. Now more than ever before, successful and timely completion of Algebra I is essential for all students.

North Carolina’s 2009 graduation requirements assume students’ academic achievement outcomes in Algebra I are due to their own academic abilities regardless of their teachers, but research clearly indicates that teachers have a tremendous effect on student achievement (Darling-Hammond, 1999; Haycock, 1998; Jordon, Mendro & Weerasinghe, 1997; Sanders & Rivers, 1996; Wright, Horn & Sanders, 1997) and therefore teacher effectiveness must be accounted for when addressing student achievement. If teaching effectiveness has a measurable effect on student achievement, then equitable access to effective teachers should be of immediate concern to all involved, as current research indicates that access is currently not equitable (Peske & Haycock, 2006; Clotfelter, Ladd, & Vigdor, 2005; Darling-Hammond, 2004). To determine the degree to which this relationship is true, a larger study that goes above and beyond current research is needed (Carter, 2008). Understanding with clarity just how much teachers matter for the success of their students is only part of the picture. How effective and ineffective teachers differ from one another can inform many other facets of the educational arena as well, including policy makers, K-12 teacher professional development and support programs, and teacher preparation programs. Teachers can differ on many fronts, including beliefs about teaching and learning, instructional styles, skills, and so on. I set out to conduct this study in part to understand these differences and how they relate to teaching effectiveness.
In order to address both components of this issue – (1) the degree to which access to effective teachers can influence a student’s academic achievement and (2) how effective and ineffective teachers differ in their approaches to instruction – I conducted this study in two phases using a mixed model methodology (Creswell & Plano Clark, 2007). Phase I measured teacher effectiveness through the use of Education Value Added Assessment System (EVAAS) and I used those results to identify teachers who profile at varying levels of effectiveness. During Phase II, I interviewed those teachers in order to look for differences in their instructional strategies and beliefs.

**Background**

In an effort to increase the number of students prepared for college and careers after high school (State Board of Education, 2009), North Carolina shifted from previous policies (State Board of Education, 2009) that offered multiple options to obtain a high school diploma to a single diploma track – one that was *college ready* only. Prior to 2009, the policy stated that students could receive a high school diploma by passing Algebra I and any two other math courses which could be taken non-sequentially, though this diploma did not carry enough credentials for admission into a four-year college. After 2009, a new policy (State Board of Education, 2009) went into effect requiring students to pass Algebra I, Geometry, Algebra II, and a 4th math course in order to graduate. This transition was grounded by research indicating that increased time in math preparation will increase student achievement and produce students who are better prepared for life after high school (State Board of Education, 2009). Research also indicates that teachers have a significant influence over student academic achievement, with increased academic achievement also contributing to higher levels of career- and college-readiness (Darling-Hammond, 1999; Haycock, 1998; Jordon, Mendro & Weerasinghe, 1997;
Sanders & Rivers, 1996; Wright, Horn & Sanders, 1997). Combining these bodies of research on the importance of math education and teacher effectiveness brings us to the realization that not only do students need more time engaging in math instruction, but they also need highly effective teachers to succeed in these advanced math courses. To further complicate this issue, we have policy that holds students themselves solely accountable for their academic achievement, or lack thereof, which is in conflict with research that indicates that teachers have a significant influence on the academic achievement of students. Research shows that whether or not a student is assigned to an effective teacher can account for some of that student’s achievement (Sanders & Horn, 1994; Thum, 2003; Webster & Mendro, 1997). Furthermore, if a student is assigned to successively effective or ineffective teachers over a series of years, the effects on that student’s achievement could compound significantly. The implications of this relationship would have a tremendous impact on equitable learning opportunities for students, and need to be addressed if a state such as North Carolina truly wishes to raise student achievement outcomes.

The concept of teacher effectiveness has been brewing underneath the surface of educational reform initiatives for more than a century (see Carter, 2008). In 1885, it was noted that, while most teachers were of similar academic aptitude, some were able to pass along this knowledge to their students better than others, calling into question the differences in teaching methods (Page, 1885). In the 1920s, research on teacher effectiveness began to focus on administrators’ perspectives of teacher effectiveness and their teaching skills (Dunkin & Biddle, 1974; Gage, 1965). In the 1930s and 1940s, researchers explored various characteristics of teachers, for example, gender and age, to assess their effectiveness on student learning (Campbell, Kyriakides, Muijs, & Robinson, 2003). From the 1940s through the 1960s,
experimental studies were set up to expose students to different teaching styles and compare student outcomes in an attempt to investigate the effectiveness of different teaching styles such as formal/informal and progressive/traditional (Mitzel, 1960). From the 1960s on, much of the research on teaching effectiveness has focused on the relationship of teacher knowledge and beliefs with student progress (Campbell, Kyriakides, Muijs, & Robinson, 2003). As early as 1963, Medley and Mitzel assert that the teacher is an important factor in determining student learning.

In 1983, a federal report titled *A Nation at Risk* caused a heightened state of concern across the country due to its portrayal of the American education system as one falling behind other countries (NBPTS, 2002). Public response to the report provoked a wave of reform initiatives that saturated the world of education, such as Goals 2000, among others (Heise, 1994). Unfortunately, most of the programs sidestepped a critical component of the education equation that so many researchers had highlighted in the preceding decades: the classroom teacher. Recently there has been a renewed focus on the power of effective teaching. This emphasis has been prompted by federal pressure to drastically improve instructional programs that ensure all students are being served. Federal, state, and district officials, as well as school administrators, are calling upon teachers to meet and exceed professional standards and to ground their work in research-proven methods of instruction (Posamentier & Jaye, 2006). No Child Left Behind (NCLB) and Race to the Top (RttT) represent the next big reform movement and its quest to provide effective teachers for every student.

**Statement of the Problem**

The rationale for the current North Carolina Board of Education policy of requiring four math courses is that setting higher standards will lead to improved student achievement and
improved life choices beyond high school (State Board of Education, 2009). While schools do bear some accountability for low test scores, a single-track graduation policy positions the majority of the accountability on the shoulders of the students who are ultimately responsible for their own test results in order to obtain a high school diploma. Not clearly stated in the policy is the recognition that a student’s assigned sequence of effective or ineffective teachers in the years preceding the exam might have an impact on student performance. These effects may affect student pass/fail rates on the state exams as well. Furthermore, by minimizing the potentially powerful influences of effective teaching on student achievement, the quality of instruction afforded to each student every year is minimized as well. Equitable access to effective teachers needs to be a vital component of this statewide initiative to increase student achievement. Unfortunately we lack sufficient knowledge of the characteristics of highly effective teachers, including their beliefs and practices, first, to identify effective teachers accurately and second, to ensure that all students have equitable access to these educators.

In summary, North Carolina’s policy decision to increase high school graduation requirements in order to raise student prospects for higher education and employment requires effective teachers for all students. If it can be shown that (1) teacher effectiveness significantly influences student achievement, then (2) ensuring equitable access to effective teachers and working to improve the effectiveness of teachers should become a human rights issue in regard to this statewide policy.

**Purpose of the Study**

The purpose of this study was to identify the impact of highly effective math teachers on student learning and the characteristics and teaching beliefs exhibited by these highly effective mathematics teachers. To accomplish this purpose, this study (1) used quantitative data from the
SAS value-added model used in North Carolina to determine the degree to which student mathematics achievement is affected by teacher assignment; and (2) assigned teachers to high/low effectiveness groups for further study.

Although there is a growing consensus among educators that teachers impact student learning, the definitions of teaching effectiveness are vast and varied. Some definitions are coalescing on the use of student standardized test score gains attributed to a particular teacher to determine teacher effectiveness (Sanders & Horn, 1994; Thum, 2003; Webster & Mendro, 1997), otherwise known as a value-added model (VAM). While the term has been used in other fields of study (see Cowan, 2003 for the use of value-added concepts in agriculture), in education the term value-added refers to the use of longitudinal test data to measure adjusted comparisons of student data and its changes over time (Doran & Izumi, 2004). The models are designed to track value added within a specific time frame in order to (a) examine how much progress is made toward a goal and/or (b) to use as a tool to evaluate the effectiveness of programs and personnel (Doran & Izumi, 2004). Carter (2008) describes it this way: students enter the classroom at varying achievement levels; a value-added approach enables one to compare the entering achievement level to that which has been obtained at a later point in time. These adjusted comparisons represent how much value has been added to a student’s learning. In other words, instead of simply measuring student achievement by examining a student’s score at a single point in time, researchers are able to look at how that score relates to that individual’s previous scores (Sanders & Horn, 1994).

Some researchers have argued that VAM may be a useful tool to determine teacher effectiveness; as a result, several states, including North Carolina, are now utilizing complex statistical value-added models to more accurately determine the amount of individual student
learning that can be attributed to a teacher in a given year (McCaffrey, Lockwood, Koretz, & Hamilton, 2003; Thum & Bryk, 1997; Sanders & Horn, 1998; Webster & Mendro, 1997). North Carolina utilizes a value-added model within the Education Value Added Assessment System (EVAAS) to track student growth in the public school system. EVAAS was developed in the 1980s by Dr. William Sanders and uses mixed-model methodology to address many of the traditional statistical problems that have been cited as impediments to the use of student achievement data when trying to assess programs, including incomplete student testing histories (Sanders, Saxton, & Horn, 1997). The EVAAS methodology is also used in Ohio, Pennsylvania, and Tennessee, among others. An important distinction between EVAAS and other VAMs is that EVAAS does not adjust for student background variables directly: the model measures each individual student’s prior learning and then determines growth from previous learning (Sanders & Horn, 1994). Other models adjust student growth based on an average of the learning of other students with similar economic and ethnic backgrounds, whereas EVAAS does not; each individual student serves as his/her own control. The EVAAS model is viewed as a robust, fair, reliable, and valid statistical value-added method (Stronge and Tucker, 2000). Furthermore, four U.S. Department of Education peer review committees have approved the reliability of the EVAAS student prediction methodology (SAS Institute Inc., n.d.).

The use of VAMs like EVAAS have led to quite a few research studies that examine questions including: how much of the increase in student test scores can be attributed to effective/ineffective teaching, what are the cumulative effects of successive effective/ineffective teaching across years, and what are effective teachers doing differently? One small-scale study of two school districts in Tennessee in 1996 compared student learning outcomes for students with three consecutive years of effective teachers as identified by VAM data compared to students
with three consecutive years of ineffective teachers. The students with three consecutive years of effective teachers appeared academically gifted, accounting for more than a 50 percentile point spread between students in each group despite starting with similar achievement levels (Sanders & Rivers, 1996). In this study, I replicated this research on a significantly larger scale. Not only did I set out to examine a larger set of teachers and students, but I also went beyond the VAM data to examine whether or not results correlated with qualitative data gathered from conversations with teachers about their practice. In this research, I strove to study the impact of multiple years of effective/ineffective teaching on student achievement, and then study the differences between effective and ineffective teachers’ beliefs on teaching and learning.

Significance of the study. By incorporating a large-scale quantitative study that helped identify the connection between mathematics teaching effectiveness and student achievement, coupled with a more intimate qualitative component that helped to ascertain some of what is going on behind the scenes in the classrooms of these teachers, this study sheds light specifically on the nuances of what effective teachers do. As colleges of education work to better prepare their teachers-in-training and current practitioners seek to improve their own effectiveness in the classrooms, research on the power of effective teaching coupled with specific practices and beliefs that are linked to improved student achievement can inform university coursework as well as current instructional practices. Schools and districts can also utilize information on effective instructional practices for mathematics to guide the selection of meaningful professional development programs, thereby further strengthening the effectiveness of the current mathematics teaching workforce. Local, state, and national education policy decisions can utilize these connections to identify the role of educator responsibility in student achievement on high stakes tests, and to inform teacher performance and evaluation issues.
Furthermore, decision makers will be more aware of the realities of effective teacher distribution issues and student assignment concerns, which are closely connected to matters of equity in educational opportunity and instruction.

If teachers do in fact demonstrate a significant influence over the educational outcomes of their students here in North Carolina, then it would also be beneficial to look at how the highly effective teachers differ from their counterparts. Understanding the real and profound educational impact of effective/ineffective teachers and getting a glimpse of their practical differences in the classroom can influence current North Carolina policies regarding graduation requirements. But more importantly it will adjust the role that other parties play in this quest for increased student achievement, for the responsibilities of the student will need to be combined with those of the teacher/school/district/state in helping students obtain the academic achievement required for graduation, including effective instructional practices and equitable teacher assignment policies.

In all arenas of education, decisions are made daily in an effort to improve our educational system for all students. Better decisions can be made if decision makers are given a more reliable measure of effective teaching and student achievement. This study explored the issues of teaching effectiveness on student achievement and identified differences in effective/ineffective teacher beliefs in an effort to inform the educational community with meaningful results that can immediately affect the work of classrooms, schools, districts, states, and universities.

**Research Questions**

The following research questions guided this mixed-methods study:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?
1a. Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

1b. Long-term effects: Is there an effect on the students’ projected Algebra I Normal Curve Equivalent (NCE) score? On their projected SAT Math scale score?

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. Compared to research: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. Compared to each other: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

Conceptual Framework

What are the connections between teacher practices and beliefs, teaching effectiveness, and student achievement? In this study, I examined this relationship through a quantitative analysis of teaching effectiveness and student achievement results coupled with a qualitative look at teacher instructional practices and beliefs at various levels of teaching effectiveness, as measured by EVAAS. I used student outcomes on standardized tests to identify highly effective and highly ineffective teachers. I interviewed randomly selected teachers from each of the two groups to identify instructional practices and beliefs, without my knowledge of their effect on student learning.

The question of teacher effectiveness is particularly salient in mathematics education. Indeed, it is one of the most widely accepted axioms in math education: good teachers matter for student learning (Cavanagh, 2008). But this proverb is not accepted on blind faith and common sense alone because there is preliminary research to support it. One small-scale study indicated that consecutive years of effective or ineffective math teachers had a dramatic effect on student
achievement: 5th graders scored at the 83rd percentile in math after three consecutive years of very effective teachers, while students with similar starting achievement levels who had ineffective teachers for three years in a row scored in the 29th percentile, a difference of more than 50 percentiles (Sanders & Rivers, 1996). These initial findings indicate that substantial differences in student math achievement are attributable to differences in teacher effectiveness, implying that teachers are crucial to students’ opportunities to learn and to their learning of math in particular.

While some claim that highly effective teachers using proven teaching methods produce high-progressing and high-achieving students (Izumi & Evers, 2002), others argue that teachers cannot be held accountable for student learning since there are so many factors outside of the teachers’ control that affect each student. Other advocates strongly disagree, claiming that outside factors have little impact; even with the plethora of constraints that exist on each classroom teacher, the teacher does the final decision-making about instructional activities (Fennema, Sowder, & Carpenter, 1999). These researchers would argue further that the influence of the teacher does not stop at the classroom, as teachers have a powerful, long-lasting influence on their students, affecting how students learn, what they learn, how much they learn, and ways they interact with each other and the world (Stronge, 2002). Considering the potential degree of the teacher’s influence, it is important to understand what teachers can do to promote positive student achievement.

Carter’s research (2008), among others, begins to peel away the magic curtain in the classroom. She looked at how teachers at different effectiveness levels planned, prepared, and implemented instructional practices in grades 3-8, and found that while many teachers were utilizing various strategies, no one single “best practice” could be isolated yet. No doubt there is
still much work to be done as we seek to connect teacher practices and beliefs with teacher effectiveness. This study aims to help fill that gap.

In this study, the first task was to use quantitative data generated by EVAAS to identify the existence of the relationship between effective teaching and student achievement in North Carolina. The strength of this relationship laid the foundation for the second task. Once highly effective and highly ineffective teachers were identified, I looked at the differences in instructional practices and beliefs among teachers who profile at various levels of effectiveness. I needed to determine the strength of the relationship between effective teaching and student achievement before that layer could then be peeled away to reveal the next level: effective/ineffective teachers’ instructional practices and beliefs. In other words, I first verified quantitatively that there is in fact a difference in student achievement progress among teachers at varying levels of effectiveness and then I went one step further in a quest to qualitatively explore those differences. It is important to note there are other factors involved in student achievement, but this study was limited to those directly related to the teacher and the instructional practices and beliefs tied to his or her effectiveness.

**Definition of Terms**

**District Effect**: a measure of the influence of a school district on indicators of student learning (Sanders and Horn, 1995).

**Effective Teaching**: Effective teaching has been defined as many things, including the ability to foster students’ affective and personal development or students’ curriculum mastery, among others (Brophy, 1986). A different version has been gaining favor among educators, researchers, and policymakers alike: to define and measure teachers’ success in terms of how much their students learn (Farr, 2010), or in other words, the teachers’ success in producing achievement
gains (Brophy, 1986), rather than simply reaching a proficient achievement level. With a focus on closing the achievement gap, it is vital to consider how effective teachers are in helping their students’ progress. Therefore in this study, effective teaching is defined by the presence of measurable student achievement growth. Teaching effectiveness was measured by the EVAAS teacher value added measure, presented as a change in scale scores and is standardized using its standard error. Teachers with a teacher effect score significantly above 0 are determined to be more effective than those with a teacher effect score significantly below 0.

EOC: “The North Carolina End-of-Course [EOC] Tests are used to sample a student’s knowledge of subject-related concepts as specified in the North Carolina Standard Course of Study [SCOS] and to provide a global estimate of the student’s mastery of the material in a particular content area” (NCDPI, 2011, para. 1). These results are used as part of the EVAAS data analyses.

EOG: “The North Carolina End-of-Grade [EOG] Tests are designed to measure student performance on the goals, objectives, and grade-level competencies specified in the North Carolina Standard Course of Study [SCOS]” (NCDPI, 2011, para. 1). These results are used as part of the EVAAS data analyses.

EVAAS: Education Value-Added Assessment System is a “statistical process which provides measures of the influence that school [districts], schools and teachers have on indicators of student learning” (Sanders & Horn, 1994, p. 2). This system determines academic growth over time (Carter, 2008). The model is the methodology designated by the state of North Carolina to ascertain the effectiveness of its schools and teachers in producing academic growth among North Carolina students (see Sanders & Horn, 1998).
Mixed Methodology: a study conducted with the use of two different methodologies (Creswell & Plano Clark, 2007). In this study an *explanatory sequential design* was used, such that quantitative data collection and analysis was followed up by qualitative data collection and analysis, and then the results from both analyses were interpreted (Creswell, 2008).

School Effect: a measure of the influence of a school on indicators of student learning (Sanders and Horn, 1995).

SCOS: “North Carolina established a *Standard Course of Study* [SCOS] in 1898 as an attempt at determining competencies for each grade level and each high school course, with a rigorous set of academic standards that is uniform across the state… The *Standard Course of Study* [SCOS] includes the curriculum that should be made available to every child in North Carolina's public schools” (NCDPI, 2011, para. 2).

Student Achievement: In many educational settings, academic achievement is defined by a standardized test given at various points in a student’s career, and delineated by a score. This score represents the accomplishments of the student on that test, at a particular point in time. (Carter, 2008)

Teacher Effect: a measure of the influence of a teacher on indicators of student learning (Sanders and Horn, 1995, p. 3).

Teacher Instructional Practices and Beliefs: that which a teacher does (*practices*) in the classroom with his/her students and the propositions (*beliefs*) that are used to create or justify those practices.

Value Added: “the amount of impact that can be accounted for and credited to the various influences on the student’s academic achievement gains” (Carter, 2008, p. 91). This study used a teacher value added model called EVAAS to identify effective and ineffective teaching.
Assumptions of the Study

Teacher Influence. The underlying assumption of this study is that teachers can influence student achievement growth. Research confirms that teaching quality is an essential factor in student achievement (Harris & Sass, 2011; Hill, Rowan, & Ball, 2005; Rockoff, 2004; Kaplan & Owings, 2002; Darling-Hammond, 1999). For better or worse, what teachers do affects student achievement. In fact, the teacher is the most influential school-related force in student achievement (Stronge, 2002). Effective teaching affects all achievement levels at all schooling levels (Kaplan & Owings, 2002). As Minner (2001) said, “Teacher quality is not just an important issue in addressing the many challenges facing the nation’s schools: It is the issue” (p. 33).

Strength of EVAAS. EVAAS estimates of teacher effects are valid, reliable, unbiased estimates of the effects of teachers on the academic progress of their students (Harville, 1995). They indicate the amount of change in student scale scores during a school year that is beyond the average change and attributable to a particular teacher (Rivers-Sanders, 1999). EVAAS estimates can be either positive or negative, depending on the teacher’s relative effectiveness or ineffectiveness: for example, a teacher with an estimated effect of –6 would have taught students who scored six points below their expected score, on average, on the EOC/EOG achievement scale based on their previous testing history; and similarly a teacher with an estimated effect of +6 would have taught students who scored six points above their expected score, on average, on the EOC/EOG achievement scale based on their previous testing history (Sanders, Saxton, & Horn, 1997). Generally effective teachers are effective with all sub-populations of students and vice versa (Sanders & Rivers, 1996).
**Strength of EOCs/EOGs.** The EOCs and EOGs provide a reliable and valid measure of student performance on the goals, objectives, and grade-level competencies specified in the North Carolina Standard Course of Study (SCOS) (Sanford, 1996a), provided they are administered in a standardized setting with appropriate modifications. The North Carolina SCOS sets content standards for what students should know and be able to do (NCDPI, 2011).

**Summary**

Like other states, the state of North Carolina has established high standards of excellence for its graduates. However, the public education system that is assumed to support students of all ability levels in reaching these standards may be underestimating teacher effectiveness. Little is known about the academic consequences for those students who spend multiple years with a series of very effective or very ineffective teachers. The primary focus of this study was to discern the relationship between student achievement scores and teacher effectiveness when that effectiveness (or lack thereof) is compounded over multiple years. The secondary focus of this study was to begin to explore possible relationships between teacher practices and beliefs and teaching effectiveness. Chapter 2 contains a review of the relevant literature concerning teacher practices and beliefs, effective teaching, and student achievement. Chapter 3 describes the methodology of both the quantitative and qualitative components of the study, as well as the rationale for choosing both. Chapter 4 reveals the results of the study from Phase I, including the quantitative relationship between student achievement scores and teacher effectiveness. Chapter 5 reveals the results of the study from Phase II, including the possible qualitative relationships between teacher practices and beliefs and teaching effectiveness. Chapter 6 explores the contradiction that occurs in this study between quantitative and qualitative results in the case of
an outlier: Jeff. In chapter 7, I discuss the impact of these results, the limitations and significance of the study, and its overall conclusions.
CHAPTER 2
LITERATURE REVIEW

Several research studies have documented the importance of developing mathematics competencies for K-12 students. According to Ball (2003), solid mathematics education creates options for people’s futures as their opportunities and choices are formed by whether they know and are able to use math. Yet for many students, an educational system plagued by large, persistent disparities in math achievement related to race and socioeconomic status crushes their opportunities (National Mathematics Advisory Panel (NMAP), 2008). There are those who are promoted to excel in math and go on to bright futures, and there are those who perpetually struggle in math, often through little fault of their own, and potentially succumb to a life of fewer opportunities (Ball, 2003). We can no longer deny that math serves as a gateway, and yet only some get to partake in the prospects it affords.

In this study, I set out to determine the impact of teaching effectiveness on student achievement, and then to understand the differing beliefs between effective and ineffective teachers. Therefore, three fields of knowledge informed this study: (1) factors impacting student achievement, (2) mathematics teacher attributes identified within the math wars, and (3) defining and evaluating effective teaching. In this chapter, I gather and review the abundant literature from these three fields.

This literature provided the background knowledge needed to address the following questions:
Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

1a. Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

1b. Long-term effects: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. Compared to research: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. Compared to each other: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

Since all questions address effective teaching and student achievement, it is important to understand what research currently conveys about these two primary concepts. There is a lot of literature on both topics, which is reviewed here in this chapter, but there is little research on the specific characteristics of effective and ineffective math teachers. This study aims to help fill that gap.

As discussed above, the goal of many education policies in North Carolina is to improve education for all students by raising standards. With this goal in mind, I also looked at how the intersection of these two factors (effective teaching and student achievement) affects the mathematics achievement gap.

**Factors Impacting Student Achievement**

Education can provide opportunities for the individual, the community, and society. Yet for many, those opportunities are limited by a school system that perpetually underserves many
of its constituents. The effects of this inequality are vast and varied. It is important to understand the forces at play, as well as all the intricate connections between what the issue is and how it is perpetuated.

Lack of Opportunity. It is not possible to talk about factors affecting student achievement without discussing the gap in learning opportunities, for the most consistently replicated findings link student achievement to the opportunity to learn the material (Brophy, 1986), thus identifying an opportunity gap. Opportunity to learn is built on many components, including curriculum coverage, test item coverage, and curriculum/test alignment (Brophy, 1986; Williams, 2003; Kaplan & Owings, 2002), as well as access to resources, quality teachers, and appropriate class sizes (DeShano da Silva, Huguley, Kakli, & Rao, 2007). Educational institutions are expected to correct these opportunity gaps rather than exacerbate them, but unfortunately that is often not the case (Diamond, 2006).

The U.S. education system is saturated with inequality (Darling-Hammond, 1997). Starting with traditions of local control that produce unequal finances, continuing with a history of legal methods for segregation, and maintained by tracking systems for students with different backgrounds that provide qualitatively different learning experiences, the system is built on a foundation of all of these components the assures unequal educational opportunity. This opportunity gap (disparities in access to high quality educational personnel and resources) helps sustain the achievement gap (disparities in student achievement outcomes) (Ferguson, 2007), and the achievement gap is very real and it is widening (Williams, 2003). According to the 2007 National Assessment of Educational Progress (NAEP) (U.S. Department of Education, 2007), the percent of high-income 4th graders in the U.S. who are proficient in reading is more than three times greater than that of low-income 4th graders, with only one in ten of those low-income
students graduating from college (Kamras, 2010). For those who qualify for free or reduced-price lunch, only about half will graduate from high school, whereas in some wealthy communities, graduation rates are between 98 and 99 percent (Farr, 2010). Despite some evidence of improvement by African American, Hispanic and students of poverty from 1970 to 1988, the education reform efforts of the last two decades have still not enabled significantly more students to become educationally competitive or to close the achievement gap (Williams, 2003).

Consider one powerful example. One Los Angeles school starts with 1000 students in the freshman class, but finishes with 240 left in the senior class, with only about 30 students who have the prerequisites for college (Farr, 2010). There have been a few recent glimmers of hope: for 4th graders nationwide, the average mathematics score in 2011 was 1 point higher than in 2009, and 28 points higher than in 1990, but there were no significant changes in the White/Black or White/Hispanic score gaps from 2009 to 2011 nationwide (National Center for Education Statistics (NCES), 2011). Admittedly, some states are starting to see some progress (NCES, 2011):

4th grade:

White/Black score gaps narrowed from 1992 to 2011 in 16 of 35 participating states with samples large enough to report results for Black students.

White/Hispanic score gaps narrowed from 1992 to 2011 in 4 of 21 participating states with samples large enough to report results for Hispanic students.

8th grade:

Score gaps between higher- and lower-income students narrowed from 2003 to 2011 in four states.

Score gaps between higher- and lower-income students widened from 2003 to 2011 in one jurisdiction.
When looking at math specifically, the achievement gap permeates all levels of school. Most children acquire basic number and math knowledge before they start kindergarten, which is important because this entering math knowledge is related to math learning through elementary, middle, and high school (NMAP, 2008). Unfortunately, most economically disadvantaged children enter school with far less knowledge than their economically advantaged peers, and the math achievement gap progressively widens through the next twelve years. Mathematics has been traditionally used as a reason to further separate students (Malloy & Malloy, 1998). Math courses have always been gatekeeper courses, and many math teachers have excluded students from those courses when they thought the students did not exhibit a sufficient math understanding. The results of this trend for students of minority or socioeconomically disadvantaged backgrounds have been devastating – about 1 in 30 Latinos and 1 in 100 African Americans can do multistep problem solving and elementary algebra, compared to about 1 in 10 white students; only 4 in 10 Latino and 3 in 10 African American 17-year-olds have mastered fractions, percentages, and averages, compared to 7 in 10 white students (Haycock, 2001). By the end of high school, African American and Latino students have reading and math skills that are the same as those of white students in the 8th grade (Haycock, 2001).

There are long-term effects of this lack of opportunity. Success in math education provides additional college and career options and increases future potential income, for a strong understanding of high school math through Algebra II or higher is correlated with access to and completion of college, as well as earnings in the top quartile of employment income (NMAP, 2008). The lack of opportunity has negative effects that reach beyond the life outcomes of individual students. Their children will be far more likely to grow up in poverty as well; for businesses, there is a lack of skilled workers; for communities, there is a risk of civic breakdown.
The high-wage low-skilled factory jobs that afforded generations to buy homes, send their children to college, and provide for their families are now a dusty memory in our shiny new global economy (Secada et al., 1998). In a more global perspective, algebraic reasoning and the use of algebraic representations such as graphs, tables, spreadsheets, and formulas are among the most powerful intellectual devices our society has developed, and without them there could be no higher math and no quantitative science – hence no technology and way of life as we know them. Clearly, success in math matters to our nation (NMAP, 2008).

*Parent Socio-Economic Status.* American children are the poorest population by age group within this country; 12 million children comprise this group, with over one third of those children living in extreme poverty (family income below 50 percent of the poverty line) (US Census Bureau, 2001). Even with early indications from Coleman (1966), there now is substantial research to support the strong relationship between socio-economic status (SES) and student achievement (Barry, 2006; Majoribanks, 1996; Baharudin & Luster, 1998; Hochschild, 2003; McNeal, 2001; Lopez, 1995). Students with low SES earn lower test scores and are more likely to drop out of school (Eamon, 2005, Hochschild, 2003). It is believed that low SES negatively affects student achievement because low SES inhibits access to vital resources and causes additional stress in the home (Eamon, 2005; Majoribanks, 1996), including decreased parenting time, increased family conflicts, and increased likelihood of parental depression (Eamon, 2005).

While these experiences can lead to decreased student achievement, other household experiences have been shown to increase student achievement or aspirations, including supportive and attentive parenting (Eamon, 2005), high parent aspirations (Majoribanks, 1996), educated mothers with high self-esteem (Baharudin & Luster, 1998; Eamon, 2005), delayed
child-bearing (Eamon, 2005), smaller family size (Majoribanks, 1996), and higher quality neighborhoods (Eamon, 2005). No doubt many of these characteristics that are connected to higher student achievement are also connected to increased SES.

Parent status may also play a role in student tracking: strong evidence suggests that schools more frequently track students on the basis of their parents’ privilege than on their own ability, which may explain why efforts to end within-school racial segregation via detracking are generally threatening to parents with higher SES, for the stakes of status and power are quite high and it challenges their position at the top of the hierarchy (Wells & Serna, 2007). Thus, in this case, it appears that the education system not only mirrors the structures of society but also significantly contributes to maintaining them, thereby perpetuating what it is ideologically believed to eradicate – class barriers to social and economic equality (Rist, 2007).

**Government Interventions.** As discussed so far, there has been a litany of factors that influence student achievement, including students’ lack of opportunity and parent socio-economic status. Another crucial element of student achievement that cannot be overlooked is the United States government. For as long as our country has been forming, the government has had an interest in, and an impact on, education; a universal government-funded and government-controlled education system was the goal even before this nation was founded (Butts, 1978). From our start, it was believed that a well-educated citizenry was essential to protect liberty and the general welfare of the people, with some colonies passing laws requiring the education of all children in a government-run public education system and some initial state constitutions requiring mass education of its residents (Allison, 1998).

But the governmental role in education has never been unanimously supported; even early on, many disdained federal participation in education and even rejected George
Washington’s plans to establish a national university (McCluskey, 2007). And now education is one of the largest state government expenditures (Poterba, 1996). While the federal government plays a role in education, state and local governments account for the vast majority (92 percent) of primary and secondary educational services funding (Poterba, 1996). There are many rationales offered for why education should be administered by governments rather than left up to the parents and the private sector. For example, since minors are not responsible for choosing the quantity or quality of their education, that decision could lie with their parents. But if parents choose to underinvest in their offspring’s education, government intervention may be justified on the grounds that it protects children from the decisions made by their parents (Poterba, 1996). Government interventions include policies about who is required to get an education and how much is required, which then become publicly funded. It is undeniable that these policies on education and education funding decisions, as well as the politics behind them, have a significant impact on student achievement.

Teaching Effectiveness. Finally, among all of the factors affecting student achievement, teachers play the biggest role: an extensive body of research has found that much of the achievement gap is due to substantially different access to high-quality teachers and teaching (see Flores, 2007; Roza & Hill, 2004; Wiener, 2006; Darling-Hammond, 1997), rather than per pupil expenditure, textbooks, curricula, or the facilities, especially when comparing high-performing, high-poverty classrooms to their low-performing counterparts (Kamras, 2010). In fact, effective teaching can make up for the typical deficits we see in students from disadvantaged backgrounds (Izumi & Evers, 2002). Research suggests that students with three consecutive years of effective teaching as compared to ineffective teaching can appear academically gifted, accounting for more than a 50 percentile point spread between students in
each group despite starting with similar achievement levels (Sanders & Rivers, 1996). Data from the 1998 NAEP also indicate that effective teaching makes a difference in minority student achievement (see Kaplan & Owings, 2002). Moreover, we can close the achievement gap between affluent white students and poor and minority students if the best teachers are assigned to the students who need them the most (Haycock, 1998). Clearly effective teaching is directly related to student achievement.

Effective teaching is a crucial component in the mission to close the achievement gap (Flores, 2007; Kamras, 2010). Studies strongly suggest that students with effective teachers make significant gains in achievement, while students with less effective teachers may actually lose ground (see Kaplan & Owings, 2002), and so perhaps the single greatest source of educational inequality is the unequal distribution of well-qualified teachers (Darling-Hammond, 1997; Flores, 2007). Low-income and minority students are nearly twice as likely to be assigned to the least effective teachers and only half as likely to be assigned to the most effective teachers (Kaplan & Owings, 2002). In California, the size and rigor of a school’s college preparatory program vary with the race and socio-economic status of its students, and some poor and minority students are taught by under-qualified teachers (teachers who lack a preliminary or full credential/license in their teaching field) for virtually their entire schooling careers (Darling-Hammond, 1997). Nearly everywhere, the least well prepared teachers are most likely to teach the least advantaged students (Mayer, Mullens, & Moore, 2000). Unequal access to quality teachers is a national epidemic that is greatly restricting our abilities to address the achievement gap. A study of student achievement in math and reading found that the teacher was a stronger predictor of student achievement than student socio-economic status (Nye, Konstantopoulos, & Hedges, 2004).
The U.S. education system’s failure to focus on teaching quality has taken a huge toll (Darling-Hammond, 1997), for teachers’ work is extremely important: “as agents of the public interest in a democracy, teachers… contribute to the dialogue about preserving and improving society, and they initiate future citizens into this ongoing public discourse” (National Board of Professional Teaching Standards (NBPTS), 2002, p. 21). The subject of teachers is strikingly absent from much of the debate about schooling and poverty, which carries important consequences for education as a cultural enterprise is constituted in and through teachers’ labor (Connell, 2007). As the U.S. moves from a manufacturing economy to a much more complex system based on information technologies and knowledge work, its schools are going through a “once-in-a-century transformation,” for never before has the success of a nation been so closely related to their ability to learn, and therefore on our ability to teach (Darling-Hammond, 1997, p. 2). It is time to take note of the importance of effective teaching and utilize this information to the best of our individual, local, and national abilities: “the common denominator in school improvement and student success is the teacher” (Stronge, Ward, & Grant, 2011, p. 351).

*Teaching Matters.* Teacher quality – what teachers do with what they know in their classrooms – has important consequences for what or how much students learn (Kaplan & Owings, 2002; Hanushek, 2012). Teacher quality should be the major focus of efforts to improve school quality (see Darling-Hammond, 1997): “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). Among issues of student background including poverty, language, and minority status, and among school issues including class size, well prepared teachers have the most effect on student achievement (Darling-Hammond, 1999). The effects
were so strong that after controlling for socioeconomic status, the large disparities in achievement between African American and white students were almost entirely accounted for by differences in their teachers’ effectiveness. The impact on the achievement gap is not the only benefit: research has shown that replacing a poor teacher with an average one would raise a single classroom’s lifetime earnings as adults by about $266,000 (Lowrey, 2012). The states that repeatedly lead the nation in math and reading student achievement have among the most highly qualified teachers in the country, and have consistently made investments in the quality of teaching. Clearly, students’ abilities to meet high academic standards and have increased life options depend on having good teachers (Kaplan & Owings, 2002; Flores, 2007). But what does it take to be an effective math teacher? This topic has been highly debated over the years, dividing many stakeholders into bitterly opposing points of view. In order to understand the traits of effective math teachers, it is important to first understand this battle that is brewing.

**Math Teacher Attributes and Student Achievement: The Math Wars**

There is little doubt that math matters both for the success of the individual and the success of the nation, and that, currently, we are not developing high levels of math achievement for all of our children. Research has shown that effective teaching is the key to increasing math achievement and that there are specific qualities of effective teaching that best support this endeavor. The National Council of Teachers of Mathematics (NCTM) adopted new mathematics standards in 1989, strongly advocating for the use of inquiry-based instruction in math classrooms across the country, and have clearly identified these standards as the benchmarks of effective math teaching. When implemented in classrooms, the standards are directly related to educational progress: “the improvement of mathematics education for all students requires effective mathematics teaching in all classrooms” (NCTM, 2000, p. 17). Others have disagreed
with this inquiry-oriented approach (see Geary, 1994), promoting more traditional forms of instruction. This divide between *inquiry-based* instruction and more *traditional* approaches has been coined as the current ‘math wars’ of modern mathematics education (Van de Walle, 2003; Klein, 2007). These two opposing camps have identified specific characteristics of teacher practices, which I discussed below.

*The New Camp: Inquiry-based instruction and effective math teaching.* Before looking at the details of the two sides of this ‘math war,’ I discuss where the push for inquiry-based instruction has come from and what its advocates are trying to accomplish. Previous methods of lecture-based instruction or traditional instruction have led to our current situation – a minute number of math-proficient graduates and a shallow understanding of math for most students across the board – and numerous studies over the past two decades have documented the need for changes in mathematics education at all levels (Smith, Ware, Cochran, & Shores, 2009). By producing the *Curriculum and Evaluation Standards for School Mathematics*, NCTM (1989) sought to promote such reforms in mathematics education and emphasized inquiry-based instruction. Mathematics achievement data continue to point to the need for improvements in mathematics instruction; the Third International Mathematics and Science Study (Mullis, et.al., 2003) concluded that many elementary and middle school mathematics teachers do not have a deep enough knowledge of mathematics to teach it in a conceptual way. Universities continue to offer an alarming number of remedial mathematics classes (McCray, et.al. 2003). For many students, the typical lecture style of mathematics instruction is not always effective.

In the end, NCTM and other advocates of constructivist learning or inquiry-based instruction are posing this method as an alternative to traditional teaching methods that have been previously unsuccessful in helping promote increased student achievement in mathematics,
in the hopes that inquiry-based instruction will help teachers be more effective. While some studies have reported gains in student performances through incorporating the practices and beliefs of inquiry-based instruction (Schoenfeld, 2002; Manswell-Butty, 2001), some claim that there is still much work to be done if we are to meet our national goals for broader and deeper math knowledge, and subsequent achievement (see Smith, Ware, Cochran, & Shores, 2009).

Debate #1: Effective math instruction and evaluation. Some believe that in their constant quest to improve instruction, effective math teachers should diligently monitor student progress, reflect on the evidence, and adjust accordingly (Farr, 2010). Furthermore, they should employ a variety of assessments to help the teacher and the students reflect on their work and redirect as needed (NBPTS, 2002). Of particular focus here is how teacher beliefs influence their student instruction and evaluation practices. Research has shown that those teachers who hold a more traditional view of education in which the teacher is in control tend to display inherently different methods of student instruction and evaluation than those who believe in a more inquiry-oriented, constructivist view of education (Stipek, Givvin, Salmon, and MacGyvers, 2001), as displayed in Table 1 below:

Table 1: The Comparison between Two Different Sets of Teacher Beliefs and Student Instruction and Evaluation Practices

<table>
<thead>
<tr>
<th>Teachers who hold…</th>
<th>Traditional Beliefs (teacher control)</th>
<th>Constructivist Beliefs (inquiry-oriented)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...about education tend to exhibit the following characteristics when instructing and evaluating students…</td>
<td>- Promote the learning of specific procedures to get the correct answer</td>
<td>- Acknowledge student effort and creativity</td>
</tr>
<tr>
<td></td>
<td>- Focus on the correctness of the answer</td>
<td>- Encourage exploration of math problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Support student attempts of multiple strategies</td>
</tr>
</tbody>
</table>
- Value student independence (as evident by those who do not ask questions or ask for help)
- Utilize extrinsic motivation strategies
- Value social interaction among students
- Employ scaffolding by fostering interactions between the learner and a more knowledgeable peer or adult

(Stipek, Givvin, Salmon, and MacGyvers, 2001)

The practices that tend to be exhibited by these two differing belief structures paint very divergent images of mathematics education as it is manifested within a teacher’s classroom, and both parties believe that their way is the best way to increase student achievement.

**Debate #2: Effective math learning environments.** There are many views on how math classrooms should look; effective math teachers understand how crucial student engagement is to the learning process (Kaplan & Owings, 2002), and work diligently to promote a safe learning environment where students are free to take risks and engage with the content (Farr, 2010), while utilizing stellar classroom management skills through the use of well-designed lessons (Posamentier & Jaye, 2006; Stronge, 2002) and consistent student behavior plans (Stronge, 2002; Nichols, Meyers, & Burling, 2009). In effective math classrooms, students see themselves as capable and worthy of success (Kaplan & Owings, 2002). Educators and other students honor their thoughts and encourage creative solutions (Secada & Berman, 1999). The students understand what is expected of them, for guidelines are clearly posted and consistently followed (Nichols, Meyers, & Burling, 2009). There is little opportunity for boredom, as activities are varied, challenging, and flow smoothly from one to the next (Stronge, 2002).

Within this wide range of images of effective math classroom environments, many researchers have focused in on how teachers incorporate student risk-taking into classroom instruction. From studies on educational contexts, research suggests that students’ concerns about performance are minimized when teachers emphasize effort, learning, and understanding, and when they foster a classroom climate where risk-taking is encouraged and supported, such as
where incorrect answers are regarded as a natural part of the learning process and can be used to address misunderstandings (see Stipek, Givvin, Salmon, and MacGyvers, 2001; Stipek 1996, 1998). These practices are supported by motivation researchers and are consistent with mathematics reformers who recommend that teachers should emphasize the learning process and encourage students to pursue alternative solutions rather than to find a single correct answer (Stipek et al., 1998). Further research highlights the value of focusing student attention on learning, including incorporating insufficient student solutions into classroom instruction, scaffolding responses to higher levels of understanding, and providing substantive feedback that can help students’ future problem-solving efforts (see Carpenter & Fennema, 1991; Cobb, Wood, & Yackel, 1993; Lampert, 1991; Prawat, Remillard, Putnam, & Heaton, 1992; Stipek et al., 1998). When studying the connection between teacher beliefs and practices, Stipek, Givvin, Salmon, and MacGyvers (2001) found the following characteristics (see Table 2 below):

**Table 2: The Comparison between Two Different Sets of Teacher Beliefs and Math Learning Environments**

<table>
<thead>
<tr>
<th>Teachers who hold…</th>
<th>Traditional Beliefs (teacher control)</th>
<th>Constructivist Beliefs (inquiry-oriented)</th>
</tr>
</thead>
<tbody>
<tr>
<td>…about education tend to exhibit the following characteristics when fostering their math learning environments…</td>
<td>Emphasize student performance and efficiency (speed)</td>
<td>Emphasize effort and understanding</td>
</tr>
<tr>
<td></td>
<td>Express to students that mistakes are to be avoided (creating a high-risk environment)</td>
<td>Express to students that mistakes are a natural part of learning (creating a low-risk environment)</td>
</tr>
<tr>
<td></td>
<td>Be relatively controlling of the students’ mathematics activities</td>
<td>Allow some student autonomy</td>
</tr>
</tbody>
</table>

As shown in Table 2 above, there is a line drawn between these two math teaching philosophies. Those with more traditional beliefs on how to best teach math emphasize student
efficiency in getting to the correct answer, discourage mistakes, and dictate the activities of the math classroom. Those with more constructivist beliefs focus on student effort, encourage mistakes, and support student autonomy in what and/or how math is learned. These are two vastly different views on what effective math education looks like in the classroom. Perhaps the most disconcerting of these findings is that the teachers who promoted student performance rather than student learning also believed that student mathematics abilities are stable and not very amenable to change (Stipek, Givvin, Salmon, and MacGyvers, 2001). This concept represents an entity theory and will be discussed further momentarily.

Debate #3: Effective math lesson planning. There are myriad views on what appropriate teacher beliefs and practices should be when developing effective math lesson plans. Effective math teachers hold very high expectations for their students (Farr, 2010; Stronge, 2002). They stress student responsibility and accountability in meeting those expectations (Stronge, 2002; Nichols, Meyers, & Burling, 2009) and emphasize higher-level thinking in all math classes, regardless of their tracks (Posamentier & Jaye, 2006). Students learn to develop strategies that effective learners use to succeed (NMAP, 2008). Educators deliberately scaffold new ideas and connect to what students already know (NMAP, 2008), and incorporate learning styles into aptly paced lessons (Stronge, 2002). They encourage students to express their thinking processes, which promotes active learning and enhanced levels of understanding (Secada & Berman, 1999). Effective teachers further promote student learning and motivation by utilizing tools and manipulatives that enhance instruction (NMAP, 2008). While effective teachers utilize a variety to techniques to keep students active and engaged, there is abundant research to support the use of explicit instruction regularly – but not exclusively – with struggling math students (NMAP, 2008). Explicit instruction means that teachers provide clear problem-solving models with an
array of examples, students have numerous opportunities to ask questions and practice their newly learned skills extensively, and students are provided with extensive feedback. With regular use of explicit instruction, struggling math students increase their foundational skills and conceptual knowledge (NMAP, 2008). Effective teachers actively support their students as they are held to high academic standards through the use of engaging methods with unwavering expectations, and students consistently rise to the challenge, achieving more than they ever have before.

Research has shown that mathematics teachers develop their instructional plans according to two primary belief structures, and exhibit the following behaviors in their instructional delivery:

**Table 3: The Comparison between Two Different Sets of Teacher Beliefs and Teachers’ Instructional Plans**

<table>
<thead>
<tr>
<th>Teachers who hold...</th>
<th>Traditional Beliefs (teacher control)</th>
<th>Constructivist Beliefs (inquiry-oriented)</th>
</tr>
</thead>
</table>
| ...about education tend to exhibit the following characteristics when developing their instructional plans... | - Incorporate less word problems into instruction, if any at all  
- Present mathematical operations and procedures in discrete units | - Incorporate more word problems into instruction  
- Focus on developing students’ strategies before teaching the facts |

(Peterson, Fennema, Carpenter, and Loef, 1989)

Here, teachers with more traditional styles tend to avoid word problems, for there is a bigger focus on more pure math in its most structured and rudimentary forms: equations, functions, statistical analysis, etc. These teachers present math topics as isolated components with little or no relation to other math topics. On the other side of the argument, math teachers with more constructivist beliefs value the importance of word problems in helping students...
process the math topics and apply them to more tangible concepts, and view problem-solving strategies as being more important to student success than simply remembering disconnected facts. Clearly, both sides have something to say about how effective math teachers should be planning and delivering their lessons.

*Debate #4: Effective math teachers’ responsibilities.* Some feel that math teachers are responsible for teaching math, while others feel that math teachers, like all teachers, are responsible for teaching students. This is a very distinct difference, as the latter is a much more holistic view of education and an encompassing representation of what teachers should strive for, including some of the following examples:

- Under the tutelage of an effective teacher, students should be provided with an abundance of respect and encouragement (Benard, 1998); students’ backgrounds should be fully utilized as effective teachers incorporate aspects of student identity, language, culture, and learning styles into the lessons and activities (Darling-Hammond, 1997; Nieto, 2010).

- Student development should be extended out into the community by enlisting the support of the family into the learning process (Darling-Hammond, 1997; Kaplan & Owings, 2002) with authentic involvement of parents and other community members (Zeichner, 2003).

- By helping students believe in themselves, incorporating their backgrounds into the classroom, and recruiting family support, effective math teachers can dramatically changing the lives of their students in real and profound ways.

In order to support the development of the whole student as discussed here, a teacher must believe that students can indeed *develop*. Those who hold a conflicting belief, referred to as an entity theory, may find it difficult to exhibit such supportive behaviors, as there is only so
much that they can do if nature deems otherwise. In this sense, the responsibility of the teacher is limited to that which the student is actually capable of doing, and could be out of the teacher’s control:

Table 4: Common Characteristics of Teachers who hold an Entity Theory of Student Ability

<table>
<thead>
<tr>
<th>Math teachers who hold...</th>
</tr>
</thead>
<tbody>
<tr>
<td>- An entity theory (the belief that mathematics ability is something a student has or does not have and a teacher cannot do much to change that) (Dweck, 1986; Dweck &amp; Bempechat, 1983)</td>
</tr>
<tr>
<td>- An entity theory may minimize a teacher’s effort and persistence with students whom they have identified as low in ability. (Dweck, 1986; Dweck &amp; Bempechat, 1983)</td>
</tr>
<tr>
<td>- A focus on individual differences in ability undermines a teacher’s attention to subject-matter learning. Instead of concentrating on students’ understanding related to a particular math problem in a particular context, teachers who hold an entity theory of ability may focus primarily on the students’ overall skill level. They may be more likely to use ability grouping and adjust assignments and teaching between groups but not within groups. The teachers’ attention would be more on how much students knew in general, relative to other students, rather than on students’ interpretations and understandings of particular math concepts. (Prawat, 1992)</td>
</tr>
</tbody>
</table>

If a teacher believes that a student’s math ability is relatively fixed – either the student can do math or they cannot – then the teacher may expend minimal effort with students who they feel have maxed out their math potential. In this case, such teachers may focus on these students’ skill levels relative to other students, rather than on each student’s own understanding of the math concepts themselves. This focus, of course, can have a dramatic effect on student achievement, and therefore is a crucial component of the effective math teaching discussion. Since research shows that holding an entity theory of student ability can inhibit a teacher’s
capacity to ardently support such a deep and lasting progression of a student’s abilities, many have focused on how to change a teacher’s beliefs in order to change his or her practices (see Stipek, Givvin, Salmon, and MacGyvers, 2001). This idea will be discussed in more detail later.

Constructivism’s final retort: The achievement gap still persists. Many inquiry-based supporters ultimately baulk at traditional teaching methods, stating that the achievement gap would no longer exist if those methods were effective. More specifically, many feel that effective teaching in low performing schools requires a shift in pedagogy and in content, with a more flexible curriculum and more student participation rather than a traditional push for standards and basic skills (Connell, 2007), for the latter are actually impeding authentic teaching and learning: using textbooks as the dominant resource; rote learning; teacher-centered transmission; and the belief that mastering the basics is required before students can engage in creative or critical work (see Nieto, 2010). Unfortunately these characteristics describe many environments where traditionally underserved students are “being educated,” and yet these students consistently complain that they are bored and not challenged by a curriculum that is dumbed down and irrelevant; they are tired of low expectations and the inability to ask questions or work with teachers that really care about them (Secada et al., 1998). Teachers of traditionally low-achievers wait less for them to answer, accept their ideas less often, and criticize them for failure more often (Brophy & Good, 1994). The constructivist model has been offered as an alternative to these traditional methods in an attempt to improve teaching effectiveness and close the achievement gap.

Defining and Evaluating Effective Teaching

The high-stakes educational system of today demands accountability of its educators. Legislators are reluctant to increase educational funding without stipulating a corresponding
increase in accountability. This increase in accountability means that educational administrators must be able to assess and identify quality teachers (Markley, 2004). The task of evaluating teachers is not new in education. Teacher evaluation processes existed in the days of the one-room school house, and the initial purpose was to affirm a teacher’s job continuation and salary increase. Local units determined evaluation objectives and standards (Markley, 2004).

Things began to shift with the onslaught of the industrial revolution as schools became larger and stronger union influences emerged. Unions promoted specific teacher evaluative criteria with rules for dismissal and advancement, but the criteria tended to be minimal and local school boards still dominated the process. During the 1950s, more men entered the teaching profession, and there was an increase in professional activity and union membership. Sputnik and the Cold War promoted a heightened focus on education by raising fears that Soviet students were better educated than American students, which spawned the desire to find better teachers in order to elevate our students and compete with the Soviets. This response led to even more men entering the teaching profession and unions further increasing their influence (Markley, 2004). In 1983, the National Commission on Excellence in Education released a shocking report called A Nation at Risk, telling the country that education was again in trouble for students were not learning and lacked even basic skills (Markley, 2004). In the decades that followed, education evolved into a system based on the premise that teacher-proof curriculums, test-based instructional management, and student competence testing alone would improve student learning (Clark, 1993). These policies assumed that a predetermined teaching format would result in the desired level of student learning, with teachers viewed as “laborers implementing a prescribed program in a manner determined by policy makers further up the educational hierarchy rather than as professionals with a repertoire of techniques and the ability to decide for themselves how
techniques should be applied” (Clark, 1993, p. 7). One of the primary consequences of *A Nation at Risk* (National Commission on Excellence in Education, 1983) was the effective schools movement. Effective schools emphasized minimum requirements to be a teacher and promoted specific characteristics such as punctuality and the provision of a safe learning environment (Markley, 2004). Teacher evaluations gained a new importance as a call for effective teachers spread across the nation. Clark (1993, p.11) wrote that three questions emerged from this movement:

(1) “What is an effective teacher?”

(2) “How can they best be evaluated?”

(3) “What can we do with this evaluation?”

These questions still drive the debate about teacher evaluation today (Markley, 2004).

So what is an effective teacher? Clark (1993, p. 10) wrote that, “Obviously, the definition involves someone who can increase student knowledge, but it goes beyond this in defining an effective teacher.” Vogt (1984) related effective teaching to differentiation, including the capacity to instruct different students of different abilities while incorporating educational objectives and assessing the effective learning methods of the students. Collins (1990), while working with the Teacher Assessment Project, established five conditions for an effective teacher: (a) is committed to students and learning, (b) knows the subject matter, (c) is responsible for managing students, (d) can think systematically about their own practice, and (e) is a member of the learning community (Clark, 1993; Markley, 2004).

Swank, Taylor, Brady, and Frieberg (1989) developed a model of teaching effectiveness that was based upon the presence and absence of specific teacher actions, including those that increased academic questions and decreased teacher lectures and ineffective practices, such as
negative feedback and low-level questions. Swank et. al believed that these factors could be easily identified in assessments of teacher performance. Million (1987) based effectiveness on the specific lesson designs and methods of delivery, where teachers who met a preset list of criteria during their evaluation were deemed effective. While some argued about the various components of effectiveness, others felt it was significantly more complicated than that; Papanastasiou (1999, p. 6) stated “that no single teacher attribute or characteristic is adequate to define an effective teacher.”

While these attempts were an improvement over earlier evaluation methods in that the role of the teacher was acknowledged, they were still incomplete (Markley, 2004). Newer research (Sanders, 2002; Strauss and Vogt, 2001) advocated for the increased use of student data to determine teacher effectiveness, especially student gain analyses that measure student growth from the beginning of the year to the end of the year.

As discussed above, definitions of effective teaching are vast and varied in the education arena. Effective teaching has been defined as many things, including the ability to foster students’ affective and personal development or students’ curriculum mastery (Brophy, 1986). Other popular definitions of teaching effectiveness include student achievement, “measurable student learning” (Ball, 1991, p. 2), teacher observation ratings, and input from stakeholders including students, parents, and administrators (Stronge, 2002). With this in mind, it will be interesting to see if effective teachers as defined in this study as the presence of measurable student achievement growth and measured by their EVAAS teacher value added measures will also show these same traits supported by the research of effective teaching characteristics outlined above.
Limitations of This Definition. Like many definitions discussed here, this definition of effective teaching, the presence of measurable student achievement growth, is not without weaknesses. Student achievement as measured by standardized tests is littered with arguments, including test and curricular alignment, reliability, cultural and socio-economic biases, cheating opportunities, and limitations of what can be assessed with multiple choice items (Kennedy, 2010; Ingersoll, 2003). Additionally, what else and who else plays a role in student achievement outcomes? Many of these factors have been discussed above and yet are not accounted for in this definition, including but not limited to the following: school-based factors such as class scheduling and interruptions (Stigler & Hiebert, 1999; Smith, 2000) or the school-based climate (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010) and student-based factors such as motivation to learn (Kennedy, 2010; Powell, 1996; Metz, 1993; Doyle, 1986).

Furthermore, not all academic subjects are, or can be, or should be tested. Standardized tests often measure very narrow concepts of student achievement or development, leaving many components unmeasured including within- and across-subject connections, student development across multiple years, student growth as a caring and contributing citizen, civic responsibility, global responsibility, environmental awareness, critical thinking skills, becoming a productive team member, respect and appreciation for others, and so on (Pearl, 2013; Hunt, Carper, Lasley II, & Raisch, 2010). Finally, teacher growth and development across years is not accounted for in this definition either, and it may be fundamental to the advancement of the teaching profession. With all of these factors completely discounted under this narrow definition of effective teaching, it is important to fully acknowledge that this definition is problematic: its scope is narrow, and it continues to place importance on the incredibly problematic world of standardized testing. None-the-less, as discussed above, educational funding is increasing
becoming tied to educational accountability, and the presence of measurable student achievement growth is part of the latest accountability trend. With such limitations in mind, this study proceeds, though not without caution.

While the main concepts of this study include effective teaching and student achievement, the amount of influence teachers have on student achievement was measured with value-added analysis. Therefore it is vital to look at the development of value-added modeling and its importance to the field of education.

Evaluating effective teaching: Necessity breeds invention. Recent research on teacher effectiveness has turned quantitative but not without analytic controversy. When closely reviewed, Hanushek (1986) found that a collection of 147 empirical studies on the relationships between school factors and student achievement were based on single regression analysis, producing biased evaluations and skewed data. Many others affirmed that simple accountability models were unsuitable for they produced erroneous results (Raudenbush & Bryk, 1986; Stevens, Estrada, & Parks, 2000; Hanushek, 1986). These critiques cultivated discussions about which factor should be analyzed: the student, the classroom, or the school. Finally, those debates were refined into a new phase of educational research called multilevel mixed effects or covariance models, also known as hierarchical linear models (HLM) (Carter, 2008). Although controversy persists, the HLM model provides better results than previous methods and enables researchers “to explore the inherently complex structure of schooling in a manner that begins to match that complexity’ (Goldstein, 2001, p. 18).

In the 1980s, Dr. William Sanders pioneered the use of HLM with student achievement gains on standardized tests, producing a way to measure how effectively a school/teacher increases student test scores, and called this process “value-added” (Sanders & Horn, 1994;
Sanders & Horn, 1998), which has since evolved into the Education Value Added Assessment System (EVAAS). While other models have since been developed and they all face critiques, critics of Sander’s value-added model have admitted that it is “the only present, fair, objective and dependable method of evaluating teacher effectiveness based on scores…” (Bock, Wolfe, & Fisher, 1996, p. 69).

Not all value-added models are the same. Of all the value-added models currently developed, there are four prominent issues that often set them apart from Sanders’ EVAAS model: how the model addresses (1) missing student test scores, (2) student demographic information, (3) individual test score measurement error, and (4) tests with different scales. A closer look at these four issues is warranted.

Issue #1: Missing student test scores. Not all students take all required standardized tests every year in every subject. Missing test scores are inevitable in education research, so any model attempting to utilize test scores must address this issue. Unfortunately the students with the most missing test scores are also generally the most economically disadvantaged and often minority (Sanders & Horn, 1998). Simply choosing to exclude these students from the analysis would produce inaccurate results, yet there are models that still drop these students’ results (Carter, 2008). Other models attempt to fill in the holes for a given student by artificially imputing the average score from the cohort, but students are often misrepresented with this method (Carter, 2008). The EVAAS model handles these scores entirely differently. Without imputing data, EVAAS utilizes all other available scores for a student to create an individualized description for him/her that is as accurate as possible. This means that all students are included in the analysis and a more accurate picture is generated (Sanders & Horn, 1998).
**Issue #2: Student demographic information.** Education researchers continue to debate the merits of incorporating student demographic information into their analytic models, including student socioeconomic status and ethnic background. Desires to adjust student data based on demographic information are maintained by the idea that achievement expectations are related to demographic information (Meyer & Dokumaci, 2011). Sanders asserts that a better estimate of teacher effect on student achievement is attained when students serve as their own control thereby making demographic variables unnecessary; if each student is followed using his/her own test scores from each year, the chances that demographic variables will change for a given child from one year to the next are highly unlikely (Carter, 2008). While the EVAAS model can incorporate these variables, Sanders maintains that their inclusion would not provide the most accurate findings available and therefore strongly advocates for the omission of demographic variables from the analyses (Carter, 2008). Others continue to disagree and the debate wears on.

**Issue #3: Individual test score measurement error.** How a student performs on any given test can vary significantly and therefore may not be most representative of what he/she actually knows, which is why single test scores contain significant measurement error. Simple value-added models may use as little as one prior test score to assess the progress of a single student, essentially discounting the effects of such errors. But these errors cannot be ignored, and the EVAAS model minimizes the influences of measurement error by using up to five years of data for each individual student across subjects, thereby increasing the precision of the estimates (SAS Institute Inc., 2003).

**Issue #4: Tests with different scales.** It is quite possible for a student to take standardized tests within the same year or across years that have different scales. Simplistic value-added models cannot accommodate such differences and therefore discount important data. The
EVAAS methodology can accommodate tests from different scales as long as they are reliable, are highly correlated with the curriculum, and have sufficient stretch to effectively measure the achievement of very low- and very high-achieving students (SAS Institute Inc., 2003).

In conclusion. When assessing the merits of a value-added model, it is important to evaluate how various factors are addressed, including (1) missing student test scores, (2) student demographic information, (3) individual test score measurement error, and (4) tests with different scales. When these fundamental differences are examined and accounted for as they are in the EVAAS methodology, the results are more precise and reliable than other more simplistic models (SAS Institute Inc., 2003).

Summary

As discussed throughout this chapter, literature identifying qualities of effective teachers and issues affecting student achievement are abundant but research identifying characteristics of mathematics teachers who positively or negatively affect student achievement is lacking. Three fields of knowledge informed this study: factors affecting student achievement; mathematics teacher attributes and the math wars; and defining and evaluating effective teaching, particularly through the use of value-added models. With most policies, such as the graduation policy North Carolina has recently adopted, policymakers are striving to improve education for all students by raising standards in an effort to essentially close the achievement gap. For the focus of this study, it is important to note that I did not control for the factors discussed above, including opportunity gaps or parent socio-economic status, when I looked at how this recent policy relates to the mathematics achievement gap. Now I shift gears and discuss the methods I used to conduct this study.
CHAPTER 3

METHODS

North Carolina’s recent policy decision (State Board of Education, 2009) to increase high school diploma requirements in order to raise student achievement needs to take into account the effects teachers have on student achievement outcomes. If it can be shown that (1) teacher effectiveness significantly influences student achievement, then (2) ensuring equitable access to effective teachers and working to improve the effectiveness of teachers should become a moral imperative in regard to this statewide policy. In order to study this problem, the primary research questions were:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

If student assignment to various mathematics teacher effectiveness sequences (question 1) is found to have substantial and significant measurable effects on student achievement, then it becomes impossible to ignore the importance of equitable access and improved teacher effectiveness, which cannot be addressed until more is known about the specific instructional practices and beliefs that differ among mathematics teachers who profile as various levels of teaching effectiveness (question 2). Below, I discuss how I handled both of these components of the problem and their related research questions.
Mixed Methods

The research questions are designed to measure the affect that teaching has on student achievement. Assuming this is a significant impact, how are the specific things that effective or ineffective teachers practice and believe different? For the purposes of this study, the following definitions apply. As seen in Table 5 below, I define teaching effectiveness as the presence of measurable student achievement growth as measured by a quantitative EVAAS teacher value added measure. Similarly, I define student achievement as an accomplishment through schooling that is made evident through learning and is measured as a quantitative standardized test score or as multiple standardized test scores. Therefore the first research question on how teaching effectiveness affects student achievement certainly lends itself toward a quantitative study. But the second research question on the specific things effective and ineffective teachers practice and believe differently evokes what a teacher does and thinks. To best explore such concepts, the words a teacher uses are most beneficial, and while it is possible to utilize more rigid quantitative methods of collecting and analyzing such linguistic information, this type of data lends itself nicely to a qualitative study (Creswell, 2008).

Table 5: Rationale for Using Mixed Methods based on Factors, Definitions, Instruments, and Data

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>DEFINITION</th>
<th>INSTRUMENT &amp; DATA</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Effectiveness</td>
<td>The presence of measurable student achievement growth.</td>
<td>Teaching effectiveness will be measured by the EVAAS teacher value added measure.</td>
<td>Quantitative</td>
</tr>
<tr>
<td>Student Achievement</td>
<td>An accomplishment through schooling that is made evident in learning.</td>
<td>A standardized test given at various points in a student’s career, and represented by a score or multiple scores.</td>
<td>Quantitative</td>
</tr>
<tr>
<td>Things Teachers Practice and Believe</td>
<td>That which a teacher does (practices) in the classroom with his/her students and the propositions (beliefs) that are used to create or justify those practices.</td>
<td>Interviews to collect teacher’s own thoughts.</td>
<td>Qualitative</td>
</tr>
</tbody>
</table>

In this study, I employed an *explanatory mixed methods design* conducted in two phases: the first phase consisted of collecting and analyzing quantitative data and the second phase consisted of collecting and analyzing qualitative data to help elaborate on the quantitative results. The rationale for this approach is that the quantitative research provided a general picture and the qualitative research helped extend that general picture through the use of a few typical cases, probing for more detail (Creswell, 2008). More specifically, Phase I quantitatively assessed the presence and significance of the compounding effects of highly effective versus highly ineffective teaching over the course of three consecutive years *in general*, and Phase II dug deeper into the practices and beliefs of a select group of typical teachers who fall within those two extreme categories, shedding light on these issues in greater detail.

**PHASE I: Quantitative Methods**

The first phase of the study addressed the first components of the conundrum at hand: if student assignment to various mathematics teacher effectiveness sequences is found to have substantial and significant measurable effects on student achievement, then the current high school diploma policy in North Carolina may need to be adjusted to accommodate the implications of this relationship, as depicted in Table 6 below.
Table 6: Overview of Phase I: Quantitative Methods

<table>
<thead>
<tr>
<th>Research Problem (1)</th>
<th>North Carolina’s recent policy decision to increase high school diploma requirements in order to raise student achievement essentially disregards the effects teachers may have on student achievement outcomes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question 1</td>
<td>Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?</td>
</tr>
<tr>
<td>Research Question 1a</td>
<td>Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?</td>
</tr>
<tr>
<td>Research Question 1b</td>
<td>Long-term effects: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?</td>
</tr>
<tr>
<td>Current Research Indications</td>
<td>In initial small-scale studies, teacher effectiveness significantly affects student achievement for the average learner (Rivers-Sanders, 1999).</td>
</tr>
<tr>
<td>Need for This Study</td>
<td>New research is needed to validate initial findings and expand these investigations to look at varying levels of entering achievement and long term impacts in order to raise enough awareness to impact potentially inequitable education policy initiatives now and in the future.</td>
</tr>
</tbody>
</table>
| Methodology: Instruments and Data | Student Achievement: an accomplishment through schooling that is made evident in learning, as defined by a standardized test given at various points in a student’s career, and represented by a score or multiple scores.  
Teacher Effectiveness: the presence of measurable student achievement growth. I will measure teaching effectiveness with EVAAS teacher value added measures. |
| Analysis | An analysis of covariance (ANCOVA) model was developed to test whether effective or ineffective teaching had an effect on mathematics student achievement outcomes. |
| Anticipated Outcomes | Based on the results of current research, it is anticipated that teacher effectiveness sequence will have a significant effect on student achievement, but the degree to which is yet to be determined until this study was conducted. It is also yet to be determined if that effect differs for students at varying achievement levels, or how it affects students’ high school math achievement. |
Implications of Research Problem 1 Findings (This leads to Research Problem 2)  
If Teacher Effectiveness is found to have a significant and substantial impact on student achievement, then current and future education policy initiatives must acknowledge this relationship and accept responsibility by implementing complementary policies to ensure equitable access to effective teachers and to improve the breadth and depth of teaching effectiveness in all classrooms and in all schools.

Quantitative Research Questions

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

1a. Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

1b. Long-term effects: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

Study Design

In order to address these questions, the quantitative analyses utilized student prior test scores coupled with EVAAS teacher value added measures to determine the 3-year compounding teacher effect on student achievement in 8\(^{th}\) grade and beyond. Specifically, the grades 6-8 three year span included school years 2008–09, 2009–10, and 2010–11. The projected Algebra I and SAT Math scores utilized the students’ EOG test data from 6\(^{th}\), 7\(^{th}\), and 8\(^{th}\) grade.

Teaching Effectiveness. While teacher effectiveness can vary from year to year, research has shown that effective teachers tend to maintain their effectiveness even if they move to schools with demographically different student populations (Sanders, Wright, & Langevin, 2008). For the purposes of this study, I represented teacher effectiveness with the EVAAS teacher value added measure, which is a function of student achievement growth. In the EVAAS value added model, teachers start out at average until the weight of the evidence pulls the
teachers’ measures away from that average. As discussed below, the EVAAS student prediction score serves as the proxy for entering achievement level. In order to increase the robustness and reduce bias, two specific protections were utilized when capturing teachers’ EVAAS value added measures: the use of 2 years of high/low effectiveness that come from years not including the year the teacher instructed the students included in this study (see Table 7 below).

Table 7: School Years A and B used to Calculate Each Teacher’s Two-Year Combination, Excluding the Grade Each Teacher had this Cohort of Students (X)

<table>
<thead>
<tr>
<th>School year ending in</th>
<th>6th Grade</th>
<th>7th Grade</th>
<th>8th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>X</td>
<td>Year A</td>
<td>Year A</td>
</tr>
<tr>
<td>2010</td>
<td>Year A</td>
<td>X</td>
<td>Year B</td>
</tr>
<tr>
<td>2011</td>
<td>Year B</td>
<td>Year B</td>
<td>X</td>
</tr>
</tbody>
</table>

As a more robust measure of effectiveness, I used teachers’ EVAAS teacher value added measures for two years (Year A and Year B in Table 7 above) to represent the effectiveness of the teacher – referred to here as the teacher’s two-year-combined effectiveness. This measure was used to reflect that the included teachers are effective or ineffective over time and with multiple cohorts of students. Each teacher needed to be highly effective or highly ineffective for both years analyzed (Year A and Year B) in order to be considered highly effective/ineffective. In addition, to minimize bias, the teacher effectiveness estimate came from the years not including the year that the teacher taught a student included in this study.

Two other options were considered here, but limitations in the data eliminated these choices: (1) the first option was to use the years preceding the year the teacher taught this cohort of students, but state-wide EVAAS teacher value added data was not available in North Carolina prior to 2009, and (2) the second option was to use a 3-year-average of teacher effect data instead of just 2 years, but only data from 2009 through 2011 was available at the time of this study.
Choosing to exclude the year the teacher taught the cohort was important in order to avoid analyses that were too circular in nature to reveal anything useful.

*Entering Student Achievement Level.* There are many ways to determine students’ entering achievement levels in a given year. The most common and simplistic method is to use the student’s EOG exam score in the same subject from the previous year. In this case, students’ 6\textsuperscript{th} grade entering achievement would be indicated by their 5\textsuperscript{th} grade EOG exam scores. There are two substantial problems with this method. (1) There is a significant amount of measurement error associated with a single test score. A student may have a bad test day, get unusually lucky with guessing, be ill or get tired; there are a plethora of reasons why any single score for a student contains measurement error and therefore is not a ‘true’ measure of his/her actual knowledge. (2) A student may not have a test score in the same subject in the previous year. Missing scores are rampant in test data sets and students miss tests for a number of reasons including skipping the exam, becoming ill, or a miscoding that disconnects the student’s score from his/her name. Since missing data is disproportionately connected to student socioeconomic status, the automatic omission of data for students with incomplete testing histories can lead to skewed results (Wright, 2004). When considering the validity and reliability of the results of this study, these two problems were too much to overcome under more simplistic approaches, and so a simplified approach of utilizing students’ 5\textsuperscript{th} grade EOG scores was not considered.

A second common approach is to use the average of the past two years’ scores to represent entering achievement. In this case, that method would involve taking the average of a student’s 4\textsuperscript{th} grade math EOG score and the 5\textsuperscript{th} grade math EOG score to represent his/her entering 6\textsuperscript{th} grade achievement level. While this method somewhat addresses the issue of measurement error by using two scores instead of one, it does not account for the possible
relationship between each score and the student’s entering 6th grade math achievement – as it is likely that the most recent score (5th grade) carries a more direct relationship than older scores (4th grade). As such, I did not utilize this approach either.

For the purposes of this study, students’ individual EVAAS prediction score for the 6th grade math EOG exam represented their entering achievement levels at the start of 6th grade. The EVAAS model develops predictions to a given test by using all available standardized test scores from previous years and subjects to determine where the student will most likely score on an upcoming exam. However, in this study, the predictions included prior math data to keep all aspects of the study focused on math. In order to receive an EVAAS prediction, students must have at least three prior test scores from a pre-determined list of available tests in order to significantly dampen the effects of measurement error associated with such standardized tests. Since the data used for this study further limited those prior test scores to just prior math test scores, these students had to have math test scores from 3rd, 4th, and 5th grade, which still helps minimize the effects of measurement error. Furthermore, the EVAAS prediction model naturally provides more weight to the 5th grade scores over the 4th grade scores, and so on, as the most recent score should be more directly related to the students’ actual entering achievement in 6th grade. Thus, I selected the EVAAS student predictions as the best option for measuring the entering achievement level for students.

To begin these analyses, students were ranked in order according to their EVAAS predictions based on Normal Curve Equivalents (NCEs). Like all NCE ranks, a student who falls near the 50th NCE indicates half of the students rank above this student and half rank below this student, making this student’s rank the mathematical “average.” The students in this study were
then split into three equally sized groups based on their NCEs such that there was a low, average, and high group; I then followed those students through their next three years of schooling.

As they progressed through 6th, 7th, and 8th grade and were subsequently placed with teachers of varying levels of teaching effectiveness as determined by the teachers’ EVAAS teacher 2-year-combined value added measure, students only remained in the study if their assigned 6th grade teacher was either to a teacher who had been labeled “highly effective” or “highly ineffective,” and then that student was similarly assigned to a teacher in 7th grade with an identical level, and likewise assigned to a teacher in 8th grade with that same effectiveness level (see Figure 1 below, where static student assignment is indicated by a solid line and therefore will be used in the study). Students who were initially assigned to teachers of average effectiveness or those who later changed to a teacher of a different effectiveness level at any time throughout these 3 years were not included in the study (see Figure 1 below, where wavering student assignment is indicated by a dashed line and therefore will NOT be used in the study).
Figure 1: Various Paths of Student Assignment to Teacher Effectiveness Levels by Grade

6th Grade Students’ Entering Achievement Level by NCE Rank
1 10 20 30 40 50 60 70 80 90 99

Low Achievers
Bottom 1/3

Average Achievers
Middle 1/3

High Achievers
Top 1/3

6th Grade
Highly Ineffective
Math Teacher

6th Grade
Average in Effect
Math Teacher

6th Grade
Highly Effective
Math Teacher

7th Grade
Highly Ineffective
Math Teacher

7th Grade
Average in Effect
Math Teacher

7th Grade
Highly Effective
Math Teacher

8th Grade
Highly Ineffective
Math Teacher

8th Grade
Average in Effect
Math Teacher

8th Grade
Highly Effective
Math Teacher

Where will these incoming 6th grade low/average/high achievers end up after three consecutive years of highly effective or highly ineffective teaching?

8th Grade Students’ Exiting Achievement Level by NCE Rank
1 10 20 30 40 50 60 70 80 90 99

KEY
—— Student Assignment: Used in Study
----- Student Assignment: NOT Used in Study
For the purposes of this study, the process depicted in Figure 1 above tracked students who initially enter 6th grade with “low, average, and high” achievement to see what affect the teacher effectiveness sequence has on these types of learners.

For students of low, average, or high entering achievement who remain in the study – those who are initially assigned to highly effective or highly ineffective teachers and are subsequently assigned to teachers of a similar level in the following years – their final 8th grade achievement level as indicated by their EOC Algebra I predictions (based on all available prior EOG math exam results) by NCE rank were used to address research question 1a: Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students? I chose to use the students’ EVAAS predictions to Algebra I instead of their actual Algebra I EOC scores for two reasons: as discussed above, there is measurement error associated with any single test score and the EVAAS model reduces the effects of measurement error by utilizing multiple test scores to determine each student’s predicted score; and each student has an EVAAS prediction for Algebra I, regardless of whether the student actually takes the Algebra EOC exam.

To answer this question, I followed three groups of students (low, average, and high achieving) through three years of schooling (6th, 7th, and 8th grade) as they are assigned to one of two extreme levels of teaching effectiveness (highly effective and highly ineffective) consistently every year. To track each group of students throughout the data and this discussion, they will be delineated as follows:
Table 8: Distinguishing Three Levels of Student Achievement Status (Low, Average, High) as Paired with Three Years of Highly Ineffective or Highly Effective Teachers

<table>
<thead>
<tr>
<th></th>
<th>Low Achieving Status</th>
<th>Average Achieving Status</th>
<th>High Achieving Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Ineffective Teachers All 3 Years</td>
<td>Low/Ineff</td>
<td>Ave/Ineff</td>
<td>High/Ineff</td>
</tr>
<tr>
<td>Highly Effective Teachers All 3 Years</td>
<td>Low/Eff</td>
<td>Ave/Eff</td>
<td>High/Eff</td>
</tr>
</tbody>
</table>

Finally, I addressed research question 1b as well: *Long-term effects*: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

**Participants and Site**

*Student Participants.* I utilized student standardized math test scores from the entire state of North Carolina for this study. Criteria for eligibility for student participation in the study included (a) the student must have state math scores in grades 3-8, and (b) the student must be linked to a specific teacher each year that also had an EVAAS teacher 2-year-combined effect score available.

*Teacher Participants.* Criteria for eligibility for teacher participation in the study included (a) the teacher must teach at least one of the three tested grades being investigated and as such, have students included in the study, and (b) the teacher must have an EVAAS 2-year-combined teacher effectiveness estimate available from the years discussed in Table 8 above. The school years being examined in this study are 2008–09, 2009–10, and 2010–11.

I used *all available students and teachers* who met the criteria discussed above within the state of North Carolina in the analysis. I did not use any sampling to restrict further the population in any way.
Data Collection

The student-level data needed for these analyses were acquired from NCDPI as part of their statewide data submission and prepared by the SAS EVAAS department. This preparation required that school year 2010-2011 student EOG test results be merged with student historical data and teacher effectiveness estimates for those who instructed the included students (teacher-student linkages are discussed below). The 2010-2011 student files contained student name, student ID, grade, date of birth, race, gender, test date and subject, raw and scale score, achievement level, and indicators for special education, limited English proficiency (LEP), and academically or intellectually gifted (AIG). These student records were matched at the student level by name, student ID, and birthdate with records in the EVAAS database. Students can be matched to historical database records even if they move from one district to another, minimizing the number of incomplete records in the system.

Statewide teacher-student linkage data comes from NCDPI as well. The 2010-2011 file contained teacher name, teacher ID, district and school IDs, and course/subject information including student name, ID, grade, and date of birth. These teacher records are matched with student records by district, school, student name, student ID, student date of birth, test, subject, and grade. Finally, the teachers are merged across years with their own previous data by matching teacher name, teacher ID, and district.

Instruments and their Reliability and Validity

Student Achievement Scores. The instruments used to obtain the students’ academic achievement scores are the End of Grade (EOG) and End of Course (EOC) standardized exams that are designed by the state and administered through each school district. EOG exams are administered in various middle school subjects including mathematics, reading comprehension,
and science, and EOC exams were administered in various high school subjects including English I, Algebra I, and Biology for the 2011-2012 school year, with previous testing years also including Geometry, Algebra II, U.S. History, Civics and Economics, and Physical Science. The EOG exams are “…designed to measure student performance on the goals, objectives, and grade-level competencies specified in the North Carolina Standard Course of Study [SCOS]” (NCDPI, 2011, para. 1). The EOC exams are “…used to sample a student’s knowledge of subject-related concepts as specified in the North Carolina Standard Course of Study and to provide a global estimate of the student’s mastery of the material in a particular content area” (NCDPI, 2011, para. 1). Reports prepared by Sanford (1996a & 1996b) and released by the North Carolina Division of Accountability/Testing provide evidence that the EOG and EOC exam types are reliable and valid.

**EVAAS Student Predictions.** The students’ math testing history was utilized to create an EVAAS student prediction score to the 6th grade EOG exam, which represented their incoming 6th grade student achievement. A minimum of three prior test scores must be available for a given student in order to create the EVAAS student prediction score from a pre-determined set of standardized tests (see Appendix A), but the model utilizes as many prior test scores as possible if more than three were available for a given student. For the purposes of this study, only prior math scores were used as predictors. The EVAAS student predictions are significantly stronger than using just one prior test score, even if the prediction is to a test that is still three years away: if the student prediction is calculated *three years prior* to a given test with just four previous scores, the multiple correlation is higher three years out than the simple single-test-score correlation between adjacent years (SAS Institute Inc., n.d.).
*Teacher Effectiveness Scores.* Effective teaching is defined by the presence of *measurable student achievement growth.* Teaching effectiveness was measured by the 2-year-combination of two EVAAS teacher value added measures for each teacher. Teachers with a teacher effect score significantly above 0 are more effective than those with a teacher effect score significantly below 0, where 0 represents the average amount of growth made by students in each tested subject across the state. Two-year-combined EVAAS teacher value added measures were used in order to ensure a more reliable estimate of the effectiveness of the teacher as it has been maintained over time and with different groups of students. EVAAS estimates of teacher effects are valid, reliable, unbiased estimates of the effects of teachers on the academic progress of their students (Harville, 1995). They indicate the amount of change in student scale scores during a school year that is beyond the average change for teachers across the state (Rivers-Sanders, 1999).

**Data Analysis**

The EOG exam scale scores for each individual student were merged at the student level into the EVAAS longitudinal database. At the time of this study, this database included individual student records from EOG and EOC exam administrations from 1999 to 2011. The EVAAS database is the basis for North Carolina’s estimation of district, school, and teacher effects in all available tested subjects. State legislation requires school improvement teams to use EVAAS (or a compatible and comparable system approved by the State Board of Education) to collect diagnostic information on students and to use that information to improve student achievement (General Assembly of North Carolina, 2010). EVAAS first reported district and school effects in 2001 for one district, in 2002 for two districts, and further expanded to a handful of pilot districts in 2005. Statewide reporting for all school districts and charter schools
began in 2006. Starting in 2001, EVAAS collected, analyzed, and reported data linking individual students to teachers in one school district, which allowed individual teacher effects to be estimated. Over time, the NCDPI expanded the calculation of teacher effects to include statewide teacher-student linkages, analysis, and reporting for all schools in North Carolina in 2009. This reporting has been repeated annually from that time on. EVAAS teacher value added estimates are reported for the past three individual years and a three-year average is calculated for each teacher when available.

*Teacher Effectiveness Score Analysis.* The EVAAS teacher value added measure was calculated by SAS EVAAS. A brief explanation of that process is included here, but more information is available in the research papers on the SAS website (see http://www.sas.com/govedu/edu/k12/evaas/papers.html). As explained by Wright, White, Sanders, and Rivers (2010), the teacher effect analysis uses a univariate response model (URM) which is an analysis of covariance (ANCOVA) model in which the categorical variable is the teacher and the estimated parameters are pooled-within teacher. Conceptually, this regression-based approach compares the students’ *expected* and *observed* scores: each student’s expected score is defined by how other students with the same entering achievement did on average across the state, whereas each student’s observed score is what the student actually scored on the assessment (Texas Education Agency (TEA), 2014). Algebraically, the “expected score ($\hat{y}$) for Student A in, say, 6th grade math, would include Student A’s prior test scores ($x_1, x_2, \text{etc.}$), the average prior test score ($\bar{x}_1, \bar{x}_2, \text{etc.}$) for all students who took 6th grade math at the same time as Student A, and the regression coefficients ($b_1, b_2, \text{etc.}$) for each prior test score, which take into account the relationship between the prior test scores to 6th grade math and accommodates the different scaling on the tests” (TEA, 2014, p. 1):
\[
\hat{y} = \bar{y} + b_1(x_1 - \bar{x}_1) + b_2(x_2 - \bar{x}_2) + \ldots
\]

The next step in the URM is to estimate teacher effects \((a_j)\) using the following ANCOVA model:

\[
y_i = \beta_0 + \beta_1C_i + \alpha_j + \epsilon_i
\]

The effects \((a_j)\) are considered to be random effects. Consequently the \(\hat{\alpha}_j\)'s are obtained by shrinkage estimation (empirical Bayes) (see Wright, White, Sanders, & Rivers, 2010 for more information).

For the purposes of this study, each teacher with a unique EVAAS teacher identification number and effectiveness score for mathematics teachers in grades six through eight beginning in school year 2008–09 was merged with the individual student records. The grade and teacher identification values were utilized to match EVAAS teacher value added measures to the individual student records by student-year in order to follow the students through three years of highly effective/ineffective teachers. I dropped students with no teacher identified from the analyses. The EVAAS teacher value added measures for math in each grade were assigned one of three labels: Below, Not Detectibly Different, and Above, and were assigned as follows:

BELOW  Not Detectibly Different  ABOVE

\[ \begin{array}{cccccc}
-2 SE & -1 SE & \mu & 1 SE & 2 SE
\end{array} \]
EVAAS Teacher Value Added Estimates (Below, Not Detectibly Different, Above) as Related to Standard Error (SE)

- $\mu$ is the average teacher effect in the state.
- **Below** means that students taught by this teacher made significantly less progress than students taught by the average teacher.
- **NDD** means that the progress made by students taught by this teacher was Not Detectably Different from the progress made by students taught by the average teacher.
- **Above** means that students taught by this teacher made significantly more progress than students taught by the average teacher.

(SAS EVAAS, n.d.)

These EVAAS teacher value added measures for each year were added to the individual student records to facilitate the analyses and the reporting of the results.

*Teacher Effectiveness Sequence Analysis.* Students’ 6th grade math entering achievement level (as indicated by their EVAAS student predictions to the EOG 6th grade math exam) was compared to those students’ exiting achievement level (as indicated by their EVAAS student predictions to the EOC Algebra I exam) at the end of 8th grade, for those students who had three sequential years of either highly effective or highly ineffective teachers (as indicated by teachers’ EVAAS teacher value added measures) in order to see if their achievement had been significantly impacted by the high or low teacher effectiveness sequences that the students experienced for the three years. Students were split into three equally-sized entering achievement subgroups and tracked in that subgroup through the highly effective/ineffective teachers (see Figure 2 below).
Figure 2: Three Groups were analyzed to Determine the Impact of Teacher Assignment on Exiting Student Achievement Level based on Varying Levels of Entering Student Achievement

1st Group: High Achieving Students

Students’ 6th grade Entering Achievement Level
EVAAS Predictions

3 years of Highly Effective Teachers
OR
3 years of Highly Ineffective Teachers
EVAAS Value Added Measures

What are Students’ 8th grade Exiting Achievement Level?
EVAAS Predictions

2nd Group: Average Achieving Students

Students’ 6th grade Entering Achievement Level
EVAAS Predictions

3 years of Highly Effective Teachers
OR
3 years of Highly Ineffective Teachers
EVAAS Value Added Measures

What are Students’ 8th grade Exiting Achievement Level?
EVAAS Predictions

3rd Group: Low Achieving Students

Students’ 6th grade Entering Achievement Level
EVAAS Predictions

3 years of Highly Effective Teachers
OR
3 years of Highly Ineffective Teachers
EVAAS Value Added Measures

What are Students’ 8th grade Exiting Achievement Level?
EVAAS Predictions
These three subgroups of students were based on the students’ entering achievement levels. Those levels were calculated based on the students’ EVAAS prediction for 6th grade math EOG by using all prior math EOG testing data for each student. The students were then split into thirds by tertile, creating a bottom third, middle third, and top third of the entire population of students.

Testing for significance. There are multiple components to the quantitative research questions in this study, and various tests of significance were employed based on what fit best for each part. Question 1a had three parts: (1) how did the students fare, overall, based on these three-year compounding effects, and (2) how did students fare, by achievement group, based on these three-year compounding effects, and (3) is the effect different for different achievement groups? As summarized in Table 9 below, the results from part (1) were tested for significance with a two-sample t-test with pooled variances, part (2) with multiple two-sample t-tests with pooled variances, and the results from part (3) were tested for significance with a two-way ANOVA. Pooled variance t-tests were used because all tests for unequal variances were non-significant. Question 1b had two parts: (1) how did this experience effect the students’ projected Algebra I scores, and (2) how did this experience effect the students’ projected SAT Math scores? The results from both parts (1) and (2) were tested for significance with a two-sample t-test.
Table 9: Quantitative Questions and Their Tests for Significances

<table>
<thead>
<tr>
<th>Sub-Question</th>
<th>Testing</th>
<th>Method</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a (1) – When students are assigned to effective/ineffective middle school</td>
<td>Whether the difference of entering &amp; exiting achievement varied</td>
<td>Two-sample</td>
<td>Factor 1: 3-Year Teacher Assignment Group (LLL, HHH)</td>
</tr>
<tr>
<td>mathematics teachers for three years in a row, what is the measurable</td>
<td>teacher assignment group</td>
<td>t-test of Factor 1</td>
<td></td>
</tr>
<tr>
<td>effect on student achievement?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a (2) – What is the measurable effect on student achievement for students</td>
<td>Whether the difference of entering &amp; exiting achievement varied</td>
<td>Two-sample t-test of Factor 1 within Factor 2</td>
<td>Factor 1: 3-Year Teacher Assignment Group (LLL, HHH)</td>
</tr>
<tr>
<td>at varying levels of entering achievement?</td>
<td>teacher assignment group for students of differing achievement levels</td>
<td></td>
<td>Factor 2: Student Achievement Group (low, average, high)</td>
</tr>
<tr>
<td>1a (3) – Is the measurable effect different depending on the entering</td>
<td>Whether the effect of teacher assignment group on the change in</td>
<td>Two-way ANOVA</td>
<td>Factor 1: 3-Year Teacher Assignment Group (LLL, HHH)</td>
</tr>
<tr>
<td>achievement level of students?</td>
<td>achievement differed by entering achievement level</td>
<td></td>
<td>Factor 2: Student Achievement Group (low, average, high)</td>
</tr>
<tr>
<td><strong>Long-term effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b (1) – Is there an effect on the students’ projected Algebra I NCE score?</td>
<td>Whether the Algebra I projections varied by teacher assignment group</td>
<td>Two-sample t-test</td>
<td>Factor 1: 3-Year Teacher Assignment Group (LLL, HHH)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Factor 2: Projected Algebra I NCE score</td>
</tr>
<tr>
<td>1b (2) – On their projected SAT Math scale score?</td>
<td>Whether the SAT Math projections varied by teacher assignment group</td>
<td>Two-sample t-test</td>
<td>Factor 1: 3-Year Teacher Assignment Group (LLL, HHH)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Factor 2: Projected SAT Math scale score</td>
</tr>
</tbody>
</table>
In question 1a, where I looked for the short-term effects of these three years that the students experienced, part (1) was testing whether the difference of entering & exiting achievement varied across teacher assignment group, part (2) was testing whether the difference of entering & exiting achievement varied across teacher assignment group for students of differing achievement levels, and part (3) was testing whether the effect of teacher assignment group on the change in achievement differed by entering achievement level. In question 1b, where I looked for the long-term effects of these three years, part (1) was testing whether the Algebra I projections varied by teacher assignment group, and part (2) was testing whether the SAT Math projections varied by teacher assignment group. In each situation, I was testing to see if there was a statistical difference in the groups. The results from Phase I, the quantitative portion of this mixed-methods study, are reported in Chapter 4.

PHASE II: Qualitative Methods

The second phase of this study hinged on the outcomes of the first phase. While initial findings from other studies discussed above already indicated that significant results would be likely, in the event that the quantitative analyses were inconsequential, I developed a contingency plan and discuss it briefly below. However, for the remainder of this section, I describe my much more developed plan for Phase II.

If Results from Phase I were NOT significant. In this case, I proposed that I would still interview teachers from various levels of effectiveness as indicated by their EVAAS teacher value added measures, but I would include teachers from all three ranges of effectiveness (Above, Not Detectibly Different, and Below). Since the quantitative effects of the extreme cases (Above and Below) were not significant in this hypothetical plan, there will be no reason to limit the interviews to only the extreme cases. Teachers who profile at all three levels of effectiveness
would be included in Phase II, for this information would still add to the current knowledge about teacher practices and beliefs.

*If Results from Phase I were significant.* The second phase of the study was much smaller in scope than the first phase, and was designed to address the subsequent components of the conundrum at hand: if the potentially powerful influence of effective teaching on student achievement is to be addressed, then the quality of instruction afforded to each student every year is a large piece of that puzzle. Equitable access to effective teachers may need to serve as a vital component of this statewide initiative to increase student achievement *if* access to a high school diploma is supposed to be equitable for all students. Understanding what differentiates effective teachers from ineffective ones is imperative to the cause if the effectiveness of teachers is to be raised in order to promote more equitable access and subsequently to improve student achievement outcomes for every student. After all, better preparing students for college and careers beyond high school is the ultimate goal of this statewide policy initiative in the first place (State Board of Education, 2009). The scope of this phase is depicted in Table 10 below.

**Table 10: Overview of Phase II: Qualitative Methods**

<table>
<thead>
<tr>
<th>Research Problem (2) - Implications of Research Problem 1a Findings</th>
<th>If teacher effectiveness is found to be significant and substantial, then current and future education policy initiatives must acknowledge this relationship and accept responsibility by instilling complementary policies to ensure equitable access to effective teachers and to improve the breadth and depth of teaching effectiveness in all classrooms and in all schools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question 2</td>
<td>What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?</td>
</tr>
<tr>
<td>Research Question 2a</td>
<td><em>Compared to research:</em> How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?</td>
</tr>
<tr>
<td>Research Question 2b</td>
<td><em>Compared to each other:</em> How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?</td>
</tr>
</tbody>
</table>
| Current Research Indications: The Math Wars | Side #1: Traditional Beliefs  
- Promote procedures, efficiency, speed  
- Emphasize accuracy  
- Students learn independently, with extrinsic motivation  
- Teacher is in control of the learning  

Side #2: Constructivist Beliefs  
- Promote effort, creativity, mistakes  
- Emphasize understanding  
- Students learn through social interaction, exploration, and discovery, with internal motivation  
- Student have some autonomy |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for This Study</td>
<td>New research is needed to validate initial findings based on changing definitions of teaching effectiveness in order to raise enough awareness to impact potentially inequitable education policy initiatives.</td>
</tr>
</tbody>
</table>
| Methodology: Instruments and Data | **Teacher Effectiveness**: the presence of measurable student achievement growth. Teaching effectiveness will be measured by the EVAAS teacher value added measure.  

**Teacher Practices and Beliefs**: that which a teacher does (practices) in the classroom with his/her students and the propositions (beliefs) that are used to create or justify those practices. Teacher practices and beliefs will be collected through interviews. |
| Analysis | Round 1: I coded interview data line by line and sorted according to common and uncommon characteristics, as well as connections to current research on effective teaching (traditional versus constructivist beliefs).
Round 2: I initially categorized participants into one of the two camps: traditional versus constructivist.
Round 3: EVAAS teacher value added measures were then merged with participant identification to study the relationships between initial categorization and these scores.
Round 4: I reanalyzed original interview data for negative cases and to assess the differences between these two groups of teachers. |
| Anticipated Outcomes | Based on the results of current research, I anticipated that characteristics of effective teachers as defined by constructivists would hold true under this new definition of teaching effectiveness, but the degree to which was yet to be determined until this study was conducted. |
Implications of Research Problem 2
Findings

If currently researched characteristics of effective teachers as defined by constructivists were found to be true for this new definition of teaching effectiveness, then current and future education policy initiatives must acknowledge the importance of these characteristics and accept responsibility by instilling complementary policies to ensure equitable access to effective teachers and to improve the breadth and depth of teaching effectiveness in all classrooms and in all schools that align with these characteristics, among others.

Qualitative Research Questions

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. *Compared to research*: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. *Compared to each other*: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

Qualitative Methodology & Design

In order to address the issues of identifying effective teachers’ beliefs and practices that promote student achievement, I conducted one-on-one semi-structured interviews. Interviews provide in-depth insight pertaining to participants’ experiences and viewpoints of a particular matter (Turner, 2010). Teacher self-reported measures including interviews provide the unique perspective of the teacher and can be used to study otherwise unobservable factors that may impact teaching, such as knowledge, intentions, expectations, and beliefs (National Comprehensive Center for Teacher Quality, 2010).

*Examining Teacher Practices and Beliefs with Interviews.* Among traditional educational research methods including observations, interviews, and surveys, the most prevalent approaches used with teachers are observations and questionnaire surveys (see Stipek, Givvin, Salmon, and MacGyvers, 2001; Yates, 2005). Research that utilizes interviews of teachers, which can be more
complicated and time consuming, is less common, but can provide rich insights into the minds of the participants. Marta Civil (1990) interviewed four pre-service teachers about their views of mathematics, finding that they approached math instruction from a rule-oriented point of view, where “doing” math was simply abiding by simple algorithms and procedures. When math problems were approached from a slower and less formal path (i.e. trial and error), this was viewed as childish or immature.

These more traditional views of mathematics and math instruction are quite common, and, for many teachers who hold these views, reform efforts handed down from above appear to fall on deaf ears until the reforms are forgotten and replaced with the latest fad, which is received with even less excitement and due diligence. For the past several decades, mathematics has been the subject with the highest number of fleeting innovation attempts (Handal & Herrington (2003), and this transience has caused cynicism among many teachers. Several research studies have utilized interviews to show a disconnect between teachers’ beliefs and the beliefs behind particular math reform movements. Brew, Rowley, and Leder (1996) interviewed 40 teachers on their perceptions of the implementation of a curriculum that relied heavily on investigative work by the students. The authors found that a number of teachers held contradictory beliefs to the reform, and some teachers admitted having difficulties while other teachers were just paying lip service to the curriculum goals without actually implementing them. Among the mitigating factors accounting for these subversive behaviors were heavy workloads, lack of training, and the pressure to cover large amounts of content. Buzeika (1996) interviewed three Auckland primary teachers in regard to the Mathematics in the New Zealand Curriculum, which emphasized constructivist practices, and found that the teachers felt that the curriculum was vague and unstructured. Teachers lacked knowledge about some topics and terminology used in
the curriculum. The teachers also had “difficulties in maintaining control over what was happening if children were left to explore an idea for themselves” (p. 97).

Frykholm (1995) investigated mathematics teachers' beliefs of 44 pre-service mathematics teachers throughout a two year study in order to determine teachers' adherence to the reforms posed by the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989). Although most participants agreed with the principles outlined in the *Standards* and claimed that they were actually implementing them in their student-teaching practicums, other evidence showed they were essentially unable to implement the Standards due to their perceived lack of training in the principles underlining the reform. Participants felt pressured within their teaching education programs to implement the principles, but expressed that the *Standards* were “not as practical as they were made out to be, especially in dealing with the structure of most schools' short periods, no collaboration, no team teaching” (Frykholm, 1995, p. 14) as well as rigid departmental policies, lack of support from their assigned cooperating teachers, and textbook limitations. Sowell and Zambo (1997) provided further evidence of the lack of alignment between the *Standards'* reform goals and teachers' actual practices. The authors found that the use of official guidelines, competency based examinations, and school textbooks were insufficient in providing enough knowledge and incentives for teachers to modify their instruction. In particular, the authors found that teachers who held more traditional conceptions of teaching based on information transmission were unlikely to realign to the goals of the *Standards* and therefore continued to teach traditionally. Watts (1991, cited in Schwartz & Riedesel, 1994), studied 36 teachers' beliefs about the *Standards*. The researcher found that only four of the participants held a perspective congruent with the principles of problem solving outlined in the *Standards*. According to Schwartz and
Riedesel (1994), the respondents' agreement that mathematics education should focus on problem solving evidently reflected their explicit beliefs. However, their underlying meaning of problem solving indicated their implicit beliefs. The difference between explicit and implicit beliefs resulted in apparent agreement with reformers about the need for problem solving, but in actual disagreement with reformers about what that meant (p. 10). As can be seen from these studies, observations would not be sufficient when trying to capture what teachers believe. Talking directly to teachers can provide significant information about their beliefs, and this study adds to this field by looking at the beliefs of teachers who profile as highly effective and those that profile as highly ineffective (according to their EVAAS teacher value added data).

Teaching matters, and while the first phase of this study sought to determine just how much teaching matters by looking at the compounding effects of effective versus ineffective teaching on math student achievement, this is only part of the picture. What do effective teachers do differently? How do instructional practices and beliefs differ among mathematics teachers who profile at various levels of teaching effectiveness? In order to acquire this information it was vital to capture the teachers’ own thoughts about their beliefs and practices, which is why I employed a qualitative approach utilizing one-on-one, semi-structured interviews. It is estimated that 90 percent of all social science investigations use interviews in one way or another (Briggs, 1986), and while it is a widely popular way of collecting information in the social sciences, it is particularly useful here because it was a conduit for teachers to describe detailed personal information about their own practices and beliefs (Creswell, 2008).

The interviews would hopefully stimulate the production of meanings behind what effective teachers do and why they do it (Holstein & Gubrium, 1997). Of course there are concerns with the validity of interviews. While triangulation and other methods can help
alleviate these issues, the reality is that it is difficult to ascertain if the interviewee’s responses are a good representative of his/her actual beliefs and practices or if he/she is dishonest with his/her answers. Any dishonesty may not be a conscious choice for the respondent could have imperfect recall about the topics in question. In hindsight, the teacher may also inadvertently reflect differently on a situation and respond in a manner that is now altered from what they actually felt at the time (Sociology Central, n.d.).

There are a variety of ways to think about and to study mathematics education (the nature of its subject matter, its purposes, content, and methods) (Stemhagen, 2011). Teachers’ views are a “system of beliefs” that often serves as a de facto philosophy of mathematics (Ernest, 1989, p. 20). It is important to note that teachers typically do not articulate a fully formed philosophy of mathematics (Thompson, 1992), for “teachers’ conceptions of the nature of mathematics by no means have to be consciously held views; rather they may be implicitly held philosophies” (Ernest, 1989, p. 20). It is well documented in the literature that these beliefs matter (Thom, 1973; Lerman, 1983; Thompson, 1985; Ernest, 1987; Pajares, 1992; Schoenfeld, 2001), but trying to study the exact nature of the relationship between teacher beliefs and practices can be quite difficult: “A growing body of literature shows that mathematics teachers’ beliefs affect their classroom practices although the nature of the relationship is highly complex and dialectical” (Handal & Herrington, 2003, p. 59). These self-reported measures can be intentionally or unintentionally unrepresentative of the teachers’ actual beliefs and practices. Talking to teachers is certainly a good place to start, but clearly there are limitations with capturing their beliefs and how those beliefs relate to their practices. What is captured in an interview may or may not best represent the teacher’s actual beliefs and practices. However, for most researchers, there is little doubt that if the authentic beliefs can be captured, they will reveal
a lot about a teacher’s practices for beliefs and practices go hand-in-hand (for research, see Stipek, Givvin, Salmon, and MacGyvers, 2001; for reviews, see Handal & Herrington, 2003; Clark & Peterson, 1986; Fang, 1996; Kagan, 1992; Thompson, 1992).

Collecting the Data. In addressing the first qualitative research question regarding the differences between highly effective/ineffective teachers’ instructional practices and beliefs, I utilized a widely distributed survey called the Teaching and Learning International Survey (TALIS) to inform my interview questions. According to the National Comprehensive Center for Teacher Quality (2010, para. 1), the Organization for Economic Cooperation and Development developed the TALIS survey to “assess the working conditions teachers experience; teacher practices, beliefs, and attitudes; and the professional development needs of teachers.” Specifically, I applied parts of the section titled “Teaching Practices, Beliefs and Attitudes” (International Association for the Evaluation of Educational Achievement (IEA), 2008) to inform my interview questions to address the differences between highly effective/ineffective teachers’ instructional practices and beliefs from my sample group of teachers (see Appendix B for interview questions).

As discussed above, there are currently two dichotomous views on what effective math teaching looks like:

Side #1: Traditional Beliefs

- Promote procedures, efficiency, speed
- Emphasize accuracy
- Students learn independently, with extrinsic motivation
- Teacher is in control of the learning
Side #2: Constructivist Beliefs

- Promote effort, creativity, mistakes
- Emphasize understanding
- Students learn through social interaction, exploration, and discovery, with internal motivation
- Student have some autonomy

Ultimately, both sides promote their methods as the best way to impact what students learn and how much they grow. To address the second qualitative research question regarding how highly effective/ineffective teachers’ instructional practices and beliefs relate to these current opposing views, I also employed additional interview questions that were informed by that research (see Appendix B for interview questions).

In order to conduct the interviews and collect the data needed to address these research questions, I proceeded through the following steps:

- Sought participants from highly effective/ineffective teaching groups (process outlined below, also see Appendix C for recruiting letter).
- Scheduled interviews with the participants.
- Obtained informed consent from each participant.
- Upon consent, conducted the interview (interview protocol in Appendix B).
- Summarized key data at the close of the interview to promote accuracy in data collection.

I used an interview protocol to guide the administration and implementation of the interviews in order to ensure consistency between interviews (Boyce & Neale, 2006) (see Appendix B).
I conducted all of the interviews myself, and employed the following behaviors during the interview process (Guion, Diehl, & McDonald, 2011):

- **Open-minded and patient.** I tried to avoid judgment or criticism, maintained a sense of openness, and encouraged the participant to speak freely at his/her own pace.

- **Flexible and responsive.** In the anticipation of unpredictability, I had to think on my feet, respond to challenges, and strived to protect the core purpose of the interview.

- **Observant.** I observed subtle cues such as facial expressions, body language, and voice tone.

- **A good listener.** I listened actively by focusing wholly on what was being said, paraphrased to confirm to the participant that the message was received as intended, while maintaining the emotions inherent in the message.

By utilizing these techniques, I hoped to promote a quality interview experience that was as enriching to my study as it was rewarding to each participant. During each interview, I utilized an audio recorder to capture the participant’s responses, I took notes during the interview process, and I also took notes immediately following the interview in order to capture additional observations while they were fresh on my mind.

**Research Participants and Purposeful Sampling**

**Teacher Participants.** Criteria for eligibility for teacher participation in the qualitative phase of this study included (a) the teacher must teach as least one of the three tested grades being investigated, (b) the teacher must have an EVAAS 2-year-combined teacher effect score that can be calculated from 2 of the 3 years under investigation where the teacher did not teach this cohort of students, and (c) the teacher must still be employed by a school district in the 2011–12 school year. Of the teachers who meet these criteria and are used in Phase I, I chose a
small representative sample for Phase II, the qualitative portion of the study. I used purposeful sampling in order to choose participants who can best represent the varying levels of effective teaching and therefore might provide useful information about the practices and beliefs of teachers who profile at these varying levels (Creswell, 2008). I did not use any other form of sampling, including convenience sampling. Researchers often employ such methods in order to scale down the geographic scope of covering an entire state and ensuring the study can be conducted in a timely manner. However, I felt it was vital to cast a wide net and so I chose not to impose a geographic restriction on the participant selection process. The final participants were from all over the State of North Carolina. Purposeful sampling occurred in two iterations in order to identify the final sample of teacher participants contacted for the study.

1st Iteration of Purposeful Sampling. In the first iteration of sampling, I divided teachers into varying levels of effectiveness as discussed above, including Below (below average in effectiveness, or *highly ineffective*), Not Detectibly Different (*average in effectiveness*), and Above (above average in effectiveness, or *highly effective*) based on their individual 2-year-combined EVAAS teacher value added measures. In order to address Research Question 2: How do instructional practices and beliefs differ among mathematics teachers who profile at various levels of teaching effectiveness?, only those who profiled at the highest level of effectiveness (Above) and the lowest level of effectiveness (Below) were further considered for participation. This is an example of extreme case sampling and was utilized in order to learn more about these levels of effectiveness that are particularly enlightening or troublesome, and how they differ from each other (Creswell, 2008).

2nd Iteration of Purposeful Sampling. In the second iteration of sampling, I further whittled down the two extreme case potential pools of participants through homogeneous
sampling from within these two divergent levels of teaching effectiveness. Of all teachers who profile at the highest level of EVAAS teaching effectiveness, I identified a small randomly selected subset to represent teachers at this level. Similarly, of all teachers who profile at the lowest level of EVAAS teaching effectiveness, I identified a small randomly selected subset to represent teachers at this level. The EVAAS teaching effect score served as the sole reason for why a teacher is eligible for selection from either group, and served as their homogeneous trait (Creswell, 2008).

**Final Selections.** After the second iteration, there were 100 total teachers identified, with 50 profiling at each of the two extreme effectiveness levels. I contacted all 100 teachers for voluntary participation in the study with the hopes of obtaining 5 volunteers from each level. Of the preliminary participants who volunteered, I chose ten for the study based on the primary criteria of needing 5 who profiled as highly effective based on their EVAAS value added measures, and 5 who profiled as highly ineffective, as well as forming high/low pairs that came from similar geographic regions (urban versus rural). From the pool of volunteers, many more were from rural regions than urban regions. Furthermore, the participant pairs were matched based on two additional criteria as much as possible: the percentage of minority students served in their schools, and the percentage of students eligible for receiving free or reduced-price lunch.

**Blind Participation.** It is important to note that neither the participant nor I, the researcher, knew which level each participant profiled at. Each participant never knew, through the course of this study or after its conclusion, his/her teacher effectiveness level or its relation to this study. At the time of this study, that information was accessible to every teacher who has an EVAAS teacher value added measure in the state of North Carolina through his/her own school district as it pertains to local school board authority and those authorities were not overridden by
participation in this study. Participants did not know that their inclusion in this study had anything to do with their EVAAS teacher value added measure. I communicated to them that their inclusion was based on a random sampling of teachers who teach middle school mathematics in North Carolina. Furthermore, I informed the participants that the goal in my research was to examine the underlying differences in practices and beliefs of mathematics teachers.

Likewise, I, as the researcher, did not know which level each participant profiled at until the interviews had concluded, the data collection was complete, and the interviews were coded and extensively analyzed. All sampling iterations mentioned above and subsequent procedures for obtaining the 5 participant minimums were conducted with the assistance of an external person such that I remained unaware of any individual participant’s effectiveness level until the first round of analysis was already conducted and I wrote my initial findings below. Only at that time were individual participant effectiveness levels finally revealed to me in order to aid in my second round of analysis. All contact with participants, including interviews, were conducted similarly and without knowledge of effectiveness levels in order to promote a less biased data collection process.

Data Analysis Procedures

Why I am qualified to conduct the analysis. As the only researcher conducting, analyzing, and reporting on these interviews, I am both the instrument of data collection and the analyst for the qualitative portion. Therefore, it is important to note who I am and what skills I bring to the table. My background is both experiential and theoretical, as I have been a classroom teacher and have studied teacher education. I taught middle and high school mathematics for six years, covering pre-Algebra up through Advanced Placement Calculus for students ranging from 7th
grade through 12th grade. I served as the mathematics department chair for two years. I taught in four different schools, where the settings ranged from urban and rural and the communities ranged from low socio-economic status to medium social-economic status. Academically, the students I taught ranged from very low to very high. As a graduate student in a mathematics teacher education program, I have been studying its intricacies for eight years. During this time, I also taught graduate-level courses at the university, helping fellow teachers work toward a master of arts in education. I drew upon all of this experience as I conducted the interviews, and then transcribed, coded, analyzed and reported on them. It is also important to note that I have been employed at SAS in the EVAAS department for the past eight years, where I serve as a technical trainer, helping educators and administrators understand and use their EVAAS reports.

*How the analysis was conducted.* Once all 10 highly effective/ineffective teachers had been interviewed, I transcribed all interviews from their audio recordings and combined them with my notes from each interview. As discussed above, the identity of each teacher as an EVAAS highly effective/ineffective teacher was still not merged with their interview data at this time. I reviewed the data from each case study and began to look for patterns or themes to emerge from the participants’ responses by coding each interview line by line. Specifically, I looked for concepts the participants had in common and those not in common with each other. I also applied the lens of current research and views about effective teaching regarding traditional and constructivist methods to see which side of the math war each participant was on. Specifically, Tables 1-4 from the literature review section above contain research-based characteristics of teaching that have been strongly correlated to these differing belief structures, where some beliefs (i.e. inquiry-oriented) that have been touted as more desirable than others
(i.e. traditional) (NCTM, 2000) were considered for part of the analysis when working through the teachers’ responses.

I initially developed a set of codes to look for these opposing characteristics, and, as I coded each interview line by line, new codes emerged from the data that were not present in my pre-determined set of codes (see Appendix D for the full list of codes used). In fact, as I worked through all 10 interviews, my list of codes continued to grow with emerging codes from the data itself. I then went back through all 10 interviews a second time to (1) recheck previous interviews for codes that I had noticed in later interviews, and (2) to search once again for more codes in the data. I completed these two rounds of coding by hand, marking each printed interview with lots of ink, underlining, and scribbles. I then wanted to capture these codes digitally, so I cut and pasted each coded section of a participant’s response into a list of the codes, such that all four times the participant talked about the role of parents, for example, those sections of text were now grouped under that code in a word document, as follows:

Code #T1

- 1st time the participant response matches this code
- 2nd time the participant response matches this code
- 3rd time the participant response matches this code
- 4th time the participant response matches this code

I created 10 bulleted lists of codes, one for each participant, such that all of their data was now reorganized by code. My initial reasons for reorganizing all of the coded data for each interview into these coded lists were to gather all the similarly coded text together in order to aid in the eventual analysis of this information. However, I quickly discovered that by going through this process, my first two rounds of coding were going to get altered, as there were many times when
(1) I would disagree with my initial coding and drop or change that initial code, or (2) I would discover many places where I missed a coding opportunity entirely. This ‘digital grouping’ of the codes unintentionally turned into a thorough round of coding or uncoding, for a third time.

One of the reasons why I think there was so much cleaning-up of the codes during this round was because it took me two months to do the first round of coding all 10 interviews, and one week to do the second round of coding all 10 interviews. The prolonged duration of that first round involved a lot of stops and starts within an interview and between interviews, which I now believe was the reason for some initial inconsistencies in what and how I coded certain things. However, the relatively quick turnaround of the second round was, in hindsight, quite light; I skimmed many sections simply looking for the ‘new’ codes that had emerged from other interviews and did not focus on diligently checking my first codes for consistency or accuracy. Subsequently, when I thought I was finished coding and began to digitally organize the codes, I quickly discovered that there was still a good amount of cleaning up to do due to these inconsistencies that had gone unnoticed. Thus, the task of digitally organizing the codes turned into a much more thorough third round of coding, which was completely unplanned but turned out to be much needed. In the end, I feel the data analysis process ended up with much cleaner and more consistent coding than I would have gotten if I simply stopped after that second round.

I utilized these digitally organized lists greatly in writing up the initial information for each participant. After writing up these initial findings about each teacher, I then made initial inferences about which category each participant fell into: a highly effective teacher or highly ineffective teacher as indicated by his/her EVAAS teacher value added measure. Once the group was initially divided and their write-up was complete, their effectiveness rankings were finally revealed to me, and were merged with their interview data in order to assess if my initial
categorizations based on characteristics of the opposing math wars match their opposing EVAAS teacher value added measures as well. Research conducted by Konting (1998) revealed a substantial mismatch between the principles of good practice prescribed by an innovative mathematics curriculum in Malaysia and the actual teaching practices of teachers who were previously identified as effective practitioners.

A disconnect between EVAAS value added measures and characteristics of “good teaching” (i.e. constructivist, inquiry-based instruction) or “not-so-good teaching” (i.e. traditional, teacher-led instruction) as defined by current popular math reforms widely promoted by NCTM and others would be quite interesting, if this trend was found in the data. Many of the math education reforms from the second half of the 20th century called for massive changes that were poorly defined in operational terms and had no known connection to positive gains in student learning (Hall & Loucks, 1978). While still blind in my analysis, I pondered how fascinating it would be to see if my study tied the current reform initiative of inquiry-based instruction directly to gains in student learning or not, which is precisely what the EVAAS teacher value added measures are measuring.

Once my initial analysis and write-up was complete and I then merged the EVAAS teacher value added measures with the interview data, I also sifted back through each teacher’s coded lists, original transcripts, and notes to see if there were discrepancies between their actual EVAAS categorizations and the consistency of their responses. In other words, I checked to see if their responses were consistently profiling with that side of the math war, or if there were inconsistencies within any given teacher. This negative case checking (internal to the teacher) helps to indicate the strength of the relationships between the characteristics themselves of effective/ineffective teaching. These math wars inconsistencies within the same teacher may
indicate that the teacher resides somewhere within a continuum along the math wars spectrum—rather than a more dichotomous identification process—where a teacher may exhibit characteristics of both sides and in fact reside somewhere in between these two divergent views.

The rationale for using semi-structured interviews with a small set of purposefully sampled highly effective/ineffective teachers and analyzing the data to look for certain themes and characteristics is that this approach allowed me to explore who these teachers are and what they have in common with two key pieces of information: (1) their EVAAS teacher value added measures, and (2) currently opposing views about highly effective teaching. These select case studies shed valuable light on these issues and further aid in the advancement of effective teaching information.

Methods of Validation

The reliability and validity of self-reported measures such as interviews are not fully established and depend on the instrument used (National Comprehensive Center for Teacher Quality, 2010). While some of the interview questions were directly informed by the previously developed TALIS survey which has been utilized with over 70,000 educators and has been found to be highly valid and reliable (OECD, 2009), removing a small group of questions from the survey and altering them to fit my interview voids these claims. Furthermore, I developed additional interview questions to study the results of currently opposing views on effective teaching. Therefore my interview protocol needed to go through its own processes to support its validity and reliability.

To begin to build this support, I piloted my initial interview questions with a group of mathematics teachers with no knowledge of or connection to this study. Their responses elicited certain modifications to the original questions, and I have since adjusted the questions
accordingly. Furthermore, I employed instant member checking (Lincoln & Guba, 1985) throughout each interview by reiterating what I was hearing with what the teacher was saying. By interviewing highly ineffective teachers as well as highly effective teachers, this provides an opportunity for negative case analysis (Lincoln & Guba, 1985) against the current research on effective teaching. During the analysis, I also searched for negative cases that were internal to each participant by looking for data that conflict with their own EVAAS teacher value added measures and current research on effective teaching. Furthermore, two of the professors overseeing this study, Dr. Catherine Scott and Dr. Jocelyn Glazier, independently coded an interview in its entirety and each of their results were compared to my own in order to establish inter-rater reliability of the qualitative analysis and the coding process. In order to promote full disclosure by the participants, throughout the entire study, all participants’ identities were protected at all times and their anonymity was maintained in the study’s write-up and beyond. It is important to note that the qualitative portion of this study incorporated purposeful random sampling but is still quite small, and therefore I am not claiming external validity or generalizability of the results to the larger population.

**Research Questions and Anticipated Results**

The purpose of this study was to answer the following research questions:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

1a. **Short-term effects**: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

1b. **Long-term effects**: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?
Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. *Compared to research:* How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. *Compared to each other:* How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

Based on the results of current research, I anticipated that teacher effectiveness sequence would have a significant effect on student achievement, but the degree to which was yet to be determined until this study was conducted. It was also yet to be determined if that effect differs for students at varying achievement levels, or how it affects students’ high school math achievement. I also anticipated that current research-based constructivist characteristics of effective teachers would hold true under this new definition of teaching effectiveness, but the degree to which was yet to be determined until this study was conducted.

*Implications of this study.* North Carolina’s recent policy decision (2009) to increase high school diploma requirements in order to raise student achievement does not address the effects teachers may have on student achievement outcomes. If it can be shown that (1) teacher effectiveness significantly influences varying levels of student achievement, then (2) ensuring equitable access to effective teachers and working to improve the effectiveness of teachers should become a human rights issue in regard to this statewide policy. This information will greatly add to the budding body of knowledge already supporting the influences, practices, and beliefs of effective teachers. It will certainly inform current educational policy in North Carolina and beyond, and it will further support practitioners as they continuously strive to improve their craft of teaching.
CHAPTER 4

RESULTS FROM PHASE I: QUANTITATIVE

I report findings from the quantitative analyses and the interviews separately: I report the quantitative results here in Chapter 4, and I report the qualitative results in Chapter 5. In Phase I (the quantitative portion of the study) I attempted to answer the following questions:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

1a. Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

1b. Long-term effects: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

I address the results from these questions below. Both chapters 4 and 5 include demographic information: the quantitative section (Phase I) includes the demographic information on the schools used in the statistical analyses and the qualitative section (Phase II) includes demographic information about both the schools and the teachers included in the interviews.

Descriptive Statistics

I had to make a choice about which version of two years of effectiveness to use: (1) each individual year had to be high/low consistently, or (2) simply a 2-year average as high/low. For option 1, with both years needing to be high/low, there were a total of 330 students who spent three years with highly effective (high) teachers, and 96 who spent three years with highly
ineffective (low) teachers. For option 2, in which only the teacher’s 2-year average needed to be high/low, there were a total of 1286 students who served three years with highly effective (high) teachers, and 677 who served three years with highly ineffective (low) teachers. Ultimately, there seemed to be enough students with the first option, which held the pool of teachers to the highest possible standard based on the available data, and therefore that was the final choice. Of the students used in this study (from option 1 discussed above), the NCEs of the two groups (students with HHH teachers and students with LLL teachers) is roughly average, or around 50.

**Results for Question 1a**

For the first question of this study, I looked for the measurable effects of student-teacher assignment on student achievement when it is compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers as indicated by their EVAAS value added measures. This question has three parts: (1) how did the students fare, overall, based on these three-year compounding effects, (2) how did students fare, by achievement group, based on these three-year compounding effects, and (3) is the effect different for different achievement groups? Formally, the research question was as follows:

1a. *Short-term effects*: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

As with all portions of Phase I, the analyses were conducted using SAS statistical software under the direction of the EVAAS analytic team. The results of our analyses are reported here.
Profile of the Entire Cohort of Students Used

Of the 18,705 students with sufficient testing data that were tracked from 3rd grade through 8th grade, a total of 426 students met all of the criteria for inclusion in this study (outlined in Chapter 3 above). I will refer to these 426 students as the cohort of students used in this study. The students’ prior test data in third grade through fifth grade math EOG exams were used in the EVAAS model to determine each student’s predicted 6th grade EOG score (reported here in NCEs). This serves as an indicator of their 6th grade entering achievement level – where they were academically prior to experiencing the three-year compounding effects of effective/ineffective teachers as indicated by their EVAAS value added measures. Then, each student’s actual 8th grade EOG score (reported here in NCEs) is used as an indicator of where these students were academically after experiencing the three-year compounding effects.

Table 11: The Entire Cohort’s Entering and Exiting Academic Achievement

<table>
<thead>
<tr>
<th>Student Achievement</th>
<th>Number of Students</th>
<th>Mean (NCEs)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th Grade Entering Achievement</td>
<td>426</td>
<td>60.8</td>
<td>18.5</td>
</tr>
<tr>
<td>8th Grade Exiting Achievement</td>
<td>426</td>
<td>62.6</td>
<td>19.5</td>
</tr>
<tr>
<td>Difference</td>
<td>426</td>
<td>1.8</td>
<td>13.6</td>
</tr>
</tbody>
</table>

This cohort of students started 6th grade at the 60.8 NCE relative to their peers across the state, and finished 8th grade at the 62.6 NCE, with a difference of +1.8 NCEs.

Part (1): Overall Effects of Being Assigned to 3 High/Low Teachers

These 426 students were tracked through the data to see how they fared based on experiencing three years in a row with middle school math teachers who all profiled as highly
effective (shown below as High-High-High or HHH) or highly ineffective (shown below as Low-Low-Low or LLL) based on their EVAAS value added measures.

**Table 12: Students’ Entering and Exiting Academic Achievement based on Teacher Effectiveness Sequences**

<table>
<thead>
<tr>
<th>Teacher Effectiveness Sequence</th>
<th>Student Achievement</th>
<th>Number of Students</th>
<th>Mean (NCEs)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLL</td>
<td>6th Grade Entering Achievement</td>
<td>96</td>
<td>56.4</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>8th Grade Exiting Achievement</td>
<td>96</td>
<td>45.9</td>
<td>18.9</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>96</td>
<td>-10.5</td>
<td>12.0</td>
</tr>
<tr>
<td>HHH</td>
<td>6th Grade Entering Achievement</td>
<td>330</td>
<td>62.1</td>
<td>18.1</td>
</tr>
<tr>
<td></td>
<td>8th Grade Exiting Achievement</td>
<td>330</td>
<td>67.5</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>330</td>
<td>5.4</td>
<td>11.8</td>
</tr>
</tbody>
</table>

Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with middle school math teachers who all profiled as highly ineffective as indicated by their EVAAS value added measures and 330 students spent three years in a row with middle school math teachers who profiled as highly effective as indicated by their EVAAS value added measures. It is interesting to note that the second group of students is over three times larger than the first group of students; further investigation would be needed to figure out why this was the case. Regardless of the students’ achievement levels, those with LLL teachers lost 10.5 NCE points, on average, and students with HHH teachers gained 5.4 NCE points, on average. This results in a difference of 15.9 NCE points between these two groups of students after spending three years with their respective teachers (see Figure 3 below).
**Figure 3: Student Achievement and Teacher Effectiveness Sequences**

**Statistical significance.** The differences between these two groups of students (LLL versus HHH) reported above are highly statistically significant based on a two-sample t-test.

**Table 13: Statistical Significance of Students’ Entering and Exiting Academic Achievement based on Teacher Effectiveness Sequences**

<table>
<thead>
<tr>
<th>Teacher Effectiveness Sequence</th>
<th>Number of Students</th>
<th>Mean (NCEs)</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>95% CL Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLL</td>
<td>96</td>
<td>-10.51</td>
<td>11.97</td>
<td>1.22</td>
<td>-12.94</td>
</tr>
<tr>
<td>HHH</td>
<td>330</td>
<td>5.39</td>
<td>11.79</td>
<td>0.65</td>
<td>4.11</td>
</tr>
</tbody>
</table>
Of all the students across the entire state of North Carolina who had enough data to be included in the study, 96 were assigned to teachers who profiled as highly ineffective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These students’ mean change in achievement was -10.51 (measured in NCEs), with a standard deviation of 11.97 and a standard error of 1.22. In contrast, 330 students had been assigned to teachers who profiled as highly effective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These students’ mean achievement was 5.39 (measured in NCEs), with a standard deviation of 11.79 and a standard error of 0.65. The difference between these two groups of students was -15.90.

While these results were found to be statistically significant, it is also important to note the effect size. The effect size of these results (15.90 / 21.07) is 0.8, which is considered a large effect size (Cohen, 1988).

Part (2): Effects by Achievement Level

These 426 students were then split into three different groups based on their entering student achievement level (defined as their EVAAS projection to 6th grade math). Of the 96 students who spent three years in a row with ineffective teachers, 19 were low achieving students (20 percent), 31 were average achieving students (32 percent), and 46 were high achieving students (48 percent), based on profiling in the bottom third, middle third, or top third of the cohort achievement. Of the 330 students who spent three years in a row with effective teachers, 44 were low achieving students (13 percent), 78 were average achieving students (24 percent), and 208 were high achieving students (63 percent). Each group’s entering and exiting achievement levels are listed in Table 14 below.
Table 14: Students’ Entering and Exiting Academic Achievement based on Teacher Effectiveness Sequences, by Student Achievement Level

<table>
<thead>
<tr>
<th>Student Achievement Level</th>
<th>Teacher Effectiveness Sequence</th>
<th>Number of Students</th>
<th>Student Achievement Mean (NCEs)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Achieving Students</td>
<td>LLL</td>
<td>19</td>
<td>6\textsuperscript{th} Grade Entering Ach 28.05</td>
<td>11.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8\textsuperscript{th} Grade Exiting Ach 23.48</td>
<td>14.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference -4.58</td>
<td>9.64</td>
</tr>
<tr>
<td></td>
<td>HHH</td>
<td>44</td>
<td>6\textsuperscript{th} Grade Entering Ach 28.33</td>
<td>9.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8\textsuperscript{th} Grade Exiting Ach 41.94</td>
<td>13.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference 13.61</td>
<td>13.36</td>
</tr>
<tr>
<td>Average Achieving Students</td>
<td>LLL</td>
<td>31</td>
<td>6\textsuperscript{th} Grade Entering Ach 50.75</td>
<td>4.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8\textsuperscript{th} Grade Exiting Ach 43.09</td>
<td>14.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference -7.67</td>
<td>13.42</td>
</tr>
<tr>
<td></td>
<td>HHH</td>
<td>78</td>
<td>6\textsuperscript{th} Grade Entering Ach 51.86</td>
<td>4.93</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8\textsuperscript{th} Grade Exiting Ach 59.78</td>
<td>10.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference 7.92</td>
<td>10.99</td>
</tr>
<tr>
<td>High Achieving Students</td>
<td>LLL</td>
<td>46</td>
<td>6\textsuperscript{th} Grade Entering Ach 71.92</td>
<td>10.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8\textsuperscript{th} Grade Exiting Ach 57.04</td>
<td>13.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference -14.88</td>
<td>10.26</td>
</tr>
<tr>
<td></td>
<td>HHH</td>
<td>208</td>
<td>6\textsuperscript{th} Grade Entering Ach 73.06</td>
<td>9.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8\textsuperscript{th} Grade Exiting Ach 75.76</td>
<td>11.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference 2.70</td>
<td>10.72</td>
</tr>
</tbody>
</table>
For those students who started 6\textsuperscript{th} grade as \textit{low} achieving (6\textsuperscript{th} grade entering achievement was around the 28\textsuperscript{th} NCE), the 19 students who spent the next three years with \textit{highly ineffective} teachers based on the teachers’ EVAAS value added measures dropped over 4.5 NCEs by the time they finished 8\textsuperscript{th} grade. Their counterparts, the 44 students who spent three years in a row with \textit{highly effective} teachers based on the teachers’ EVAAS value added measures gained over 13.6 NCEs by the time they finished 8\textsuperscript{th} grade. For those students who started 6\textsuperscript{th} grade as \textit{average} achieving (6\textsuperscript{th} grade entering achievement was around the 51\textsuperscript{st} NCE), the 31 students who spent the next three years with \textit{highly ineffective} teachers based on the teachers’ EVAAS value added measures dropped over 7.6 NCEs by the time they finished 8\textsuperscript{th} grade. Their counterparts, the 78 students who spent three years in a row with \textit{highly effective} teachers based on the teachers’ EVAAS value added measures gained over 7.9 NCEs by the time they finished 8\textsuperscript{th} grade. And for those students who started 6\textsuperscript{th} grade as \textit{high} achieving (6\textsuperscript{th} grade entering achievement was around the 72\textsuperscript{nd} or 73\textsuperscript{rd} NCE), the 46 students who spent the next three years with \textit{highly ineffective} teachers based on the teachers’ EVAAS value added measures dropped over 14.8 NCEs by the time they finished 8\textsuperscript{th} grade. Their counterparts, the 208 students who spent three years in a row with \textit{highly effective} teachers based on the teachers’ EVAAS value added measures gained about 2.7 NCEs by the time they finished 8\textsuperscript{th} grade. These results displayed in Table 14 above and discussed here are also displayed in the graph below.
**Figure 4: Student Achievement and Teacher Effectiveness Sequences by Achievement Level**

![Graph showing student achievement by teacher effectiveness and achievement level.](image)

**Statistical significance.** The differences for each of the six groups of students (low w/ LLL, low w/ HHH, average w/ LLL, average w/ HHH, high w/ LLL, high w/ HHH) are highly statistically significant based on two-sample t-tests (see Table 15 below), when comparing where the students in each group started to where they finished at the end of these three years.
Table 15: Statistical Significance of Students’ Entering and Exiting Academic Achievement based on Teacher Effectiveness Sequences, by Student Achievement Level:

<table>
<thead>
<tr>
<th>Student Ach Level</th>
<th>Teacher Effectiveness Sequence</th>
<th># of Students</th>
<th>Mean (NCEs)</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>95% CL Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Achieving Students</td>
<td>LLL</td>
<td>19</td>
<td>-4.58</td>
<td>9.64</td>
<td>2.21</td>
<td>-9.22</td>
</tr>
<tr>
<td></td>
<td>HHH</td>
<td>44</td>
<td>13.61</td>
<td>13.36</td>
<td>2.01</td>
<td>9.55</td>
</tr>
<tr>
<td></td>
<td>Difference (Pooled)</td>
<td></td>
<td>-18.18</td>
<td>12.38</td>
<td>3.40</td>
<td>-24.98</td>
</tr>
<tr>
<td>Method</td>
<td>Variances</td>
<td>DF</td>
<td>t value</td>
<td>Pr &gt;</td>
<td>t</td>
<td></td>
</tr>
<tr>
<td>Pooled</td>
<td>Equal</td>
<td>61</td>
<td>-5.35</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Ach Level</th>
<th>Teacher Effectiveness Sequence</th>
<th># of Students</th>
<th>Mean (NCEs)</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>95% CL Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Achieving Students</td>
<td>LLL</td>
<td>31</td>
<td>-7.67</td>
<td>13.42</td>
<td>2.41</td>
<td>-12.59</td>
</tr>
<tr>
<td></td>
<td>HHH</td>
<td>78</td>
<td>7.92</td>
<td>11.00</td>
<td>1.24</td>
<td>5.44</td>
</tr>
<tr>
<td></td>
<td>Difference (Pooled)</td>
<td></td>
<td>-15.59</td>
<td>11.73</td>
<td>2.49</td>
<td>-20.52</td>
</tr>
<tr>
<td>Method</td>
<td>Variances</td>
<td>DF</td>
<td>t value</td>
<td>Pr &gt;</td>
<td>t</td>
<td></td>
</tr>
<tr>
<td>Pooled</td>
<td>Equal</td>
<td>107</td>
<td>-6.26</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Ach Level</th>
<th>Teacher Effectiveness Sequence</th>
<th># of Students</th>
<th>Mean (NCEs)</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>95% CL Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Achieving Students</td>
<td>LLL</td>
<td>46</td>
<td>-14.88</td>
<td>10.26</td>
<td>1.51</td>
<td>-17.93</td>
</tr>
<tr>
<td></td>
<td>HHH</td>
<td>208</td>
<td>2.70</td>
<td>10.72</td>
<td>0.74</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>Difference (Pooled)</td>
<td></td>
<td>-17.58</td>
<td>10.64</td>
<td>1.73</td>
<td>-20.99</td>
</tr>
<tr>
<td>Method</td>
<td>Variances</td>
<td>DF</td>
<td>t value</td>
<td>Pr &gt;</td>
<td>t</td>
<td></td>
</tr>
<tr>
<td>Pooled</td>
<td>Equal</td>
<td>252</td>
<td>-10.14</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Of all the students across the entire state of North Carolina who had enough data to be included in the study, 96 were assigned to teachers who profiled as *highly ineffective* based on
their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These
96 students were then split into three groups: low, average, and high achieving, based on how
they profiled within the bottom, middle, or top third of the cohort population distribution. This
resulted in 19 low, 31 average, and 46 high achieving students assigned to highly ineffective
teachers for three years in row. For the 19 low achieving students (with LLL teachers), their
mean was -4.58 (measured in NCEs), with a standard deviation of 9.64 and a standard error of
2.21. For the 31 average achieving students (with LLL teachers), their mean was -7.67 (measured
in NCEs), with a standard deviation of 13.42 and a standard error of 2.41. For the 46 high
achieving students (with LLL teachers), their mean was -14.88 (measured in NCEs), with a
standard deviation of 10.26 and a standard error of 1.51.

In contrast, 330 students had been assigned to teachers who profiled as highly effective
based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th
grade. These 330 students were then split into three groups: low, average, and high achieving,
based on how they profiled within the bottom, middle, or top third of the cohort population
distribution. This resulted in 44 low, 78 average, and 208 high achieving students assigned to
highly effective teachers for three years in row. For the 44 low achieving students (with HHH
teachers), their mean was 13.61 (measured in NCEs), with a standard deviation of 13.36 and a
standard error of 2.01. For the 78 average achieving students (with HHH teachers), their mean
was 7.92 (measured in NCEs), with a standard deviation of 11.00 and a standard error of 1.24.
For the 208 high achieving students (with HHH teachers), their mean was 2.70 (measured in
NCEs), with a standard deviation of 10.72 and a standard error of 0.74.

While these results were found to be statistically significant, it is also important to note
the effect sizes. The effect sizes of these results were as follows: for low achieving students, the
effect size (18.18 / 21.07) is 0.9; for average achieving students, the effect size (15.59 / 21.07) is 0.7; and for high achieving students, the effect size (17.58 / 21.07) is 0.8. These effect sizes are large for low and high achieving students, and the effect size for average achieving students is medium (Cohen, 1988).

**Part (3): Differences in Effects by Achievement Level**

For the final part of this question, I looked at whether the *gaps* for each student achievement level *differed from each other*. A two-way ANOVA test was utilized to test the significances of the differences in these three gaps, where the three gaps are defined as:

1. Gap 1: Low achieving students with HHH teachers versus LLL teachers (resulted in a difference of 18.18 NCEs).
2. Gap 2: Average achieving students with HHH teachers versus LLL teachers (resulted in a difference of 15.59 NCEs).
3. Gap 3: High achieving students with HHH teachers versus LLL teachers (resulted in a difference of 17.58 NCEs).

Thus, the two factors compared through an ANOVA were:

1. Factor 1: Student Achievement Group (low, average, high).
2. Factor 2: 3-Year Teacher Assignment (LLL, HHH).

Based on this two-way ANOVA test for significance, there was no statistically significant difference in how each of the three student achievement levels (low, average, high) were affected, when compared to each other, for the interaction term had a *p* value of 0.74 and thus was not significant. However, it is interesting to note that the largest increase was when low achieving students were tracked to HHH teachers, and the largest decrease was then high achievement students were tracked to LLL teachers. This will be further discussed in Chapter 7.
Question 1a: Summary of Findings

For the first question of this study, I looked for the measurable effects of student-teacher assignment on student achievement when it is compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers as indicated by their EVAAS value added measures. This question had three parts: (1) how did the students fare, overall, based on these three-year compounding effects, (2) how did students fare, by achievement group, based on these three-year compounding effects, and (3) is the effect different for different achievement groups? Formally, the research question was as follows:

1a. Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

As with all portions of Phase I, the analyses was conducted using SAS statistical software under the direction of the EVAAS analytic team. The results of their analyses were reported in the sections above and are summarized here.

Part (1): How did the students fare, overall, based on these three-year compounding effects? Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with middle school math teachers who profiled as highly ineffective as indicated by their EVAAS value added measures and 330 students spent three years in a row with middle school math teachers who profiled as highly effective as indicated by their EVAAS value added measures. Regardless of the students’ achievement levels, those with LLL teachers lost 10.5 NCE points, on average, and students with HHH teachers gained 5.4 NCE points, on average. This resulted in a difference of 15.9 NCE points between these two groups of students after spending three years with their respective teachers.
Part (2): How did students fare, by achievement group, based on these three-year compounding effects? For those students who started 6th grade as low achieving (6th grade entering achievement was around the 28th NCE), the 19 students who spent the next three years with highly ineffective teachers based on the teachers’ EVAAS value added measures dropped over 4.5 NCEs by the time they finished 8th grade. Their counterparts, the 44 students who spent three years in a row with highly effective teachers based on the teachers’ EVAAS value added measures gained over 13.6 NCEs by the time they finished 8th grade. For those students who started 6th grade as average achieving (6th grade entering achievement was around the 51st NCE), the 31 students who spent the next three years with highly ineffective teachers based on the teachers’ EVAAS value added measures dropped over 7.6 NCEs by the time they finished 8th grade. Their counterparts, the 78 students who spent three years in a row with highly effective teachers based on the teachers’ EVAAS value added measures gained over 7.9 NCEs by the time they finished 8th grade. For those students who started 6th grade as high achieving (6th grade entering achievement was around the 72nd or 73rd NCE), the 46 students who spent the next three years with highly ineffective teachers based on the teachers’ EVAAS value added measures dropped over 14.8 NCEs by the time they finished 8th grade. Their counterparts, the 208 students who spent three years in a row with highly effective teachers based on the teachers’ EVAAS value added measures gained about 2.7 NCEs by the time they finished 8th grade.

Part (3): Is the effect different for different achievement groups? No, the gaps between the students in HHH versus LLL for each achievement group do not differ from one group to another.

As noted above, both of the first two results for Question 1a (parts 1 and 2) were highly statistically significant. Whether looking at the overall impact on students, or the impact on
students at varying levels of achievement, clearly it made a difference if the students spent three years in a row with highly effective teachers or three years in a row with highly ineffective teachers as measured by their EVAAS value added measures. The implications of these results are further discussed in Chapter 7.

**Results for Question 1b**

For the second question of this study, I looked for the measurable effects of student-teacher assignment on student achievement beyond 8th grade math when it is compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers as indicated by their EVAAS value added measures. This question has two parts: (1) how did this experience affect the students’ projected Algebra I scores, and (2) how did this experience affect the students’ projected SAT Math scores? Formally, the research question was as follows:

1b. *Long-term effects*: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

As with all portions of Phase I, the analyses was conducted using SAS statistical software under the direction of the EVAAS analytic team. The results of their analyses are reported here.

**Part (1): Effect on Algebra I**

In this section, I looked for any possible impact that these three sequential years of teaching effectiveness had on the students’ Algebra I results. This was studied in two ways: after experiencing three years in a row of effective/ineffective teaching, what were these students’ EVAAS projections to Algebra I, and how many students took Algebra I in middle school? The results across the entire cohort of students are reported in Table 16 below.
Table 16: Students’ Algebra I Impact based on Teacher Effectiveness Sequences

<table>
<thead>
<tr>
<th>Teacher Effectiveness Sequence</th>
<th>Projected Algebra I NCE Score</th>
<th>Percent who took Algebra I in Middle School (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
</tr>
<tr>
<td>Entire Cohort (across all student achievement levels)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLL (96)</td>
<td>49.76</td>
<td>19.66</td>
</tr>
<tr>
<td>HHH (330)</td>
<td>67.19</td>
<td>16.95</td>
</tr>
<tr>
<td>Difference</td>
<td>17.43</td>
<td></td>
</tr>
</tbody>
</table>

Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with middle school math teachers who all profiled as highly ineffective as indicated by their EVAAS value added measures and 330 students spent three years in a row with middle school math teachers who profiled as highly effective as indicated by their EVAAS value added measures. Regardless of the students’ achievement levels, those who had LLL teachers had a projected Algebra I NCE score of just under 50, on average, and students who had HHH teachers had a projected Algebra I NCE score of just over 67, on average. There is a difference of 17.43 NCE points between these two groups of students after spending three years with their respective teachers. Furthermore, of the 96 students who spent three years in a row with highly ineffective teachers, 66 of these students (or 69 percent) actually took Algebra I in middle school (as evident by the existence of an EOC Algebra I assessment score). For their counterparts, of the 330 students who spent three years in a row with highly effective teachers, 151 of these students (or 46 percent) actually took Algebra I in middle school. This result is surprising, and I will discuss this further in Chapter 7: Discussion and Conclusions.
Next, I looked at these results by student achievement level. These results are reported in Table 17 below.

**Table 17: Students’ Algebra I Impact based on Teacher Effectiveness Sequences, by Student Achievement Level**

<table>
<thead>
<tr>
<th>Teacher Effectiveness Sequence</th>
<th>Projected Algebra I NCE Score</th>
<th>Percent who took Algebra I in Middle School (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
</tr>
<tr>
<td>Low Achieving Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(profile in the bottom 1/3 of the cohort population)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLL (19)</td>
<td>22.43</td>
<td>14.61</td>
</tr>
<tr>
<td>HHH (44)</td>
<td>38.24</td>
<td>13.69</td>
</tr>
<tr>
<td>Difference</td>
<td>15.81</td>
<td></td>
</tr>
<tr>
<td>Average Achieving Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(profile in the middle 1/3 of the cohort population)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLL (31)</td>
<td>46.34</td>
<td>10.76</td>
</tr>
<tr>
<td>HHH (78)</td>
<td>59.01</td>
<td>6.83</td>
</tr>
<tr>
<td>Difference</td>
<td>12.67</td>
<td></td>
</tr>
<tr>
<td>High Achieving Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(profile in the top 1/3 of the cohort population)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLL (46)</td>
<td>63.35</td>
<td>11.87</td>
</tr>
<tr>
<td>HHH (208)</td>
<td>76.38</td>
<td>10.57</td>
</tr>
<tr>
<td>Difference</td>
<td>13.03</td>
<td></td>
</tr>
</tbody>
</table>

Of all the students across the entire state of North Carolina who had enough data to be included in the study, 96 were assigned to teachers who profiled as *highly ineffective* based on their EVAAS value added measures for three years in a row though 6th, 7th, and 8th grade. These 96 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 19 low, 31 average, and 46 high achieving students assigned to highly ineffective
teachers for three years in row. For the 19 low achieving students (with LLL teachers), their mean projected Algebra I score was 22.43 (measured in NCEs), with a standard deviation of 14.61. Of these 19 students, 2 (or 11 percent) took Algebra I in middle school. For the 31 average achieving students (with LLL teachers), their mean projected Algebra I score was 46.34 (measured in NCEs), with a standard deviation of 10.76. Of these 31 students, 22 (or 71 percent) took Algebra I in middle school. For the 46 high achieving students (with LLL teachers), their mean projected Algebra I score was 63.35 (measured in NCEs), with a standard deviation of 11.87. Of these 46 students, 42 (or 91 percent) took Algebra I in middle school.

330 students had been assigned to teachers who profiled as highly effective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These 330 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 44 low, 78 average, and 208 high achieving students assigned to highly effective teachers for three years in row. For the 44 low achieving students (with HHH teachers), their mean projected Algebra I score was 38.24 (measured in NCEs), with a standard deviation of 13.69. Of these 44 students, 1 (or 2 percent) took Algebra I in middle school. For the 78 average achieving students (with HHH teachers), their mean projected Algebra I score was 59.01 (measured in NCEs), with a standard deviation of 6.83. Of these 78 students, 19 (or 21 percent) took Algebra I in middle school. For the 208 high achieving students (with HHH teachers), their mean projected Algebra I score was 76.38 (measured in NCEs), with a standard deviation of 10.57. Of these 208 students, 131 (or 63 percent) took Algebra I in middle school.
**Statistical significance.** The differences in Algebra I projections between these two groups of students (LLL versus HHH) reported above are highly statistically significant based on a two-sample t-test.

**Part (2): Effect on SAT Math**

In this section, I looked for any possible impact that these three sequential years of teaching effectiveness had on the students’ SAT Math projections. This was studied in order to assess any long-term effects from these middle school teaching effectiveness experiences, long after the students had left middle school. The results across the entire cohort of students are reported in Table 18 below.

**Table 18: Students’ SAT Math Impact based on Teacher Effectiveness Sequences**

<table>
<thead>
<tr>
<th>Teacher Effectiveness Sequence</th>
<th>Projected SAT Math Scale Score (max = 800)</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Cohort (across all student achievement levels)</td>
<td>LLL (96)</td>
<td>453.58</td>
<td>86.26</td>
</tr>
<tr>
<td></td>
<td>HHH (330)</td>
<td>526.77</td>
<td>77.23</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>73.19</td>
<td></td>
</tr>
</tbody>
</table>

Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with middle school math teachers who all profiled as highly ineffective as indicated by their EVAAS value added measures and 330 students spent three years in a row with middle school math teachers who profiled as highly effective as indicated by their EVAAS value added measures. Regardless of the students’ achievement levels, those with LLL teachers had a projected SAT Math scale score of around 453, on average, and students with HHH teachers had a projected SAT Math scale score of around 526,
on average. This resulted in a difference of 73 scale score points between these two groups of students after spending three years with their respective teachers. These scale score results will look very similar to NCE results.

Next, I looked at these results by student achievement level. These results are reported in Table 19 below.

Table 19: Students’ SAT Math Impact based on Teacher Effectiveness Sequences, by Student Achievement Level

<table>
<thead>
<tr>
<th>Teacher Effectiveness Sequence</th>
<th>Projected SAT Math Scale Score</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Achieving Students (profile in the bottom 1/3 of the cohort population)</td>
<td>LLL (19)</td>
<td>332.76</td>
<td>51.56</td>
</tr>
<tr>
<td></td>
<td>HHH (44)</td>
<td>390.65</td>
<td>51.88</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>57.89</td>
<td></td>
</tr>
<tr>
<td>Average Achieving Students (profile in the middle 1/3 of the cohort population)</td>
<td>LLL (31)</td>
<td>434.25</td>
<td>44.32</td>
</tr>
<tr>
<td></td>
<td>HHH (78)</td>
<td>486.94</td>
<td>30.01</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>52.69</td>
<td></td>
</tr>
<tr>
<td>High Achieving Students (profile in the top 1/3 of the cohort population)</td>
<td>LLL (46)</td>
<td>516.51</td>
<td>53.54</td>
</tr>
<tr>
<td></td>
<td>HHH (208)</td>
<td>570.50</td>
<td>46.11</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>53.99</td>
<td></td>
</tr>
</tbody>
</table>

Of all the students across the entire state of North Carolina who had enough data to be included in the study, 96 were assigned to teachers who profiled as highly ineffective based on their EVAAS value added measures for three years in a row though 6th, 7th, and 8th grade. These
96 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 19 low, 31 average, and 46 high achieving students assigned to highly ineffective teachers for three years in row. For the 19 low achieving students (with LLL teachers), their mean projected SAT Math scale score was 332.76, with a standard deviation of 51.56. For the 31 average achieving students (with LLL teachers), their mean projected SAT Math scale score was 434.25, with a standard deviation of 44.32. For the 46 high achieving students (with LLL teachers), their mean projected SAT Math scale score was 516.51, with a standard deviation of 53.54.

In contrast, 330 students had been assigned to teachers who profiled as highly effective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These 330 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 44 low, 78 average, and 208 high achieving students assigned to highly effective teachers for three years in row. For the 44 low achieving students (with HHH teachers), their mean projected SAT Math scale score was 390.65, with a standard deviation of 51.88. For the 78 average achieving students (with HHH teachers), their mean projected SAT Math scale score was 486.94, with a standard deviation of 30.07. For the 208 high achieving students (with HHH teachers), their mean projected SAT Math scale score was 570.50, with a standard deviation of 46.11. These scale score results will look very similar to NCE results.

**Statistical significance.** The differences in SAT Math projections between these two groups of students (LLL versus HHH) reported above are highly statistically significant based on a two-sample t-test.
**Question 1b: Summary of Findings**

For the second question of this study, I looked for the measurable effects of student-teacher assignment on student achievement beyond 8th grade math when it is compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers as indicated by their EVAAS value added measures. This question had two parts: (1) how did this experience affect the students’ projected Algebra I scores, and (2) how did this experience affect the students’ projected SAT Math scores? Formally, the research question was as follows:

1b. *Long-term effects*: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

As with all portions of Phase I, the analyses was conducted using SAS statistical software under the direction of the EVAAS analytic team. The results of their analyses were reported in the sections above and are summarized here.

**Part (1): How did this experience affect the students’ projected Algebra I scores?** Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with middle school math teachers who all profiled as highly ineffective as indicated by their EVAAS value added measures and 330 students spent three years in a row with middle school math teachers who profiled as highly effective as indicated by their EVAAS value added measures.

*Overall results*: Regardless of the students’ achievement levels, those with LLL teachers had a projected Algebra I NCE score of just under 50, on average, and students with HHH teachers had a projected Algebra I NCE score of just over 67, on average. This resulted in a difference of 17.43 NCE points between these two groups of students after spending three years with their respective teachers.
Results by student achievement level: Of all the students across the entire state of North Carolina who had enough data to be included in the study, 96 were assigned to teachers who profiled as highly ineffective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These 96 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 19 low, 31 average, and 46 high achieving students assigned to highly ineffective teachers for three years in row. For the 19 low achieving students (with LLL teachers), their mean projected Algebra I score was 22.43 (measured in NCEs), with a standard deviation of 14.61. For the 31 average achieving students (with LLL teachers), their mean projected Algebra I score was 46.34 (measured in NCEs), with a standard deviation of 10.76. For the 46 high achieving students (with LLL teachers), their mean projected Algebra I score was 63.35 (measured in NCEs), with a standard deviation of 11.87.

Furthermore, 330 students had been assigned to teachers who profiled as highly effective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These 330 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 44 low, 78 average, and 208 high achieving students assigned to highly effective teachers for three years in row. For the 44 low achieving students (with HHH teachers), their mean projected Algebra I score was 38.24 (measured in NCEs), with a standard deviation of 13.69. For the 78 average achieving students (with HHH teachers), their mean projected Algebra I score was 59.01 (measured in NCEs), with a standard deviation of 6.83. For the 208 high achieving students (with HHH teachers), their mean projected Algebra I score was 76.38 (measured in NCEs), with a standard deviation of 10.57.
Part (2): How did this experience affect the students’ projected SAT Math scores?

Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with middle school math teachers who all profiled as highly ineffective as indicated by their EVAAS value added measures and 330 students spent three years in a row with middle school math teachers who profiled as highly effective as indicated by their EVAAS value added measures.

**Overall results:** Regardless of the students’ achievement levels, those with LLL teachers had a projected SAT Math scale score of around 453, on average, and students with HHH teachers had a projected SAT Math scale score of around 526, on average. This resulted in a difference of 73 scale score points between these two groups of students after spending three years with their respective teachers.

**Results by student achievement level:** Of all the students across the entire state of North Carolina who had enough data to be included in the study, 96 were assigned to teachers who profiled as highly ineffective based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These 96 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 19 low, 31 average, and 46 high achieving students assigned to highly ineffective teachers for three years in row. For the 19 low achieving students (with LLL teachers), their mean projected SAT Math scale score was 332.76, with a standard deviation of 51.56. For the 31 average achieving students (with LLL teachers), their mean projected SAT Math scale score was 434.25, with a standard deviation of 44.32. For the 46 high achieving students (with LLL teachers), their mean projected SAT Math scale score was 516.51, with a standard deviation of 53.54.
Furthermore, 330 students had been assigned to teachers who profiled as *highly effective* based on their EVAAS value added measures for three years in a row through 6th, 7th, and 8th grade. These 330 students were then split into three groups: low, average, and high achieving, based on how they profiled within the bottom, middle, or top third of the cohort population distribution. This resulted in 44 low, 78 average, and 208 high achieving students assigned to highly effective teachers for three years in row. For the *44 low achieving students (with HHH teachers)*, their mean projected SAT Math scale score was 390.65, with a standard deviation of 51.88. For the *78 average achieving students (with HHH teachers)*, their mean projected SAT Math scale score was 486.94, with a standard deviation of 30.07. For the *208 high achieving students (with HHH teachers)*, their mean projected SAT Math scale score was 570.50, with a standard deviation of 46.11. These scale score results will look very similar to NCE results.

As noted above, the results for Question 1b regarding both Algebra I and SAT Math were significant. Whether looking at the overall impact on students, or the impact on students at varying levels of achievement, clearly it made a difference in the short term (Algebra I) and the long term (SAT Math) if the students spent three years in a row with highly effective teachers or three years in a row with highly ineffective teachers as measured by their EVAAS value added measures. The implications of these results are further discussed in Chapter 7: Discussion and Conclusions.

**Summary of Chapter 4: Phase I Results**

In Phase I (the quantitative portion of the study), I attempted to answer the following questions:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?
1a. **Short-term effects**: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

1b. **Long-term effects**: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

The results from these questions were addressed above and are summarized here.

**Question 1a**: For the first question of this study, I looked for the measurable effects of student-teacher assignment on student achievement when it is compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers as indicated by their EVAAS value added measures. This question had three parts: (1) how did the students fare, overall, based on these three-year compounding effects, and (2) how did students fare, by achievement group, based on these three-year compounding effects, and (3) is the effect different for different achievement groups? The results of these three parts are summarized here, and the significances are displayed in Table 21 below.

**Question 1a – Part (1): How did the students fare, overall, based on these three-year compounding effects?** Regardless of the students’ achievement levels, those with LLL teachers lost 10.5 NCE points, on average, and students with HHH teachers gained 5.4 NCE points, on average. This resulted in a difference of 15.9 NCE points between these two groups of students after spending three years with their respective teachers.

**Question 1a – Part (2): How did students fare, by achievement group, based on these three-year compounding effects?** For those students who started 6th grade as low achieving (6th grade entering achievement was around the 28th NCE), the 19 students who spent the next three years with highly ineffective teachers based on the teachers’ EVAAS value added measures dropped over 4.5 NCEs by the time they finished 8th grade. Their counterparts, the 44 students
who spent three years in a row with *highly effective* teachers based on the teachers’ EVAAS value added measures gained over 13.6 NCEs by the time they finished 8th grade. For those students who started 6th grade as *average* achieving (6th grade entering achievement was around the 51st NCE), the 31 students who spent the next three years with *highly ineffective* teachers based on the teachers’ EVAAS value added measures dropped over 7.6 NCEs by the time they finished 8th grade. Their counterparts, the 78 students who spent three years in a row with *highly effective* teachers based on the teachers’ EVAAS value added measures gained over 7.9 NCEs by the time they finished 8th grade. For those students who started 6th grade as *high* achieving (6th grade entering achievement was around the 72nd or 73rd NCE), the 46 students who spent the next three years with *highly ineffective* teachers based on the teachers’ EVAAS value added measures dropped over 14.8 NCEs by the time they finished 8th grade. Their counterparts, the 208 students who spent three years in a row with *highly effective* teachers based on the teachers’ EVAAS value added measures gained about 2.7 NCEs by the time they finished 8th grade.

**Question 1a – Part (3): is the effect different for different achievement groups?** No, the gaps between the students in HHH versus LLL for each achievement group do not differ from one group to another.

**Question 1b:** For the second question of this study, I looked for the measurable effects of student-teacher assignment on student achievement *beyond 8th grade math* when it is compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers as indicated by their EVAAS value added measures. This question has two parts: (1) how did this experience affect the students’ projected Algebra I scores, and (2) how did this experience affect the students’ projected SAT Math scores? The results of both parts are summarized here, and the significances are displayed in Table 20 below.
Question 1b – Part (1): How did this experience affect the students’ projected Algebra I scores? Regardless of the students’ achievement levels, those with LLL teachers had a projected Algebra I NCE score of just under 50, on average, and students with HHH teachers had a projected Algebra I NCE score of just over 67, on average. This resulted in a difference of 17.43 NCE points between these two groups of students after spending three years with their respective teachers.

Question 1b – Part (2): How did this experience effect the students’ projected SAT Math scores? Regardless of the students’ achievement levels, those with LLL teachers had a projected SAT Math scale score of around 453, on average, and students with HHH teachers had a projected SAT Math scale score of around 526, on average. This resulted in a difference of 73 scale score points between these two groups of students after spending three years with their respective teachers.
Table 20: Quantitative Questions and the Results of Their Tests for Significances

<table>
<thead>
<tr>
<th>Sub-Question</th>
<th>Testing</th>
<th>Method</th>
<th>Statistically Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a (1) – When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement?</td>
<td>Whether the difference of entering &amp; exiting achievement varied across teacher assignment group</td>
<td>Two-sample t-test</td>
<td>YES</td>
</tr>
<tr>
<td>1a (2) – What is the measurable effect on student achievement for students at varying levels of entering achievement?</td>
<td>Whether the difference of entering &amp; exiting achievement varied across teacher assignment group for students of differing achievement levels</td>
<td>Two-sample t-test</td>
<td>YES</td>
</tr>
<tr>
<td>1a (3) – Is the measurable effect different depending on the entering achievement level of students?</td>
<td>Whether the effect of teacher assignment group on the change in achievement differed by entering achievement level</td>
<td>Two-way ANOVA</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Long-term effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b (1) – Is there an effect on the students’ projected Algebra I NCE score?</td>
<td>Whether the Algebra I projections varied by teacher assignment group</td>
<td>Two-sample t-test</td>
<td>YES</td>
</tr>
<tr>
<td>1b (2) – On their projected SAT Math scale score?</td>
<td>Whether the SAT Math projections varied by teacher assignment group</td>
<td>Two-sample t-test</td>
<td>YES</td>
</tr>
</tbody>
</table>

As displayed in Table 20 above, the short-term effects of these three years were mostly statistically significant: Question 1a parts (1) and (2) were both statistically significant and had
large effect sizes, but part (3) was not statistically significant. For the long-term effects, Question 1b parts (1) and (2) were both statistically significant.

**In closing.** Whether looking at the overall impact on students, or the impact on students at varying levels of achievement, clearly it made a difference on *student achievement* if the students spent three years in a row with highly effective teachers or three years in a row with highly ineffective teachers as measured by their EVAAS value added measures. The same was true for short term impacts (Algebra I) and long term impacts (SAT Math). The implications of these quantitative results from Phase I are further discussed in Chapter 7.
CHAPTER 5

RESULTS FROM PHASE II: QUALITATIVE

This chapter highlights the differences between the effective and ineffective teachers based on qualitative data collected during interviews with each of the participants. In Phase II, I focused on the instructional practices teachers reportedly employed in their classrooms and teacher beliefs about how students learn mathematics and answered the following questions:

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. Compared to research: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. Compared to each other: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

In order to address these questions, I interviewed ten teachers. Five of the teachers profiled as highly effective at helping students make academic progress as defined by their EVAAS value-added score and five profiled as highly ineffective at helping students make academic progress as defined by their EVAAS value-added score. To avoid researcher bias, I was unaware of which group the teachers were identified. During the recruitment of the ten participants, conducting interviews, transcribing, coding, and analyzing each interview; and writing up these initial results, I was completely blind regarding which teachers profiled as highly effective and which ones were not. The descriptions and initial results of each participant’s interview written below were completed while still blind.
Descriptive Information of the Participants

All ten teachers interviewed for this study were middle school math teachers in North Carolina. Most of their descriptive information was self-reported, while some characteristics were based on my observations or inferences. The teachers’ descriptive information is broken out into three sections, starting with their personal characteristics, followed by the amount of instructional time each teacher had coupled with basic information about their schools, and finally, the academic range of students that each teacher taught.

Personal Characteristics (reported blind)

The teachers interviewed in this study were geographically chosen at random, and therefore came from across the entire state, though two of the teachers’ school sites were repeated within this sample, as discussed below. All ten teachers’ names have been changed to protect their identities. Of all the descriptive information included in Table 21 below, the only selection criterion was that these ten individuals were middle school math teachers during the scope of the data-relevant years: from 2009 through 2011. I summarize their basic descriptive information in the following table:
Table 21: Phase II – Basic Description Information of the Ten Interviewed Teachers

<table>
<thead>
<tr>
<th>Participant</th>
<th>Male</th>
<th>Female</th>
<th>Gender</th>
<th>Race</th>
<th>Years Taught</th>
<th>Lateral Entry</th>
<th>Still Teaching</th>
<th>Math?</th>
<th>Courses Taught (ever)</th>
<th># of Students</th>
<th>Ave # of Stud./Class</th>
<th>Ave # of minutes per Student</th>
<th>Total minutes for the year (CL x 180)</th>
<th>Ave # of minutes per Student</th>
<th>School Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>F</td>
<td>W</td>
<td>8</td>
<td></td>
<td>7 8</td>
<td>7</td>
<td></td>
<td>75</td>
<td>25 90 16,200 648</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Jeff</td>
<td>M</td>
<td>W</td>
<td>5</td>
<td>LE</td>
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<td></td>
<td>28 60</td>
<td>10,800 400 U</td>
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<td>27 60</td>
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<tr>
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<td>30 80</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I selected the participants randomly so the characteristics identified in Table 21 above were for descriptive purposes only. The first two characteristics were recorded based on my observations of the participants during the interview: gender and race. Of the ten teachers, there were 7 females and 3 males. Seven teachers were white, 2 were African American, and 1 of Asian descent. Participant responses provided the remaining four characteristics displayed in Table 21 above (years taught, lateral entry, still teaching, and courses taught). The self-reported number of years taught ranged from 5 to 24 years in the classroom, with an average of 13.1 years. Three participants identified themselves as entering the profession after being in other professions, labeled here as “lateral entry.” Of the ten teachers pulled from the data covering 2009 through 2011, seven were still teaching middle school math at the time of the interviews (2013), one had switched to middle school science, and the last two had moved to non-teaching positions within the school district. Teachers self-reported which courses they had taught throughout their teaching career: five had taught 6th grade math, six had taught 7th grade math, seven taught 8th grade math, five taught middle school Algebra, two taught geometry, one has also taught middle school science, and one had taught elementary and middle school art. Although this is a small sample of just ten teachers, the sample covers a wide range of characteristics.

**Instructional Time & School Characteristics (reported blind)**

In addition to the teachers’ characteristics noted above, I also recorded additional attributes of their basic instructional times and school characteristics. Each teacher self-reported the total number of students taught, the average number of students per class period, and the length of each class period based on a “typical year” (see Table 22.
below). I then calculated the total number of minutes per class period for the entire school year by multiplying the self-reported typical class period length by the state-required minimum of 180 school days in North Carolina. I then divided this total by the typical number of students per class period to get each teacher’s average number of minutes per student. As I was conducting these interviews and began to hear such a wide range of both the quantity of students taught and the length of class periods among the teachers interviewed, I became curious if there was a relationship between such a seemingly simple characteristic (how much time does a teacher have to teach each student) and his/her EVAAS value added measure. Since at the time of this portion of the write-up I did not yet know the teachers’ effectiveness levels, I will come back to this average, and its relationship (or lack thereof) to the teachers’ effectiveness levels in a section below.

For each participant’s school setting, I categorized the school as either urban or rural. I combined each school’s location with state population maps to determine this value. Sites that were located within a more densely populated portion of the state (population was greater than or equal to 1000 people per square mile) were labeled as urban. Sites that were located within a less densely populated portion of the state (population was less than 1000 people per square mile) were labeled as rural. This distinction resulted in two sites labeled urban, while all other locations were labeled rural. This characteristic, among others, is also included in Table 22 below.
### Table 22: School Demographics

<table>
<thead>
<tr>
<th>Site #</th>
<th>School Setting*</th>
<th>School Size**</th>
<th>Grades Served at the School**</th>
<th>Average Number of Students per Grade</th>
<th>% Minority***</th>
<th>% Eligible for Free or Reduced-price Lunch***</th>
<th>Title I School***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site #1</td>
<td>U</td>
<td>1,092</td>
<td>6-8</td>
<td>364</td>
<td>39%</td>
<td>18%</td>
<td>No</td>
</tr>
<tr>
<td>Site #2</td>
<td>R</td>
<td>696</td>
<td>6-8</td>
<td>232</td>
<td>40%</td>
<td>28%</td>
<td>No</td>
</tr>
<tr>
<td>Site #3</td>
<td>R</td>
<td>436</td>
<td>PK-6</td>
<td>55</td>
<td>43%</td>
<td>59%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #4</td>
<td>R</td>
<td>421</td>
<td>6-8</td>
<td>140</td>
<td>32%</td>
<td>64%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #5</td>
<td>R</td>
<td>412</td>
<td>6-8</td>
<td>137</td>
<td>32%</td>
<td>52%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #6</td>
<td>U</td>
<td>1,182</td>
<td>6-8</td>
<td>394</td>
<td>47%</td>
<td>39%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #7</td>
<td>R</td>
<td>788</td>
<td>K-8</td>
<td>88</td>
<td>65%</td>
<td>69%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #8</td>
<td>R</td>
<td>675</td>
<td>6-8</td>
<td>225</td>
<td>32%</td>
<td>39%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Determined by me  ** Source: NC Report Card, 2014  *** Source: NCES, 2014

The ten sites where each of the ten participants taught during the school years included in this study (2009-2011) ranged in size, location, and in student body characteristics. Two sets of participants came from the same school; this duplicity of sites was a result of initially trying to match each high and low teacher by school contexts as much as possible. For the purposes of reporting these results, the duplicate sites will be treated as two distinct sites throughout this chapter. The school sizes ranged from 412 to 1,182, with 55 to 394 students per grade. The percentage of minority students served by the schools range from 32 percent to 65 percent, and the percentage of free or reduced-price lunch recipients range from 18 percent to 69 percent across the ten sites. Eight of
the ten sites were Title I schools (note: two of the sites were repeated across the ten teachers) and received federally-funded financial assistance due to “high numbers or high percentages of children from low-income families” (U.S. Department of Education, 2014, para. 1).

**Range of Students Taught (reported blind)**

In line with most of the information reported throughout this section, this information came directly from the participants themselves. All ten teachers reported that they taught students with an extremely wide range of ability, regardless of the teachers’ actual course levels:

**Table 23: Phase II – Range of Students Taught by the Ten Interviewed Teachers**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Range of Students Taught (Self-Reported)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>“I have everything from just no math sense... [to] the widest range”</td>
</tr>
<tr>
<td>Jeff</td>
<td>&quot;You have what I call your AG kids, your thoroughbreds, that's where you can give a little bit of instruction, drop the gate and let them run. Just kinds keep them within the guardrails. Then you have kids that really do need one-on-one, yet they're not identified but they really do need the one-on-one. They need very small groups, small group instruction.&quot;</td>
</tr>
<tr>
<td>Kendra</td>
<td>&quot;...when we would do STAR math testing, I had some kids that would test on the end of the 1st grade year all the way up until past high school.&quot;</td>
</tr>
<tr>
<td>Carol</td>
<td>&quot;The children I have this year, my 1st period and 2nd period classes, are very high functioning students, very high flyers. Now the last class, I've got some students on a 2nd grade level, don't know those foundations, don't know those times tables, don't know those math facts.&quot;</td>
</tr>
<tr>
<td>Jerome</td>
<td>&quot;Because I am teaching Math I and I'm also teaching inclusion, that's a broader range, inclusion class you have LD, then of course you have ADD, ADHD students, people with writing deficiencies, things of that nature, then with those students in Math I, most of those are AIG students, so the range is from the bottom to the top.&quot;</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Francesca</td>
<td>&quot;From super gifted down to Exceptional Children, and even students that performed lower than what the EC range was. So really a wide range.&quot;</td>
</tr>
<tr>
<td>Matt</td>
<td>&quot;Extremely poor to excellent. They cover the gamut&quot;</td>
</tr>
<tr>
<td>Alice</td>
<td>&quot;I have low level all the way up to gifted&quot;</td>
</tr>
<tr>
<td>Liann</td>
<td>&quot;Anywhere from ranging from I would say the beginning to the end of 2nd grade all the way up to college level math. It's a big discrepancy.&quot;</td>
</tr>
<tr>
<td>Helen</td>
<td>&quot;Zero to sixty. It was everything from EC children in an inclusion environment to accelerated students at the top of the heap.&quot;</td>
</tr>
</tbody>
</table>

Whether the teacher officially instructed remedial-level courses, regular education courses, or advanced courses, all ten teachers reported that their classes included students ranging from very low-level learners to students who were well beyond their assigned grade level (see their actual responses in Table 23 above).

This preliminary descriptive information for the teachers paves the way for the remaining sections in this chapter, where I discuss the teachers’ interview responses and how the responses relate to the teachers’ EVAAS value added measures. The first question from Phase II covers how the teachers’ EVAAS value added measures relate to the beliefs identified in the math wars literature. The second question from Phase II highlights the differences between the teachers who profiled as highly effective versus those who profiled as highly ineffective based on their EVAAS value added measures.

**Results for Question 2a: The Math Wars**

The first question from Phase II was based on the current research about effective math teachers, which largely stems from the differing beliefs identified in the math wars research. Side #1 touts more traditional beliefs; it promotes procedures, efficiency, and speed; emphasizes accuracy; students learn independently, with extrinsic motivation; and the teacher is in control of the learning. Side #2 touts more constructivist beliefs; it
promotes effort, creativity, and mistakes; emphasizes understanding; students learn through social interaction, exploration, and discovery, with internal motivation; and students have some autonomy. It is important to note that while much of the literature argues for constructivist views based on the notion that these characteristics will yield higher student outcomes, such direct connections are not claimed (Onkvisit & Shaw, 2004). My results show there may be a connection between constructivist beliefs and increased student outcomes, as discussed below, but my results are not as clear as the literature implies. As discussed in the literature review, research currently indicates that constructivist views are more effective than traditional views, though the term ‘effective’ is not directly related to increased student outcomes. Therefore, I asked teachers with effective ratings that are directly tied to increased student outcomes various questions in an attempt to determine which views their own beliefs ultimately sided with. I then connected their EVAAS value added measures with their interview answers in order to address the following research question:

2a. Compared to research: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

However, before those EVAAS value added measures were revealed to me, I coded and analyzed the interviews and then extracted the information that was solely indicative of the teachers’ views in relation to the math wars. Thus, this section addresses just the first layer of this question: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers? – without the teachers’ effectiveness indicators. First, I asked these ten teachers questions pertaining to their personal views, in order to get an idea of where
they fell on the traditional-constructivist spectrum. Then, I applied their EVAAS value added measures to this data to see if there was a connection between traditional versus constructivist views and teacher effectiveness – specifically defined as increased student outcomes.

All ten teachers discussed a plethora of topics that were not related to the math wars, which I will discuss later. For this section, I only pulled out their math-wars-related answers, and found that all ten leaned toward one side of the math wars or the other, but to varying degrees (see Figure 5 below).

**Figure 5: Teachers’ Interview Answers that Related to the Math Wars**

![Figure 5: Teachers’ Interview Answers that Related to the Math Wars](image)

The data from Figure 5 is discussed teacher-by-teacher in the following sections. I originally wrote up each teachers’ initial section while still blind, and then went back and reorganized them in this report based on their EVAAS value added measures (high vs. low).
The 5 highly effective teachers. I start by introducing the five teachers who profiled as highly effective based on their EVAAS value added measures. While I will discuss each teacher individually, all five highly effective teachers gave more constructivist answers than traditional. While there were three males and seven females interviewed, all five highly effective teachers were female. None of these five teachers were lateral entry. Their years of experience ranged from six to 24, and two of these teachers had moved out of the classroom and into district-level positions.

Table 24: Phase II – Basic Description Information of the 5 Highly Effective Teachers

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Race</th>
<th>Years Taught</th>
<th>Lateral Entry</th>
<th>Still Teaching Math?</th>
<th>Courses Taught (ever)</th>
<th>Urban/Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>F</td>
<td>W</td>
<td>8</td>
<td></td>
<td></td>
<td>7 7 8</td>
<td>U</td>
</tr>
<tr>
<td>Francesca</td>
<td>F</td>
<td>W</td>
<td>23</td>
<td>District now</td>
<td></td>
<td>6 7 8 Art</td>
<td>R</td>
</tr>
<tr>
<td>Alice</td>
<td>F</td>
<td>W</td>
<td>24</td>
<td></td>
<td></td>
<td>8 A</td>
<td>R</td>
</tr>
<tr>
<td>Liann</td>
<td>F</td>
<td>A</td>
<td>6</td>
<td></td>
<td></td>
<td>6</td>
<td>R</td>
</tr>
<tr>
<td>Helen</td>
<td>F</td>
<td>W</td>
<td>18</td>
<td>District now</td>
<td></td>
<td>7 8 A</td>
<td>R</td>
</tr>
</tbody>
</table>

Each of these five teachers who profiled as highly effective based on their EVAAS value added measures are introduced below

**Highly Effective Teacher #1: Ashley (initially reported blind).** Ashley is a white female in her 20s. At the time of the interview, she had been teaching for 8 years and all of her experience was with 7th grade math and 8th grade math, covering both general and
advanced levels within those curriculums. Of Ashley’s responses that were indicative of typical math wars beliefs, 35 percent of her answers leaned toward the more traditional side and 65 percent profiled as more constructivist in nature. Ashley let her students figure things out on their own by often working in groups, and did not want to limit the students to her method of solving problems. Overall, Ashley came across as a very bright, dedicated, and energetic young teacher who was fully invested in her students. She did express concern about the future of the teaching profession, which I will discuss in the following chapter.

**Highly Effective Teacher #2: Francesca (initially reported blind).** Francesca is a white female in her 40s. At the time of the interview, she had been teaching for 23 years, and had just recently left the classroom to serve as an instructional facilitator. The first half of her teaching career was spent in a foreign country teaching elementary and middle school art, and the second half has been in North Carolina teaching middle school math. While Francesca had just finished her first year as an instructional facilitator, she was asked to speak from the perspective of her own math teaching experiences. Of Francesca’s responses that were indicative of typical math wars beliefs, 22 percent of her answers leaned toward the more traditional side and 78 percent profiled as more constructivist in nature. She utilized a lot of cooperative learning techniques that were highly structured, with students assigned to certain rolls within the group. Francesca also noted the importance of *socially* structuring the learning process in three distinct phases, by having students first learn concepts in groups, then again in pairs, and finally, on their own. Overall, Francesca came across as an extremely passionate teacher who felt that it was her job to do whatever it took to help a child learn. Of all ten teachers interviewed,
she had the most to say about teaching and the responsibility that teachers had for the education of their students. She spoke repeatedly of the importance of students constantly talking with each other and with her: she seemed to focus heavily on verbal learning, where students were asked to explain their thoughts and prove their understanding.

**Highly Effective Teacher #3: Alice (initially reported blind).** Alice is a white female in her 40s. At the time of the interview, she had been teaching for 24 years, all within North Carolina and all in 8th grade – either 8th grade general math or 8th grade Algebra. Her career has covered five different schools, but she has been at her most recent school near a Native American reservation for many years now. Of Alice’s responses that were indicative of typical math wars beliefs, 31 percent of her answers leaned toward the more traditional side and 69 percent profiled as more constructivist in nature. Alice spoke of the importance of cooperative learning techniques, while keeping a balance; she expressed that most students performed better when they were seated in rows, but would rearrange the room regularly to accommodate group work. Overall, Alice came across as a very committed teacher who was concerned with her students’ home lives just as much as their education. Building personal relationships with her students was on equal par with helping them learn math. Alice’s own two children have had very different levels of quality math teachers, which she clearly identifies with her children’s subsequent depth of understanding, or lack thereof. She paints a vivid picture of the struggles her students both at school and at home. Alice had much more to say about the role of teachers and realities of her students’ lives, which I will come back to below.
**Highly Effective Teacher #4: Liann (initially reported blind).** Liann is an Asian American female in her 30s. At the time of the interview, she had been teaching for 6 years. Her math teaching experience has been entirely with 6th grade at two different schools within North Carolina. At her current school, there is only one teacher per subject, per grade. Thus, Liann teaches the entire 6th grade math by herself. Of Liann’s responses that were indicative of typical math wars beliefs, 25 percent of her answers leaned toward the more traditional side and 75 percent profiled as more constructivist in nature. Overall, Liann came across as a teacher who highly valued independent, self-paced student learning. The vast majority of her teaching methods focused on individual and group work, with some small-group instruction. She rarely employed whole-class instruction. Liann expected every student to do what was expected, both academically and behaviorally. She seemed very comfortable with the methods she had settled into over the past six years. Liann had much more to say about the roles of assessment and technology in the classroom, which I will come back to a bit later on.

**Highly Effective Teacher #5: Helen (initially reported blind).** Helen is a white female in her 30s. At the time of the interview, she had been teaching for 16 years and then switched to an instructional coach position for the past 2 years. Her math teaching experience included 7th grade math, 8th grade math, and middle school Algebra. While she was no longer in the classroom, Helen had been teaching math during the time the data was pulled for Phase I, and was asked to speak from the perspective of her math teaching experiences for the purposes of the interview. Of Helen’s responses that were indicative of typical math wars beliefs, 36 percent of her answers leaned toward the more traditional side and 64 percent profiled as more constructivist in nature. Helen utilized
group work to promote student learning, but insisted that she always choose the groups; nothing was left to chance in her classroom. Helen felt it was important to have varying ability levels in each student work group to maximize learning. Overall, Helen came across as a very devoted teacher who was spent the vast majority of her waking time planning, teaching, or grading. She generally avoided the use of technology, and focused more on the basics of pencil-and-paper learning methods. Helen felt that the naturally unstable state of adolescence was best addressed by providing students with a calm, predictable, and steady classroom environment where they knew exactly what to expect every day. She kept her classroom desks set up in rows to promote a more orderly and efficient environment. One of Helen’s biggest beliefs was the importance of keeping the students moving at a constant and steady pace of learning, where there was never any down time or opportunities to be bored or misbehave. She had much more to say about the expectations for teachers and students, which I will discuss more of below.

**The 5 Highly Effective Teachers: their school contexts.** The five highly effective teachers based on their EVAAS value added measures came from five different school sites across the state of North Carolina. As displayed in Table 25 below, the average number of students served per grade level across each school ranged from 55 to 364 students, with an average across all five schools of 186 students per grade level. The percent of students served at these five schools who are from minority groups range from 32 to 43 percent, with an average of 37 percent across the five schools. The percent of students receiving free or reduced-price lunch services range from 18 to 64 percent, with an average of 44 percent. Three of these five schools were identified as Title I schools.
Table 25: School Demographics for the 5 Highly Effective Teachers

<table>
<thead>
<tr>
<th>Site #</th>
<th>School Setting*</th>
<th>School Size**</th>
<th>Grades Served at the School**</th>
<th>Average Number of Students per Grade</th>
<th>% Minority***</th>
<th>% Eligible for Free or Reduced-price Lunch***</th>
<th>Title I School***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site #1</td>
<td>U</td>
<td>1,092</td>
<td>6-8</td>
<td>364</td>
<td>39%</td>
<td>18%</td>
<td>No</td>
</tr>
<tr>
<td>Site #2</td>
<td>R</td>
<td>696</td>
<td>6-8</td>
<td>232</td>
<td>40%</td>
<td>28%</td>
<td>No</td>
</tr>
<tr>
<td>Site #3</td>
<td>R</td>
<td>436</td>
<td>PK-6</td>
<td>55</td>
<td>43%</td>
<td>59%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #4</td>
<td>R</td>
<td>421</td>
<td>6-8</td>
<td>140</td>
<td>32%</td>
<td>64%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #5</td>
<td>R</td>
<td>412</td>
<td>6-8</td>
<td>137</td>
<td>32%</td>
<td>52%</td>
<td>Yes</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>611</td>
<td>186</td>
<td>37%</td>
<td>44%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Determined by me  ** Source: NC Report Card, 2014  *** Source: NCES, 2014

The 5 highly ineffective teachers. Now I introduce the five teachers that profiled as highly ineffective based on their EVAAS value added measures. While I will discuss each teacher individually, three of these least effective teachers were the only three who gave more traditional answers than constructivist. The other two ineffective teachers were right in the middle of this group of ten teachers, with slightly more constructivist answers than traditional. All three males of the ten teachers interviewed were part of the five who were ineffective, and these same three teachers were also lateral entry (see Table 26 below). These five highly ineffective teachers’ years of experience ranged from five to fifteen. All five of these teachers were still teaching in the classroom at the time of the interviews, but one had transitioned to science.
Table 26: Phase II – Basic Description Information of the 5 Highly Ineffective Teachers

<table>
<thead>
<tr>
<th>Participant</th>
<th>Male</th>
<th>Female</th>
<th>Race</th>
<th>Years Taught</th>
<th>Lateral Entry</th>
<th>Still Teaching Math?</th>
<th>Courses Taught (ever)</th>
<th>School Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeff</td>
<td>M</td>
<td>W</td>
<td>White</td>
<td>5</td>
<td>LE</td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Kendra</td>
<td>F</td>
<td>A</td>
<td>Afr. Am.</td>
<td>15</td>
<td>Science now</td>
<td></td>
<td>6 7 8 A G Sci</td>
<td>R</td>
</tr>
<tr>
<td>Carol</td>
<td>F</td>
<td>W</td>
<td>Asian</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Jerome</td>
<td>M</td>
<td>A</td>
<td>Afr. Am.</td>
<td>12</td>
<td>LE</td>
<td></td>
<td>6 7 8 A</td>
<td>R</td>
</tr>
<tr>
<td>Matt</td>
<td>M</td>
<td>W</td>
<td>White</td>
<td>7</td>
<td>LE</td>
<td></td>
<td>8 A G</td>
<td>R</td>
</tr>
</tbody>
</table>

Each of these five teachers who profiled as highly ineffective based on their EVAAS value added measures are introduced below.

**Highly Ineffective Teacher #1: Jeff (initially reported blind).** Jeff is a white male in his 40s. At the time of the interview, he had been teaching for 5 years after a long career in the military followed by a lateral entry into the classroom under both a middle school math and science teaching license. Despite his dual licensure, all of Jeff’s experience was with 7th grade math thus far, covering both general and advanced levels within those curriculums. Of Jeff’s responses that were indicative of typical math wars beliefs, 32 percent of his answers leaned toward the more traditional side and 68 percent profiled as more constructivist in nature. Jeff had the desks in his classroom arranged in groups of four, and primarily utilized group work and small group instruction as his primary teaching methods. Overall, Jeff came across as a very calm, intelligent, seasoned
man who ran his classroom with structure coupled with high expectations for every student. Throughout his interview, it became apparent that Jeff thought of himself as the commander of his classroom, expecting students to do what they were supposed to do, and he was there to put them back on track if they inadvertently strayed from the task at hand. His mannerisms were firm without being threatening. Jeff clearly took his job of teaching math seriously, but also exhibited an equal desire to instill a strong sense of confidence and responsibility in his students. Jeff had much more to say about teaching, which I will discuss later.

**Highly Ineffective Teacher #2: Kendra (initially reported blind).** Kendra is an African American female in her 30s. At the time of the interview, she had been teaching for 15 years, the first 10 of which were in another southeastern state and the last 5 years have been in North Carolina. Kendra carries a dual license in both math and science, and has taught both over the years. Her math teach experience spans 6th grade through 11th grade. Also at the time of the interview, Kendra had been teaching middle school science but was teaching math during the time the data was pulled for Phase I, and was asked to speak from the perspective of her math teaching experiences for the purposes of the interview. Of Kendra’s responses that were indicative of typical math wars beliefs, 36 percent of her answers leaned toward the more traditional side and 64 percent profiled as more constructivist in nature. Kendra utilized both group work and direct instruction, and spoke about the importance of constantly moving throughout the room to ensure students were on task. She felt it was more pertinent for students to know how to use the technology in the classroom (such as computers and calculators) to do the math, than for the students to know how to do the math themselves. Overall, Kendra came across as a
very dedicated teacher who was more concerned with her students enjoying the learning process and actually learning the concepts than with following stereotypically “boring” teaching methods. She sighed multiple times throughout the hour-long interview, almost as if she was generally exhausted from fighting the battle of trying to make education exciting in an environment that tried to suppress such outlandish behavior. Kendra had much more to say about the role of teachers and what good teaching should actually look like, which I will cover a bit later on.

**Highly Ineffective Teacher #3: Carol (initially reported blind).** Carol is a white female in her 40s. At the time of the interview, she had been teaching for 13 years and all of her experience was with 6th grade math, covering both general math and pre-Algebra. Carol had been teaching for the past 4 years at a brand new school, joining the staff when the school first opened. Of Kendra’s responses that were indicative of typical math wars beliefs, 73 percent of her answers leaned toward the more traditional side and 27 percent profiled as more constructivist in nature. Carol relied heavily on computer programs to ensure students were demonstrating mastery of the material. When students were not working at the computers, there were sitting in groups, though Carol employed mostly lecture-based, direct instruction while the students sat in these groups. Overall, Carol came across as a very traditional teacher who focused heavily on the behavior of her students and ensuring they were doing what they were supposed to be doing. Carol expressed that she had gotten into a rut in her teaching methods, and recently had tried to break out and start trying new things, including learning new technology. She had much more to say about what both teachers and students should be doing, which I will come back to below.
Highly Ineffective Teacher #4: Jerome (initially reported blind). Jerome is an African American male in his 40s. At the time of the interview, he had been teaching for 12 years, and had entered the profession through a lateral entry program after spending the first part of his career in a non-teaching field of education. Over the years, Jerome has always taught in a very rural part of the state, covering 6th, 7th, and 8th grade math as well as Algebra I. Of Jerome’s responses that were indicative of typical math wars beliefs, 57 percent of his answers leaned toward the more traditional side and 43 percent profiled as more constructivist in nature. All of the student learning was delivered through computer programs or direct instruction in Jerome’s classroom, which he referred to as “modeling demonstration.” In terms of student-to-student interaction, Jerome described this as having the students turn to their neighbors and discuss their answers. Overall, Jerome came across as a teacher who was concerned about the severe lack of preparation his students arrived with, and attempted to address that by providing opportunities for students to learn the basics at a pace of their own choosing. He was not a fan of standardized testing. Jerome ran a very controlled classroom environment with limited student-to-student interaction. He had much more to say about teaching and learning, which I will revisit later.

Highly Ineffective Teacher #5: Matt (initially reported blind). Matt is a white male in his 20s. At the time of the interview, he had been teaching for 7 years. Matt entered the classroom through a lateral entry program after trying a brief career with a computer company. His math teach experience has all been at the same school teaching various levels of 8th grade math, including general math, Algebra, and geometry. Of Matt’s responses that were indicative of typical math wars beliefs, 69 percent of his
answers leaned toward the more traditional side and 31 percent profiled as more constructivist in nature. Matt relied heavily on lecture-based direct instruction. He did not utilize group or project work, as he said the learning standards he teaches in Algebra such as the slope and intercepts of lines do not have projects that “go along with that sort of memorization or that sort of work.” Matt had an interesting take on the success that other countries exhibit in mathematics: “The countries that are really successful in mathematics, they essentially just force their kids to do it. They either shame their children or force their children or beat their children until they do mathematics. We don’t have those luxuries.” Overall, Matt came across as a rather jaded teacher who had strict views on the outcomes for which teachers should actually be held responsible. He was dismissive of the pressures to have all students excel, especially when it came to standardized testing. Matt seemed to embrace the reality that many of his students would not be going on to college. He had much more to say about education including multiple facets of what affects it and what its goals should be, which I will discuss below.

**The 5 Highly Ineffective Teachers: their school contexts.** The five highly ineffective teachers based on their EVAAS value added measures came from three different schools across the state of North Carolina (the possible implications of this will be discussed later); as noted above, this duplicity of sites was a result of initially trying to match each high and low teacher by school contexts as much as possible. As displayed in Table 27 below, the average number of students served per grade level across each school ranged from 88 to 394 students, with an average across all three schools of 236 students per grade level. The percent of students served at these three schools who are of members of minority groups range from 32 to 65 percent, with an average of 48 percent across the
schools. The percent of students receiving free or reduced-price lunch services range from 39 to 69 percent, with an average of 49 percent. And all three of these schools were identified as Title I schools.

**Table 27: School Demographics for the 5 Highly Ineffective Teachers**

<table>
<thead>
<tr>
<th>Site #</th>
<th>School Setting*</th>
<th>School Size**</th>
<th>Grades Served at the School**</th>
<th>Average Number of Students per Grade</th>
<th>% Minority***</th>
<th>% Eligible for Free or Reduced-price Lunch***</th>
<th>Title I School***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site #6</td>
<td>U</td>
<td>1,182</td>
<td>6-8</td>
<td>394</td>
<td>47%</td>
<td>39%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #7</td>
<td>R</td>
<td>788</td>
<td>K-8</td>
<td>88</td>
<td>65%</td>
<td>69%</td>
<td>Yes</td>
</tr>
<tr>
<td>Site #8</td>
<td>R</td>
<td>675</td>
<td>6-8</td>
<td>225</td>
<td>32%</td>
<td>39%</td>
<td>Yes</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>882</td>
<td>236</td>
<td>48%</td>
<td>49%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: NC Report Card, 2014
***Source: NCES, 2014

**Question 2a: Summary of findings.** For Phase II, I conducted interviews with ten middle school math teachers across the state of North Carolina and analyzed those interviews through the lens of the math wars. All of this was done in an attempt to answer the following question:

2a. **Compared to research:** How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

On the math-wars spectrum ranging from constructivist to traditional, the teachers profiled from highly constructivist (at 78 percent) to highly traditional (at 69 percent) and at various points in between. Three of the teachers who were the *most constructivist* in this group of ten teachers also had high EVAAS value added measures thus indicating
they are *highly effective* at helping students make academic progress, and three of the teachers who were the *most traditional* in this group also had low EVAAS value added measures thus indicating they are *highly ineffective* at helping students make academic progress.

**Concluding remarks: the math wars provide some distinction.** The first question from Phase II was based on the current research about effective math teachers, which ultimately boils down to the two opposing sides of the math wars. Using the dichotomous views of constructivist versus traditional beliefs of effective teaching, I asked teachers various questions in an attempt to determine with which side they align their beliefs. I recorded their answers were recorded while I was still unaware of their EVAAS value added measures. Then, I connected their EVAAS value added measures with their interview answers in order to *completely* address the following research question:

2a. *Compared to research:* How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

As discussed above, the ten teachers ranged from predominantly traditional to predominantly constructivist in their views on teaching and learning. Ultimately, there was some division between the five highly effective teachers and the five highly ineffective teachers as indicated by their EVAAS teacher value added measures based on their math-wars views, as displayed in Figure 6 below, though this division was not definitive.
Of the five teachers who profiled as highly effective at helping students make academic progress as indicated by their EVAAS value-added scores, their responses were constructive an average of 70 percent of the time, with three of them profiling as highly constructivist in their interviews (exhibiting the largest quantity of constructivist views of this group). Of the five teachers who profiled as highly ineffective at helping students make academic progress as indicated by their EVAAS value-added scores, their responses were traditional an average of 53 percent of the time, with three of these teachers profiling as highly traditional in their interviews (exhibiting the largest quantity of traditional views of this group).

Constructivist advocates within the math wars argue that their methods will positively impact student learning, although empirical research demonstrating this direct relationship is lacking. In this study, this relationship was directly assessed, and
constructivist tendencies did adequately account for some of these teachers’ EVAAS value added differences, as discussed above. However, all ten teachers addressed numerous topics that were not indicative of the math wars. Perhaps those topics can shed some valuable insight into these teachers’ similarities and differences. The second question from Phase II, in which I looked at the differences between these two sets of teachers without the math-wars lens, provided some additional distinctions between the two groups.

**Results for Question 2b**

The second question from Phase II was based on the desire to compare two different groups of middle school math teachers (those who profile as highly effective and those who profile as highly ineffective), and to capture similarities and differences among these teachers’ thoughts on teaching and learning.

2b. *Compared to each other:* How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

Much of what the teachers had to say in their interviews applied to the topics debated within the math wars and some of that has been addressed in question 1a above, but they had much more to say that did not apply to math wars topics which is addressed here. Dividing these teachers up by their EVAAS value added measures and then looking at what they had to say about teaching and learning provides an interesting view into the minds of teachers who profile similarly to each other versus those who profile differently. I will discuss those themes that appeared throughout their interview data shortly, but first, I look at whether there were any connections between the teachers’ effectiveness levels and their demographics or characteristics, such as race, gender, years of experience, or
lateral entry, as well as school characteristics including student demographics, school size, Title I designation, or each teacher’s average instructional minutes per student.

**Teacher characteristics and teacher effectiveness levels.** As initially reported above, there were numerous characteristics captured about each teacher including race, gender, years of experience, and traditional versus lateral entries into the profession. Each one of these characteristics is discussed below, including whether or not they relate to the teachers’ effectiveness as measured by their EVAAS value added measures.

**Teacher characteristic #1: race.** Of the ten teachers interviewed, the top five consisted of four white teachers and one Asian teacher (see Table 28 below). The bottom five consisted of three white teachers and two African American teachers.

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Race</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>High</td>
<td>W</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td>W</td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td>W</td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td>A</td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td>W</td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>W</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td>AA</td>
</tr>
<tr>
<td>Carol</td>
<td>Low</td>
<td>W</td>
</tr>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>AA</td>
</tr>
<tr>
<td>Matt</td>
<td>Low</td>
<td>W</td>
</tr>
</tbody>
</table>
It is problematic to see that neither of the African American teachers were part of the highly effective group as measured by EVAAS value added measures. Further study would need to be conducted to determine if this finding was a trend among the entire teaching population and, if so, to discern its significance, causes and implications.

**Teacher characteristic #2: gender.** Of the ten teachers interviewed, all five highly effective teachers were female, where all three males interviewed were highly ineffective as measured by their EVAAS value added measures (see Table 29 below).

**Table 29: Teacher Effectiveness & Gender**

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>High</td>
<td>F</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td>F</td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td>F</td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td>F</td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td>F</td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>M</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td>F</td>
</tr>
<tr>
<td>Carol</td>
<td>Low</td>
<td>F</td>
</tr>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>M</td>
</tr>
<tr>
<td>Matt</td>
<td>Low</td>
<td>M</td>
</tr>
</tbody>
</table>
As with the possible race implications noted above, further study would be needed to determine if teacher gender was related to teacher effectiveness, and if that were actually the case, the significance, causes and potential implications.

**Teacher characteristic #3: years of experience.** As noted above, the number of years taught for each participant was self-reported. I calculated the average years taught for each group of participants (see Table 30 below) as a simple average. For the five teachers who profiled as highly effective, their average number of years taught was 15.8, with the lowest having 6 years of experience and the highest having 24 years. For the five teachers who profiled as highly ineffective, their average years taught was only 10.4 years, with the lowest having 5 years in the classroom, and the highest 15 years.

**Table 30: Teacher Effectiveness & Years of Experience**

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Years Taught</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Ashley</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td>23</td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td>24</td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td>6</td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td>18</td>
</tr>
<tr>
<td>Average (High Teachers)</td>
<td>15.8</td>
<td></td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>5</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td>15</td>
</tr>
<tr>
<td>Carol</td>
<td>Low</td>
<td>13</td>
</tr>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>12</td>
</tr>
</tbody>
</table>
Matt | Low | 7
---|---|---
Average (Low Teachers) | 10.4

**Teacher characteristic #4: entry into the profession.** None of the five highly effective teachers as measured by EVAAS value added measures entered the teaching profession through a lateral entry program; rather, they all entered through a traditional licensure route. Three of the five highly ineffective teachers as measured by the EVAAS value added measures entered the classroom through a lateral entry program (see Table 31 below).

**Table 31: Teacher Effectiveness & Entry into the Profession**

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Lateral Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>LE</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Carol</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>LE</td>
</tr>
<tr>
<td>Matt</td>
<td>Low</td>
<td>LE</td>
</tr>
</tbody>
</table>
Further research would be needed in order to determine if either years of experience or lateral entry into the profession were directly related to teacher effectiveness, as both were mutually present and therefore indistinguishable here. Of course, this sample of ten teachers is too small for any real indicators of such a relationship, or lack thereof. If lateral entry was to be indicative of lower effectiveness levels in the field, one possible explanation could be a lack of preparation and/or support for these teachers as they strive to meet the needs of their students.

**School characteristics and teacher effectiveness levels.** In addition to the teachers’ personal characteristics, key qualities of their schools may have an impact on their effectiveness in helping students make progress as measured by their EVAAS value added measures. These include each school’s student body demographics, the school’s size and Title I designation, and each teachers’ average amount of instructional time. I discuss each of these school characteristics below to see if there is a relationship to the teachers’ effectiveness. It is important to note that all four highly ineffective teachers taught at the two repeated school sites. I will discuss the implications of this factor in Chapter 7.

**School characteristic #1: student body demographics.** For the five teachers who profiled as highly effective as measured by the EVAAS value added measures, their five school sites had an average student body that consisted of 37 percent minority students and 44 percent eligible for free or reduced-price lunch. For the five teachers who profiled as highly ineffective as measured by the EVAAS value added measures, their five school sites had an average student body comprised of 48 percent minority students and 51
percent eligible for free or reduced-price lunch. Note that the duplicate schools are counted twice to represent the average conditions in which all ten teachers are working.

The slight increases in both student body categories (percent minority and percent eligible for free or reduced-price lunch) would need to be studied further in order to assess its impact or lack thereof on teacher effectiveness.

### School characteristic #2: school size and Title I distinction.

When looking at the school sites for the five teachers who profiled as highly effective as measured by their

**Table 32: Teacher Effectiveness & Student Body Demographics**

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Site #</th>
<th>% Minority***</th>
<th>% Eligible for Free or Reduced-price Lunch***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>High</td>
<td>Site #1</td>
<td>39%</td>
<td>18%</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td>Site #2</td>
<td>32%</td>
<td>52%</td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td>Site #3</td>
<td>32%</td>
<td>64%</td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td>Site #4</td>
<td>43%</td>
<td>59%</td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td>Site #5</td>
<td>40%</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td><strong>School Average (High Teachers)</strong></td>
<td></td>
<td>37%</td>
<td>44%</td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>Site #6</td>
<td>47%</td>
<td>39%</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td>Site #7</td>
<td>65%</td>
<td>69%</td>
</tr>
<tr>
<td>Carol</td>
<td>Low</td>
<td>Site #7</td>
<td>65%</td>
<td>69%</td>
</tr>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>Site #8</td>
<td>32%</td>
<td>39%</td>
</tr>
<tr>
<td>Matt</td>
<td>Low</td>
<td>Site #8</td>
<td>32%</td>
<td>39%</td>
</tr>
<tr>
<td></td>
<td><strong>School Average (Low Teachers)</strong></td>
<td></td>
<td>48%</td>
<td>51%</td>
</tr>
</tbody>
</table>

***Source: NCES, 2014
EVAAS value added measures, the average school size was 611 students, with 186 students per grade level. In order to calculate the same values for the five teachers who profiled as highly ineffective as measured by their EVAAS value added measures, it is important to note that these five teachers came from only three different schools. Therefore, the two sites that were ‘repeated’ in this sample of ten teachers (site #7 and #8) were all repeated in Table 33 below for calculation purposes. As I mentioned above, I will discuss the possible implications of these repeated sites in Chapter 7 below. With that being said, the school averages for these five highly ineffective teachers were 822 students per school, and 204 students per grade level. It is also interesting to note that two schools among the highly effective teachers were not Title I schools, while all of the schools among the highly ineffective teachers were Title I schools.

Table 33: Teacher Effectiveness & School Size / Title I

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Site #</th>
<th>School Setting*</th>
<th>School Size**</th>
<th>Grades Served at the School***</th>
<th>Average Number of Students per Grade</th>
<th>Title I School***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>High</td>
<td>Site #1</td>
<td>U</td>
<td>1,092</td>
<td>6-8</td>
<td>364</td>
<td>No</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td>Site #2</td>
<td>R</td>
<td>412</td>
<td>6-8</td>
<td>137</td>
<td>Yes</td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td>Site #3</td>
<td>R</td>
<td>421</td>
<td>6-8</td>
<td>140</td>
<td>Yes</td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td>Site #4</td>
<td>R</td>
<td>436</td>
<td>PK-6</td>
<td>55</td>
<td>Yes</td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td>Site #5</td>
<td>R</td>
<td>696</td>
<td>6-8</td>
<td>232</td>
<td>No</td>
</tr>
<tr>
<td>School Average (High Teachers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>Site #6</td>
<td>U</td>
<td>1,182</td>
<td>6-8</td>
<td>394</td>
<td>Yes</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td>Site #7</td>
<td>R</td>
<td>788</td>
<td>K-8</td>
<td>88</td>
<td>Yes</td>
</tr>
</tbody>
</table>
With slightly higher school size and grade-level size for the ineffective teachers included in this study, further research would be needed in order to assess any possible impact on teacher effectiveness within these settings. Likewise, further research would be needed to consider the role of Title I designation on teacher effectiveness as well.

**School characteristic #3: instructional time.** During the interview, I asked the teachers about the number of classes they taught per day, the average number of students per class, and length of each class. I used this self-reported information to determine a number of specifications for each teacher (as reported in Table 34 below), including:

- \# of students = number of classes X average number of students per class
- Average \# of students/class = self-reported
- Class length = self-reported
- Total minutes for the year = class length X 180 days of instruction per year
- Average \# of minutes per student = Total minutes for the year / Average \# of students per class

For the five teachers who profiled as highly effective as measured by their EVAAS value added measures, they taught an average of 92 students for the year, with approximately 29 students in each class. These teachers reported an average of 91 minutes of instructional time per class, which resulted in 16,380 total minutes available for each class, for the entire year. This meant that these five highly effective teachers had

<table>
<thead>
<tr>
<th>Carol</th>
<th>Low</th>
<th>Site #7</th>
<th>R</th>
<th>788</th>
<th>K-8</th>
<th>88</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>Site #8</td>
<td>R</td>
<td>675</td>
<td>6-8</td>
<td>225</td>
<td>Yes</td>
</tr>
<tr>
<td>Matt</td>
<td>Low</td>
<td>Site #8</td>
<td>R</td>
<td>675</td>
<td>6-8</td>
<td>225</td>
<td>Yes</td>
</tr>
</tbody>
</table>

School Average (Low Teachers) 822 204

*Determined by me  **Source: NC Report Card, 2014  ***Source: NCES, 2014
an average of 577 minutes of instruction per student. For the five teachers who profiled as highly ineffective as measured by their EVAAS value added measures, they taught an average of 116 students for the year, with approximately 29 students in each class. These teachers reported an average of 70 minutes of instructional time per class, which resulted in 12,600 total minutes available for each class, for the entire year. This meant that these five highly ineffective teachers had an average of 427 minutes of instruction per student.

**Table 34: Teacher Effectiveness & Instructional Time**

<table>
<thead>
<tr>
<th>Participant</th>
<th>EVAAS Value Added Measure</th>
<th>Site #</th>
<th># of Students</th>
<th>Ave # of Stud/Class*</th>
<th>Class Length (CL)*</th>
<th>Total minutes for the year (CL x 180)</th>
<th>Ave # of minutes per Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>High</td>
<td>Site #1</td>
<td>75</td>
<td>25</td>
<td>90</td>
<td>16,200</td>
<td>648</td>
</tr>
<tr>
<td>Francesca</td>
<td>High</td>
<td>Site #2</td>
<td>120</td>
<td>30</td>
<td>80</td>
<td>14,400</td>
<td>480</td>
</tr>
<tr>
<td>Alice</td>
<td>High</td>
<td>Site #3</td>
<td>80</td>
<td>27</td>
<td>120</td>
<td>21,600</td>
<td>800</td>
</tr>
<tr>
<td>Liann</td>
<td>High</td>
<td>Site #4</td>
<td>83</td>
<td>28</td>
<td>75</td>
<td>13,500</td>
<td>482</td>
</tr>
<tr>
<td>Helen</td>
<td>High</td>
<td>Site #5</td>
<td>102</td>
<td>34</td>
<td>90</td>
<td>16,200</td>
<td>476</td>
</tr>
<tr>
<td>Average (High Teachers)</td>
<td></td>
<td></td>
<td>92</td>
<td>29</td>
<td>91</td>
<td>16,380</td>
<td>577</td>
</tr>
<tr>
<td>Jeff</td>
<td>Low</td>
<td>Site #6</td>
<td>140</td>
<td>28</td>
<td>60</td>
<td>10,800</td>
<td>386</td>
</tr>
<tr>
<td>Kendra</td>
<td>Low</td>
<td>Site #7</td>
<td>135</td>
<td>27</td>
<td>60</td>
<td>10,800</td>
<td>400</td>
</tr>
<tr>
<td>Carol</td>
<td>Low</td>
<td>Site #7</td>
<td>102</td>
<td>34</td>
<td>90</td>
<td>16,200</td>
<td>476</td>
</tr>
<tr>
<td>Jerome</td>
<td>Low</td>
<td>Site #8</td>
<td>83</td>
<td>28</td>
<td>80</td>
<td>14,400</td>
<td>514</td>
</tr>
<tr>
<td>Matt</td>
<td>Low</td>
<td>Site #8</td>
<td>119</td>
<td>30</td>
<td>60</td>
<td>10,800</td>
<td>360</td>
</tr>
<tr>
<td>Average (Low Teachers)</td>
<td></td>
<td></td>
<td>116</td>
<td>29</td>
<td>70</td>
<td>12,600</td>
<td>427</td>
</tr>
</tbody>
</table>

*self-reported

The five highly effective teachers had fewer students for the year (92 vs. 116), and more instructional time per student (577 minutes vs. 427 minutes) than their less
effective counterparts. Certainly more research would be needed to determine any possible relationship between instructional time and teacher effectiveness. However, it is important to note that even in this small data sample, self-reported data may be problematic: two school sites were repeated within this sample of ten teachers (site #7 and #8), and yet those teachers’ self-reported statistics differed on instructional time. Future research would need to heed this caution and use more reliable sources of information than simple self-reported values.

**Concluding thoughts on teacher/school characteristics and teacher effectiveness.** In this section, I looked at the possible connections between the teachers’ effectiveness levels and their demographics or characteristics, such as race, gender, years of experience, or lateral entry, as well as school characteristics including student demographics, school size, Title I distinction, or each teacher’s average instructional minutes per student. It was enlightening to see that most of these teacher and school characteristics seemed to be related to effectiveness in some way, though of course it is equally important to note that this small sample size of just ten teachers is certainly too small to offer any real conclusions. These initial trends, however, do indicate much need for more research in these areas to determine any possible impacts on teacher effectiveness.

For this part of the analysis, I had lifted the veil of looking at the data through the lens of the *math wars*. While it was certainly quite interesting to look into the situational characteristics of these teachers and their schools, and the possible connections to teacher effectiveness, there is much more to consider. Indeed, teachers hold a wide range of beliefs about their students, their schools, their content areas, and education more
broadly; these beliefs exist apart from their philosophy on the math wars. A closer look at what else the teachers had to say about teaching and learning is outlined below.

**Distinguishing characteristics of high and low teachers.** When combing through the data looking for themes, interesting similarities and differences between these two distinct groups of teachers emerged, beyond even those detailed above. Three of the more prevalent themes are discussed here, including these teachers’ views on assessment, their descriptions of the teacher’s responsibilities, as well as their accounts of the role of the student. These distinguishing characteristics for both high teachers and low teachers interviewed in this study are discussed below.

**Distinguishing characteristic #1: assessment.** Regardless of their EVAAS value added measures, all ten teachers had a lot to say about assessment. There were a handful of characteristics that appeared to be quite different among these two groups of teachers, but there were also some surprising overlaps both in terms of how they assessed their students and why they assessed them.

*How they assess.* The five teachers who profiled as highly *effective* as indicated by their EVAAS value added measures spoke of assessment as a constant process in their classrooms: “I’m a big ‘assess as you are going along.’ I don’t think if you wait until after a week to see if the kids get it, it’s a recipe for disaster” (Francesca). The teachers discussed a multitude of ways in which they assess the students’ understanding on the spot and in the moment, or as one said “assess as you go”: observations; student responses and explanations, questions, listening, and the students demonstrating at the board. These teachers discussed how they constantly talk to their students, there is a constant interchange, and they are constantly checking in.
The five teachers who profiled as highly ineffective as indicated by their EVAAS value added measures also had much to say on how they assess their students, including: exit tickets, small white boards, index cards, and Smartboard clickers. One teacher discussed the need to get the kids up and moving as much as possible in order to keep them engaged by using activities including scavenger hunts and four-corners games. When asked about projects, this same teacher described two types: first, she gave one example of a project that she does that was simply a word problem – “I have not really used a lot of projects… now let me take that back. They did do a project. I gave them a scenario like ‘Joe works at a pizza parlor for $9 an hour’ and with that they had to write an equation, they had to create a graph, and they had to create a table.” The second project she described was on the NCAA tournament: “Now several years ago I used to do a big project on the NCAA tournament, and we’d incorporate the fractions, decimals, and percents. We did a big bracket, and your young black male who is traditionally the hardest to reach, he was all over it.”

Differences in how they assess. There are subtle differences between how these two distinct groups of teachers assess students. The highly effective teachers employed very fluid and informal methods of assessment with constant questioning of their students: they listened to how the students were talking about math in their groups, and they observed how students solved problems individually and at the white board. The tools of data collection were the teachers’ own eyes and ears. The highly ineffective teachers were more structured and utilized more formal forms of assessment: exit tickets, small white boards, index cards, and Smartboard clickers. The tools of data collection were physical items, such as paper or computer programs.
Why they assess. The teachers who profiled as highly effective as indicated by their EVAAS value added measures stressed the following purposes for assessing their students: to quickly target who is stuck, to address what the students do not know, and to determine who needs remediation, reinforcement, or acceleration. These teachers described assessment as a work-in-progress and as a tool for them to teach the students. They spoke of the importance of going over the assessment afterwards, as well as for questions from concepts they have already covered to reappear on future tests in order to keep those skills sharp and to reinforce what some struggled with previously.

The teachers who profiled as highly ineffective as indicated by their EVAAS value added measures described assessment as a way for parents to know how the student is doing, or for the students to keep up with what they are supposed to be doing. One teacher described the assessments they give as being simple and not hard, while another teacher saw it as a way to boost their self-confidence and help the students feel good. Most of these teachers discussed the need to check for “mastery” of the material, as a way to do some “standard-checking,” or to ensure the students were “on track.”

Differences in why they assess. There are subtle differences in why these two distinct groups of teachers assess students. The highly effective teachers assessed their students to give themselves (the teachers) insight into how the students were doing. The purpose of the data collection was for personal use so they as the teachers would know the student’s status. The highly ineffective teachers assessed their students to give others (the students or parents) insight into how the students were doing. The purpose of the data collection was for general use so students/parents would know the student’s status.
One interesting discrepancy between these two groups of teachers is the highly effective teachers spoke of how the assessments indicated to them what they needed to reteach. The highly ineffective teachers spoke of how the students could retest on their own if they wanted to try for a better grade. While these two terms appear to be quite similar, the former puts the onus of understanding on the teacher, and the latter puts it on the student. All of the teachers had much more to say about the responsibilities of teachers and students, outside of assessment, which I will discuss below.

Similarities in assessment. Despite profiling as highly effective or highly ineffective at helping students progress, most of the teachers shared some similar views on assessing their students:

- alternative approaches to assessment beyond paper and pencil
- pre-assessing their students prior to starting a new concept to see what prerequisite skills that already had
- the need to ‘fix’ what the students did not know, based on the assessment outcomes

Teachers from both groups also expressed a general disdain for summative standardized testing. From a highly effective teacher: “Assessment is the devil. Summative assessment, standardized assessment, I should say, is the devil.” From a highly ineffective teacher: “I don’t take it too seriously because it’s middle school. I don’t think anybody’s going to live or die. I’m not invested in my test scores. If they [the students] were to bomb, I know they [the school] have to hire me back next year.”

Distinguishing characteristic #2: responsibilities of the teacher. The five highly effective teachers had a lot to say about the responsibilities of the teacher. Their views
varied on some issues, including the incorporation of real-world topics, the importance of classroom organization, and which methods of instruction work best. But there are four consistent themes that were prevalent from this group regarding what the teacher is most responsible for:

1. Requiring a high level of student engagement
2. Promoting confidence
3. Encouraging perseverance
4. Constantly monitoring student understanding

Above all else, these four goals dominated the highly effective teachers’ views on teaching. A closer look at each one of these goals in covered below.

*High: Requiring a high level of student engagement.* The teachers who profiled as highly effective as measured by their EVAAS value added measures talked in many ways about student engagement, from *making things fun* to limiting “*dead time*” caused by faulty transitions, and from using a *wide variety of methods* to ensure things do not stagnate to *saying silly things* to keep their attention. This focus on student engagement appears to be a vital factor of these teachers’ beliefs. While the way they go about it varies from teacher to teacher, the goal is one in the same: to get the students to engage with the content, to get students to pay attention, and to get students to *care*.

*High: Promoting confidence.* These highly effective teachers all shared another belief as well: students need to feel successful in order to actually engage. Repeated failures breeds disengagement, whereas repeated success encourages engagement. These teachers all emphasized the need for student self-confidence in order to be successful, and yet just as they varied in their approaches to student engagement, they too varied in their
tactics to instill confidence in their students. Some gave credit for “every little stitch of effort” where another utilized a “rate yourself poster” for students to indicate their own level of confidence with certain concepts. In this case, the teacher was so focused on building confidence that it mattered just as much to her as the students getting the correct answers. Collectively, these teachers spoke volumes about the importance of moving students out of such strong insecurities that many enter the teachers’ classrooms with, and into a place where they experience success – over and over again – until they believe in themselves.

**High: Encouraging perseverance.** Directly connected to requiring a high level of engagement from their students and creating a plethora of opportunities for success, the third shared component across these teachers’ beliefs was the need for patience. Some of the teachers spoke directly about the need to actually teach patience to their students, where others discussed indirectly the ways they personally worked with students to calm them down from their frustrations with failure and gently but unwaveringly insist they keep at it. These teachers spoke of failures as daily occurrences in their classrooms, and that students need to learn to keep pushing through until they get certain concepts.

**High: Constantly monitoring student understanding.** The glue that seems to hold these three pillars of engagement, confidence, and perseverance together is the teachers’ due diligence in ensuring the students understand each and every component of what is covered. None of these teachers wait for days or weeks to assess their students’ understanding – one teacher even called that a “recipe for disaster.” Instead, they incorporate various strategies for monitoring their students every day, or even every minute. Some spoke of relentlessly questioning their students throughout every lesson to
ensure each person was following, whereas others continually walk around the room to eyeball each student’s work. One teacher employed an entirely different method – she strategically assigned the weakest students to the same seats in each period of the day so that she knew those were the desks she needed to spend the most time at, as those were the students who needed the most finite level of monitoring she could provide. Once again, the teachers used their own methods to accomplish the same goal: check, check, and check again to make sure they’ve got it.

*In conclusion.* Not only were these four concepts embedded within these teachers’ answers more than any other concepts, the teachers spoke of these concepts as highly related to each other. Each highly valued the roles of student *engagement, confidence,* and *perseverance* in collectively supporting student success, and yet these seemed to fall flat without the unwavering foundation of relentless monitoring of student understanding (as illustrated in Figure 7 below).

**Figure 7: The Highly Effective Teacher’s Responsibilities**

![Diagram of the Highly Effective Teacher’s Responsibilities]

Next, I looked at how this belief system compares to the beliefs of the teachers who profiled has *highly ineffective* as measured by EVAAS value added measures.
For the five teachers who profiled as *highly ineffective*, they too had some predominant beliefs across the lot of them regarding the primary responsibilities of the teacher:

1. Requiring a high level of student attention
2. Promoting good feelings
3. Math is secondary to other objectives, like life skills
4. Ensuring students master the basics

All ten teachers discussed the importance of student behavior, but the five *high* teachers consistently described this in terms *student engagement* with the content, whereas the five *low* teachers consistently described this in terms of *student attention* within the classroom. These *low* teachers also spoke of their responsibility in helping the students feel good about themselves. Their two primary focuses of what to teach included (1) the need to prepare their students with skills beyond the scope of the math curriculum, and (2) focusing on the basic math skills required of the curriculum. I discuss each one of these themes in more detail below.

*Low: Requiring a high level of student attention.* The five teachers who profiled as *highly ineffective* based on their EVAAS value added measures spoke of the importance of student attention, such as using videos “to just get their attention, even if that’s the only thing I get out of it,” utilizing activities such as *scavenger hunts* or *video games*, or employing *group work* as an incentive to behave. These teachers discussed how they asked questions about the students’ personal lives specifically to demonstrate that they cared for the students and in turn, the students would pay more attention in class.
Low: Promoting good feelings. These teachers spoke of the importance of helping the students feel good about themselves, with techniques including not grading homework, creating projects centered about the students’ interests such as basketball, or designing vocabulary projects that the students would enjoy. While most of the ten teachers discussed working with students with extremely low math abilities, these five who profiled as highly ineffective seemed to place more value on helping the students feel good, even if it meant compromising the amount of math content they learned.

Low: Math is secondary to other objectives, like life skills. In addition to ensuring their students were paying attention in class and felt good about themselves, these teachers all discussed the importance of preparing their students for life outside of school: “If they learn math along the way, that's fabulous. But I really feel like part of my job as a teacher is to teach kids how to become better people, and learn how to deal with differences and learn how to solve conflicts and stuff.” Other teachers spoke of the desire to have the students feel valued, to know that the teacher cares, or to be a productive member of society: “But I think a good part of what teachers do, or should do, is laying that foundation for them to be productive citizens, to be able to contribute to whatever social group they're a part of, to society as a whole, to their cultural group.” Another teacher summed it up like this: “I choose the things that I think they'll need in the future and that's what I emphasize.”

Low: Ensuring students master the basics. These teachers discussed both how many prerequisites their students were lacking and the teachers’ subsequent focus on low-level skills. One teacher discussed the use of technology to handle the multiplication that students don’t know: “In 7th grade, I don't have time to go back and teach you your
multiplication facts. Do you know how to use them on the calculator? Can you figure out how to do it on a computer? Then I need to make sure know how to use the equipment.”

Another teacher discussed a similar lack of skills: “When they get to me in 6th grade, they should know those times tables. That should be a non-issue.” A third teacher discussed his/her students’ low incoming reading skills: “The reading scores in my county are extraordinarily low, as far as state-wide scores go. It's very difficult, because I think that there's somewhat of an expectation that I'll be a reading teacher as well.”

Where these teachers focused on the how ill-prepared their students came to them, they likewise discussed their focus on the mastery of basic math skills, or in other words, teaching to the bottom of their class and/or teaching to the bottom of the curriculum. Their practices included checking off every single standard for each student, requiring every student at the table to demonstrate mastery of the skill before anyone moves on, or using computer programs that require mastery of the skill before students can advance.

_In conclusion._ The fundamental views of the teacher’s responsibilities as expressed by the highly ineffective teachers are summed up in Figure 8 below.

**Figure 8: The Highly Ineffective Teacher’s Responsibilities**

```
   Student Success
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Requiring Attention</td>
</tr>
<tr>
<td>Promoting Good Feelings</td>
</tr>
<tr>
<td>Ensuring Mastery</td>
</tr>
</tbody>
</table>

Math is secondary to life skills
```
These teachers spoke with great empathy for their students’ entering low-level abilities, and the subsequent disparity between what their students are capable of versus what these teachers are expected to teach them. The teachers expressed great concern in ensuring their students felt good about themselves despite the students’ gross academic inadequacies, and likewise felt strongly about the importance of preparing their students for life outside of school.

Distinguishing characteristic #3: responsibilities of the student. The teachers who profiled as highly effective based on their EVAAS value added measures said less about the role of the student than they did about the role of the teacher, discussed above, but what they said was equally important. Despite their brevity, these teachers did share some similarities on this topic, including:

1. Show initiative
2. Care about your fellow students

These teachers discussed both the strong desire for their students to show initiative, though they all used varying descriptions of how that might look, and a necessity for their students to genuinely care for their peers. Each of these factors are discussed in more detail below.

High: Show initiative. These teachers’ explanations of student initiative ranged from the expectation that students will choose to seek out math assistance during their lunch time, students will choose to be persistent with problems that are difficult for them, and students will choose to seek help when they do not understand, to having the dedication it takes to take on a challenging math course. One teacher described it this way: “Understanding math is not genetic; a lot of it has to do with your attitude.” These
teachers spoke of the importance of students *pushing* through the difficult times, and while teachers share a role in helping them learn that, the students eventually need to internalize these traits themselves.

*High: Care about your fellow students.* The second similarity the highly effective teachers shared was the expectation that students care for their peers. Most of the teachers described this *academically*, such as using peer tutors who genuinely care for the improvement of their tutees, expecting stronger group members to care about the understanding of their peers, or simply knowing that the students must be able to count on each other for assistance as needed. One teacher described the care *behaviorally*: students could not disrupt other students.

*In conclusion.* It is interesting to note that the five teachers who profiled as highly effective as indicated by their EVAAS value added measures spoke volumes about the responsibilities of the teacher, but ultimately offered very little in terms of those of the student. Other than a couple fundamental requirements of student, these teachers’ *lack of words* on this topic may say more than their actual words.

For the five teachers who profiled as *highly ineffective*, they too had some common beliefs regarding the primary responsibilities of the student:

1. Behave
2. Speak up when confused
3. Do the work & do it well

The specifics of what these teachers had to say about these topics and their importance in the classroom is discussed below.
Low: Behave. For some teachers, proper student behavior was described simply as the students doing what they are supposed to be doing, where others noted the importance of more traditional math behaviors, such as listening, taking notes, writing neatly, and showing their work. One teacher defined a ‘good typical math kid’ as one who sits and receives the information via direct instruction, or as the teacher called it, “modeling demonstration.” In any case, some form of general student behavior was expected across all these classrooms.

Low: Speak up when confused. This is actually similar to what the highly effective teachers expected in terms of showing initiative, but for the ineffective teachers, this definition was more narrowly described as speaking, raising your hand, or looking something up yourself. Two teachers preached the importance of students owning the responsibility of saying they are confused, rather than saying nothing at all, and stressed their inability to help these students if they don’t help themselves. For example: “So there is always an effort [on the part of me, the teacher] to give understanding [to the students], but then at the same time I am constantly reminding the kids ‘I need your effort because I can’t read your mind. If you don’t say anything, I’m really not going to know.’”

Low: Do the work & do it well. These teachers used expressions such as “if they’re [the students] willing to do the work,” “you [the student] have to work and put forth effort,” and students need to have “good work ethics… [be] hard workers …care about their grades.” Some teachers spoke of their inability to change students’ work ethic: “Especially after [teaching] six and a half years with middle schoolers. You’re not going to make them want it. They’ve made up their mind a long time ago.” Another teacher spoke of students being in low-level math classes partly due to their own lack of
ambition: “Kids are [in] general math because either they really do have that knowledge gap or they just lack the desire to want to do well in math.” Thus these teachers emphasized the importance of student ownership of learning rather than learning as a responsibility shared by educator and student alike.

In conclusion. For the teachers who profiled as highly ineffective based on their EVAAS value added measures, they certainly had more to say about student responsibility than their more effective counterparts. Perhaps more importantly, though, the ineffective teachers seemed to feel a void of responsibility when students failed to bring the desired traits to the table. Ultimately, these ineffective teachers’ reactions to what students were lacking may be more important than the traits they expected the students to possess in the first place.

Question 2b: Summary of Findings

With the second question from Phase II, I sought to compare two different groups of middle school math teachers (those who profile as highly effective and those who profile as highly ineffective), and to capture similarities and differences among these teachers’ thoughts on teaching and learning. The research question was as follows:

2b. Compared to each other: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

I divided these teachers up by their EVAAS value added measures and then looked at two things: (1) possible connections between the teachers’ effectiveness levels and their personal or school demographics, and (2) what these two distinct groups of teachers had to say about teaching and learning.

First: Teacher/school characteristics and teacher effectiveness levels. I captured numerous characteristics about each teacher including his/her race, gender,
years of experience, and traditional versus lateral entry into the profession. The summary of these findings is as follows:

**RACE:** Of the ten teachers interviewed, the top five consisted of four white teachers and one Asian teacher. The bottom five consisted of three white teachers and two African American teachers.

**GENDER:** Of the ten teachers interviewed, all five highly effective teachers were female, where all three males interviewed were highly ineffective.

**YEARS OF EXPERIENCE:** For the five teachers who profiled as highly effective, their average number of years taught was 15.8 years. For the five teachers who profiled as highly ineffective, their average number of years taught was only 10.4 years.

**ENTRY INTO THE PROFESSION:** None of the five highly effective teachers entered the teaching profession through a lateral entry program; rather, they all entered through a traditional licensure route. Three of the five highly ineffective teachers entered the classroom through a lateral entry program.

In conclusion, it is disheartening to see that neither of the African American teachers nor any of the male teachers were part of the effective group. Of course, this is a very small sample, and further study is needed to determine if either race or gender has such a trend among the entire population. On another note, the discrepancy in the number of years taught between these two groups of teachers is likely related to the fact that three of the ineffective teachers were lateral entry. In this instance too, further research is needed to determine if either years of experience or lateral entry into the profession were directly related to teacher effectiveness, as both were mutually present and therefore
indistinguishable here, and furthermore, this sample of ten teachers is too small for any real indicators of such a relationship, or lack thereof.

In addition to the teachers’ personal characteristics, key qualities of their schools may affect their effectiveness in helping students make progress. These include each school’s student body demographics, the school’s size and Title I designation, and each teachers’ average amount of instructional time. The summary of these findings is as follows:

STUDENT BODY DEMOGRAPHICS: For the five teachers who profiled as highly effective, their five school sites had an average student body that consisted of 37 percent minority students and 44 percent eligible for free or reduced-price lunch. For the five teachers who profiled as highly ineffective, their five school sites had an average student body comprised of 48 percent minority students and 51 percent eligible for free or reduced-price lunch.

SCHOOL SIZE AND TITLE I DESIGNATION: When looking at the school sites for the five teachers who profiled as highly effective, the average school size was 611 students, with 186 students per grade level. The school averages for these five highly ineffective teachers were 822 students per school, and 204 students per grade level. Furthermore, two schools among the highly effective teachers were not Title I schools, while all of the schools among the highly ineffective teachers were Title I schools.

INSTRUCTIONAL TIME: For the five teachers who profiled as highly effective, they taught an average of 92 students for the year, had approximately 29 students in each class, and had an average of 577 minutes of instruction per student. For
the five teachers who profiled as highly ineffective, they taught an average of 116 students for the year, had approximately 29 students in each class, and had an average of 427 minutes of instruction per student.

In conclusion, the differences in both student characteristics (percent minority and percent eligible for free or reduced-price lunch) would need to be studied further in order to assess its impact or lack thereof on teacher effectiveness. Also, with slightly higher numbers in both school size and grade-level size for the ineffective teachers included in this study, further research is needed here as well. Likewise, this possible Title I trend indicates further research would be needed to consider the role of Title I on teacher effectiveness. For the five highly effective teachers, they had fewer students for the year (92 vs. 116), and more instructional time per student (577 minutes vs. 427 minutes), than their less effective counterparts. Certainly more research would be needed to determine any possible relationship between instructional time and teacher effectiveness. However, as discussed above, it is important to note that even in this small data sample, self-reported data may be problematic: two teachers’ self-reported statistics were quite inconsistent from each other even though these two teachers taught at the same site. Future research will need to heed this caution and use more reliable sources of information than simple self-reported values.

**Second: Distinguishing characteristics of high and low teachers.** After combing the data for popular topics debated by the math wars, I went back through to look for any other themes to emerge and thus provide some indications of similarities and differences between these two distinct groups of teachers. I discussed three of the more prevalent themes above, including these teachers’ views on assessment, their descriptions
of the teacher’s responsibilities, as well as their accounts of the role of the student. The summary of these findings is as follows:

**Distinguishing characteristic #1: assessment.** I discussed both how and why these teachers assess. The highly effective teachers employed very fluid and abstract methods of assessment, utilizing their own eyes and ears to give themselves (the teachers) insight into how the students were doing so the teachers would know what they needed to reteach, putting the onus of understanding on the teacher. The highly ineffective teachers were more structured and utilized more concrete forms of assessment, utilizing physical items such as paper or computer programs to give others (the students or parents) insight into how the students were doing so the students could retest, putting the onus of understanding on the student.

I also noted an interesting discrepancy between these two groups of teachers: the highly effective teachers spoke of how the assessments indicated to them what they needed to reteach, whereas the highly ineffective teachers spoke of how the students could retest on their own if they wanted to try for a better grade. While these two terms appear to be quite similar, the former puts the onus of understanding on the teacher, and the latter puts it on the student. Finally, I noted some similarities in assessment across both groups of teachers, including alternative approaches to assessment beyond paper and pencil, pre-assessing their students prior to starting a new concept to see what prerequisite skills that already had, and the teachers’ need to “fix” what the students don’t know, based on the assessment outcomes.

Ultimately, the divergent beliefs in assessment between these highly effective and highly ineffective teachers boils down to this theme: the highly effective teachers felt the
teachers were responsible for the students’ learning, whereas the highly ineffective teachers felt the students were responsible for their own learning.

**Distinguishing characteristic #2: responsibilities of the teacher.** There were four consistent themes from the highly effective teachers regarding what the teacher is most responsible for: (1) requiring a high level of student engagement, (2) promoting confidence, (3) encouraging perseverance, and (4) constantly monitoring student understanding. For the five teachers who profiled as highly ineffective, the teacher was most responsible for: (1) requiring a high level of student attention, (2) promoting good feelings, (3) math is secondary to other objectives, like life skills, and (4) ensuring students master the basics.

The distinctive beliefs in teacher responsibilities between these highly effective and highly ineffective teachers is summarized as: the highly effective teacher’s primary responsibilities were promoting student engagement with the content, whereas the highly ineffective teacher’s primary responsibilities were maintaining student attention within the classroom.

**Distinguishing characteristic #3: responsibilities of the student.** The highly effective teachers expected their students to: (1) show initiative, and (2) care about their fellow students. The highly ineffective teachers expected their students to: (1) behave, (2) speak up when confused, and (3) do the work and do it well. While these two groups of teachers had varying lists of preferred student responsibilities, I noted that the ineffective teachers seemed to feel a void of responsibility when students failed to bring the desired traits to the table, whereas their more effective counterparts accepted responsibility in helping students develop certain traits they were currently lacking. Ultimately, it might
not be so much about what the students are expected to bring to the table with them, but how the teacher responds when students arrive without certain expected traits.

The conflicting beliefs in student responsibilities between these highly effective and highly ineffective teachers coalesces as this: for the highly effective teacher, students need to bring A and B to the table, but if the students do not have these traits, then the teacher will help the students learn these traits, whereas for the highly ineffective teacher, students need to bring X, Y, and Z to the table, and if the students do not have these traits, then there is nothing the teacher can do about that. This clear distinction focuses around what the teachers are going to do about students missing certain skills, rather than the skills themselves.

**Summary of Chapter 5: Phase II Results**

Throughout chapter 5, I laid out the results from Phase II, the qualitative portion of this study, where I addressed the following research questions:

**Question 2** – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. *Compared to research:* How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. *Compared to each other:* How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

In order to address these questions, I covered three sections within this chapter: (1) the descriptive information of the participants, (2) the results for question 2a, and (3) the results for question 2b. Here are some concluding thoughts on each of these four sections.
Section (1): Descriptive information of the participants. I broke out the teachers’ descriptive information into three sections, starting with their personal characteristics, followed by the amount of instructional time each teacher had coupled with basic information about their schools, and finally, the academic range of students that each teacher taught. From these teachers’ gender or race, to their entry into the profession or their instructional time, there were a lot of interesting results from this small group of teachers. There is no doubt that much more information would be needed from future research in order to better assess some of the possible relationships that emerged here in this small data set surrounding teachers’ personal and school characteristics and their effectiveness as educators in helping students make progress.

Section (2): The results for question 2a. The first question from Phase II was based on the current research about effective math teachers, which ultimately boils down to the differing beliefs within the math wars. Side #1 touts more traditional beliefs, where side #2 touts more constructivist beliefs. Using these dichotomous views of effective teaching as the guidelines, I asked teachers various questions in an attempt to determine which views their own beliefs ultimately sided with. On the math wars spectrum ranging from constructivist to traditional, the teachers profiled from highly constructivist (at 78 percent) to highly traditional (at 69 percent) and at various points in between. Three of the teachers who were the most constructivist in this group of ten teachers also had high EVAAS value added measures thus indicating they are highly effective at helping students make academic progress, and three of the teachers who were the most traditional in this group also had low EVAAS value added measures thus indicating they are highly ineffective at helping students make academic progress. Thus, there was some division
between the five highly effective teachers and the five highly ineffective teachers as indicated by their EVAAS teacher value added measures based on their math-wars views. After analyzing these results, I moved on and looked for other characteristics outside of the math wars that may explain some of the differences between these two sets of teachers and their EVAAS value added measures.

Section (3): The results for question 2b. The second question from Phase II was based on the desire to compare two different groups of middle school math teachers (those who profile as highly effective and those who profile as highly ineffective), and to capture similarities and differences among these teachers’ thoughts on teaching and learning. Three of the more prevalent themes included these teachers’ views on assessment, their descriptions of the teacher’s responsibilities, as well as their accounts of the role of the student. As I set out these differences in the sections above, it became apparent that something more important was going on here: the highly effective teachers felt a need to help students learn that which they should know but currently do not, whereas the highly ineffective teachers did not.

From personal and school characteristics to differing opinions on teaching and learning, these ten teachers have provided a lot of information about their similarities and differences. But what does it all mean? Where do we go from here? There is much to discuss on these topics and more, in Chapter 7.
CHAPTER 6
THE CURIOUS CASE OF AN OUTLIER

While many results from the quantitative and qualitative data in this study were in sync, to some degree, for one teacher, these two data sources did not agree. Here I explore the contradiction that occurs in this study between quantitative and qualitative results in the case of this outlier: Jeff. After hours of interviews, weeks of transcribing, and months of coding and analyzing while still blind, I felt confident that Jeff was a highly effective teacher. In this chapter, I discuss Jeff’s qualitative results as vetted in the math wars literature, then I cover my assessment of him as someone who is highly qualified to comment on Jeff’s teaching practice, followed by his quantitative results and the subsequent conflict that occurred between these measures of effective teaching. Finally, I discuss the intricacies in trying to measure and evaluate effective teachers, including how North Carolina is currently assessing their teachers in the teacher evaluation system.

The Contradiction: When Quantitative and Qualitative Results Collide

An outlier is an observation that lies an abnormal distance away from other values in a random sample of the population (National Institute of Standards and Technology (NIST), 2014). In a sense, this definition leaves it up to the analyst to decide what will be considered abnormal, and thus before abnormal observations can be singled out, it is necessary to characterize the normal observations (NIST, 2014). When Jeff’s qualitative results and quantitative results are combined, he did not fit within the rest of the teachers
included in this study, which is why I labeled him as an outlier. For the rest of the group, or what I used as the baseline for the normal observations, the qualitative results (traditional versus constructivist views) aligned fairly well with the quantitative results (highly effective/ineffective based on EVAAS value added measures). The teachers who profiled as highly effective tended to be more constructivist and the teachers who profiled as highly ineffective tended to be more traditional. This was not the case with Jeff, as his answers were mostly constructivist too, yet he profiled as highly ineffective (see Figure 9 below).

**Figure 9: Teacher Effectiveness versus Percent Constructivist, with Jeff noted**

![Bar chart showing teacher effectiveness and percent constructivist.]

*This average does not include Jeff’s percentage, as his was excluded as an outlier.

Of the five teachers who profiled as *highly effective* at helping students make academic progress as indicated by their EVAAS value-added scores, their responses were *constructive* an average of 70 percent of the time. On the other end of the spectrum, of the five teachers who profiled as *highly ineffective* at helping students make academic progress as indicated by their EVAAS value-added scores (including Jeff), their responses were *constructive* only an average of 53 percent of the time. If Jeff is removed
as an outlier from this group, then their responses were *constructive* only an average of 41 percent of the time. Jeff’s responses were constructivist 68 percent of the time, which is much more in line with the teachers who profiled as highly effective. This contradiction is what earned him the outlier label. Below, I discuss Jeff’s qualitative results as grounded in the math wars, then I cover my assessment of him, followed by his quantitative results and the subsequent conflict that occurred between these measures of effective teaching.

**Jeff’s qualitative results.** By producing the *Curriculum and Evaluation Standards for School Mathematics*, NCTM (1989) promoted a strong emphasis on inquiry-based or constructivist instruction, including the following teacher beliefs or characteristics:

1. Support student attempts of multiple strategies
2. Acknowledge student effort and creativity
3. Encourage exploration of math problems
4. Value social interaction among students
5. Employ scaffolding by fostering interactions between the learner and a more knowledgeable peer or adult
6. Encourage mistakes as part of the learning process
7. Scaffold responses to higher levels of understanding, and
8. Provide substantive feedback that can help students’ future problem-solving efforts

(Carpenter & Fennema, 1991; Cobb, Wood, & Yackel, 1993; Lampert, 1991; Prawat, Remillard, Putnam, & Heaton, 1992; Stipek et al., 1998; Stipek, Givvin, Salmon, & MacGyvers, 2001)

The majority of Jeff’s responses in his interview were constructivist, for they aligned with the types of beliefs noted above that are prevalent in the literature on this topic. Here
are some examples of Jeff’s responses and how they align with most of the NCTM’s constructivist traits listed above:

1. Support student attempts of multiple strategies

   “There's multiple ways to do this, to arrive at the same solution.”

2. Acknowledge student effort and creativity

   “That's a 'teacher prerogative'. I think most of us do give partial credit. I think I'm the only one on our team that the kids can retake a test. They can retake it a thousand times but they have to review with me before retaking it. Typically it's during lunch. They'll come back one day and review and come back the following day and retake it. For full credit.”

3. Encourage exploration of math problems

   “I allow kids to investigate and come to the conclusion of this is what the concept is or this might be what the rule is, or this is how you might apply that. It's more investigative, which is good.”

4. Value social interaction among students

   “They have investigation problems that they run through. And they typically will work in small groups... the desks are arranged four to a group. The investigation problems are, whatever the concept it, they kinda tear that concept apart and try to allow kids to investigate and come to the conclusion of this is what the concept is or this might be what the rule is, or this is how you might apply that. It's more investigative, which is good.”

5. Employ scaffolding by fostering interactions between the learner and a more knowledgeable peer or adult

   “I typically do will do high end, low end in the same group. Within a group, 2 high and 2 low... they'll run it for 2 weeks and then we rotate it out. When you group kids 2 high and 2 low, I think it's good for the low-end kids, but I think you also hurt the high-end kids. They're not stretched enough. I think what I need to do as a teacher and diverge from that a little bit from time to time.”

   “Yeah I definitely have kids and I will typically pull kids to be, I don't want to call them TA because that's a lot more involved than just helping other kids but I have kids that will float, to help. And I think that's good, there's no better way to learn something than having to teach it. So I like to take my very high-end kids
and just have them float around. Now I can't do that too often because most times the concepts are new or deeper, but on occasion I can pull those kids.”

6. Encourage mistakes as part of the learning process

“They can retake it a thousand times but they have to review with me before retaking it.”

It was clear that inquiry-based instruction was important to Jeff, and that his beliefs on teaching and learning were coming from a solid constructivist foundation. Based on the qualitative data grounded in literature, Jeff was a very effective teacher.

My assessment of Jeff. Before offering my opinions of Jeff’s abilities, it is important to discuss my background in order to understand why I can serve as a qualified assessor of Jeff’s effectiveness. As covered in Chapter 3, I was the only researcher conducting, analyzing, and reporting on these interviews, and therefore was both the instrument of data collection and the analyst for these interviews. My background is both experiential and theoretical, as I have been a classroom teacher and have studied teacher education. I taught middle and high school mathematics for six years, and as a scholar of teacher education, I have been studying it’s intricacies for eight years. I drew upon all of this experience as I conducted Jeff’s interview, analyzed the data, and assessed his effectiveness as a teacher. In my opinion, Jeff is a stellar teacher: he is seasoned, calm, speaks intelligently, and is passionate about his students. During the hour-long interview, he spoke of running a tight ship, demanding high expectations, incorporating a complex system of differentiation, and believing in this students. These characteristics seemed to be right in line with what the literature says about good teaching, and what I personally identify as good teaching based on my own experience and expertise. In full disclosure, I most identified with Jeff’s vision of teaching and learning based on how I ran my own
classroom. Accolades came from his school as well, for he was chosen as teacher of the year the same year that I conducted his interview. Based on my expert opinion (from his interview responses), and the school’s opinion (noted by his “teacher of the year” designation), Jeff is a very effective teacher.

**Jeff’s quantitative results.** Based on the EVAAS value added measures, Jeff was rated as highly ineffective. While teachers receive EVAAS value added measures every year, they had to have two separate years of statistically significant data indicating they were highly ineffective in both years in order to be labeled as highly ineffective in this study. This meant that, for two different cohorts of students over the course of two different years, there was significant evidence that on average, his students failed to maintain the same amount of academic growth that their peers did across the state of North Carolina. In terms of the quantitative data, Jeff was a very ineffective teacher.

**Therein lies the conundrum.** Based on qualitative data grounded in constructivist literature and based on my expert opinion, Jeff is a highly effective teacher. Based on quantitative data that was statistically significant for two separate years, Jeff is a highly ineffective teacher. The case of Jeff presents a challenge in the world of assessing teaching effectiveness: various measures of teaching effectiveness can fail to align with each other. So what is to be done about that? Before that discussion, it is important to look closer at the intricacies of trying to measure teaching effectiveness, including the difficulties that come with this task, and how a state such as North Carolina attempts to address such issues in its own teacher evaluation policies.
The Intricacies of Measuring Teaching Effectiveness

It has been stated that, “theoretically, teaching effectiveness and student success should be correlated” (Onkvisit & Shaw, 2004, p. 14), but in the case of Jeff, this was not the case: different measures of teaching effectiveness yielded different results. This actually is not surprising, for each source of a teacher effectiveness measurement “can supply unique information, but also is fallible, usually in a way different from the other sources” (Berk, 2005, p. 49). In the sections below, I outline the difficulties of measuring teaching effectiveness, the potential relationship between school data and teacher data, and cover the current educator evaluation policy in North Carolina.

The difficulties in measuring teaching effectiveness. There is potential fallibility in any individual measure of teaching effectiveness; for example, “the unreliability or biases of peer ratings are not the same as those of student ratings; student ratings have other weaknesses” (Berk, 2005, p. 49). The unreliability across the sources discussed for Jeff above highlight these issues, and it is because of these difficulties that over the past two decades, there has been a trend toward augmenting any one data source with other data sources of teaching performance (Berk, 2005). The use of multiple sources can serve to broaden and deepen the evidence base used to evaluate and assess teaching effectiveness (Arreola, 2000; Braskamp & Ory, 1994; Knapper & Cranton, 2001; Seldin & Associates, 1999). The idea is that by drawing on three or more different sources of evidence, each source shows different pieces of information, thereby converging on an indicator of teaching effectiveness that is broader than one based on any single source (Appling, Naumann, & Berk, 2001). This notion of triangulation is derived from a compensatory model of decision making: given the complexity of measuring the art of
teaching, “it is reasonable to expect that multiple sources can provide a more accurate, reliable, and comprehensive picture of teaching effectiveness than just one source” (Berk, 2005, p. 49). The case of Jeff’s conflicting results across multiple sources provides the perfect case to argue for triangulation in measures of teaching effectiveness. That approach is precisely what North Carolina employs, which I will describe below.

It is also important to note that there was a lag in time between Jeff’s quantitative data and qualitative data, as was the case for all ten teachers included in this study. The quantitative data came from Jeff’s first three years of teaching, and the interview was conducted for the qualitative data in his fifth year of teaching. This disconnect with Jeff’s highly ineffective quantitative results (first three years of teaching) and his highly effective qualitative results (fifth year of teaching) could be partially explained by his own growth as a teacher over time.

*School data versus teacher data.* I have already discussed that Jeff was designated as a highly ineffective teacher based on his EVAAS value added measure. However, it is important to consider other self-reported data from Jeff based on the teaching environment within his school, including *total number of students taught* and *average number of minutes per student.*

Across all ten teachers, the self-reported data for the *total number of students taught* for the school year ranged from 75 students to 140 students. The average among the highly effective teachers was 92 students, with a range of 75 to 120. The average among the highly ineffective teachers was 116 students, with a range of 83 to 140 (see Table 34 in Chapter 4 above). There is a difference of 24 students between these two
groups of teachers, which is roughly equivalent to an entire class. Within this data, Jeff reported the highest number of students, 140, for the school year.

I used the self-reported student and class data across all ten teachers to then calculate the average number of minutes per student for each teacher (I discussed my calculation process in Chapter 4 above). For all ten teachers, this value ranged from 360 minutes to 800 minutes; the mean among the highly effective teachers was 577 minutes per student, and the mean among the highly ineffective teachers was 427 minutes per student (see Table 34 in Chapter 4 above). There is a difference of 150 minutes per student of instructional time between these two groups of teachers. Within this data, Jeff had the second lowest amount of instructional time per student: 386 minutes. However, it is interesting to note that one of the other teachers identified as highly ineffective based on his/her EVAAS value added measure had the third highest amount of instructional time per student: 514.

Jeff reported the highest number of students, 140, for the school year, and the second lowest amount of instructional time per student at 386 minutes. These data are important information to consider in conjunction with his EVAAS value added measure, as they may have an impact on Jeff’s ability to help students make progress. However, it is important to note that these data on the total number of students taught and average number of minutes per student come from Jeff’s self-reported values, and Jeff is just one sample. This may provide further support for the use of multiple methods of determining overall teacher effectiveness, and further study would be needed to determine if there is a relationship between these factors and teacher value added measures.
North Carolina educator evaluation process. The North Carolina Educator Evaluation System is the tool used across the state to evaluate teachers, with the expectation that all teachers will meet basic levels of proficiency (NCDPI, 2013). The standards that comprise the North Carolina Educator Evaluation System “reflect the complexity of education in the 21st century by emphasizing the important roles of leadership, teamwork and collaboration, higher order thinking, authentic assessment, and technology-infused learning” (NCDPI, 2013, p. 1), as noted in Figure 10 below.

Figure 10: North Carolina Educator Evaluation System

School administrators determine the ratings on the first five standards based on evidence from observations and other data, whereas the sixth standard rating is determined by student growth data aggregated at the teacher-level (NCDPI, 2013). Student growth data (EVAAS, for those teachers that have this value) is only one measure of teacher effectiveness. For Jeff, this measure happens to conflict with other indicators of effectiveness, further reinforcing the need for multiple measures. In this section, I have discussed the policy for educator evaluation in North Carolina, which
includes multiple measures, but it is important to note the implementation of the policy may not always align with the policy as it is written and intended. For example, principal observations of teachers happen throughout the school year, and EVAAS value added measures for teachers are not calculated until after students take the exams at the end of the school year and that data is analyzed. Thus, in theory, the results of the principal’s observations are not influenced by positive or negative results for the teacher from EVAAS, as those observations must occur prior to student testing (and any subsequent EVAAS analysis for that year), just as the EVAAS value added measures are not influenced by principal observations. However, it is possible that a principal may be aware of a teacher’s prior year EVAAS results when conducting observations in the current year. Therefore, whereas the educator evaluation policy seems sound, the implementation of that policy into practice may experience issues of this sort.

In the case of Jeff, I was not privy to any other data within the educator evaluation system for him with the exception of his EVAAS value added measure. It is this value (low), in conjunction with the designation of teacher of the year which might serve as a proxy for other information in his educator evaluation results (assumed to be high), and his interview data which profiled as more constructivist in nature (high, according to literature), that collectively create the discrepancies I have discussed in this chapter.

Summary

So what does this mean? Jeff was doing so many of the right things according to the literature on effective teaching, and yet his students’ data indicated poor growth results. Ultimately, this may imply that (1) the literature might not yet capture all there is to know about effective teaching, and/or (2) a quantitative indicator, such as an EVAAS
value added measure, does not encompass everything there is to know about a teacher’s effectiveness, and/or (3) an EVAAS value added measure might account for more than just the effect of the teacher. In Jeff’s interview, he clearly thought about the importance of student learning:

“Part of my job, at least I believe as a teacher, is I hear that [students think they cannot learn], I try to break down that hurdle because if a student has a hurdle of thinking that they can't learn, then that just doubles my effort to try to get them to learn. They've gotta do twice as much work. So my job is to break down that first barrier to show them 'you can learn this. You just have to start trusting in what you can do.”

Jeff also discussed the importance of pushing students to excel by allowing them to ‘get a taste’ of higher-level concepts, in an attempt to broaden their horizons. He develops and employs three levels of differentiated instruction in his classroom everyday:

“I let kids choose [which level], and everybody wants to go to the highest level, and then they find out how hard it is and they’ll back off, so after about two weeks they gravitate to where they're at. But at least they get a taste of what the higher end is.”

Despite these valiant efforts, the data from Jeff’s students did not support the claim that his system was working to achieve the desired effects: promoting student learning. Thus his EVAAS value added measure, which is a direct indicator of student growth, was significantly low for two separate years of student data. While there’s more to discuss about this outlier and its possible implications, I’ll hold those thoughts for Chapter 7.
CHAPTER 7

DISCUSSION & CONCLUSIONS

“I don’t believe that there is a formula, that you can say ‘if you do this, then this is going to work for every kid.’”

– Francesca

The art of good teaching requires that teachers assess what their students need and adjust accordingly, for there is no formula that can quantify what will work every time for every child. If students need access to good teachers in order to learn to their fullest potential, then it is important that structures are put in place to ensure students have that access, especially if the students’ success in school, class by class, grade by grade, will ultimately earn them a high school diploma, or cost them one. In this study, I set out to assess the degree to which good teaching, or effective teaching, matters to student learning, especially when its effects are compounded over the course of multiple years (Phase I). Then, I wanted to see if there was a difference in the teachers’ beliefs between those who profile as highly effective versus highly ineffective (Phase II). The research questions covering both of these issues were as follows:

Question 1 – Does mathematics teacher effectiveness affect student achievement when compounded over multiple years?

1a. Short-term effects: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?
1b. *Long-term effects*: Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

Question 2 – What are effective/ineffective mathematics teachers’ beliefs about teaching and learning?

2a. *Compared to research*: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

2b. *Compared to each other*: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

Below, I summarize and discuss the results from this study and discuss its limitations as well as its implications for future research.

**Summary & Discussion of Major Results**

In general, I found that, quantitatively, the compounding effects of highly effective or highly ineffective teaching over the course of three years is quite staggering, and, qualitatively, the teachers who profile as highly effective or highly ineffective have some very distinct views on teaching and learning. Both of these results have implications for how we measure effective teaching through such tools as value-added models, but go much further than that, for these results could influence how we train, support, and assess our educators, and how we work to ensure students have equal access to highly effective teachers as we seek to prepare them for life after graduation. In fact, policies on graduation requirements may need to consider *student access* to highly effective teachers when determining how high to set the bar for our youngsters these days. Before these myriad implications can be discussed, it is important to review the major results of this mixed methods study.
Summary of the Major Quantitative Results (Phase I)

**Question 1a**

For the first quantitative question of this study, I looked for the measurable effects of teacher effectiveness on student achievement when it gets compounded by three years in a row of students being assigned to highly effective or highly ineffective teachers as indicated by their EVAAS value added measures. This question had three parts: (1) how did the students fare, overall, based on these three-year compounding effects, and (2) how did students fare, by achievement group, based on these three-year compounding effects, and (3) is the effect different for different achievement groups? Formally, the research question was as follows:

1a. *Short-term effects*: When students are assigned to effective/ineffective middle school mathematics teachers for three years in a row, what is the measurable effect on student achievement? What is the measurable effect on student achievement for students at varying levels of entering achievement? Is the measurable effect different depending on the entering achievement level of students?

As with all portions of Phase I, the analyses were conducted under the direction of the EVAAS analytic team. The results of their analyses were reported above and are summarized here.

**Question 1a – Part (1): How did the students fare, overall, based on these three-year compounding effects?** Regardless of students’ achievement levels, those with LLL teachers lost 10.5 NCE points, on average, and students with HHH teachers gained 5.4 NCE points, on average.

**Answer:** This resulted in a difference of 15.9 NCE points between these two groups of students after spending three years with their respective teachers (statistically significant based on a two-sample t-test).
Question 1a – Part (2): How did students fare, by achievement group, based on these three-year compounding effects?

*Low Achieving Students:* There was a difference of 18.1 NCE points between these two groups of low achieving students: one group that spent three years with highly effective teachers and one that spent three years with highly ineffective teachers.

*Average Achieving Students:* There was a difference of 15.5 NCE points between these two groups of average achieving students: one group that spent three years with highly effective teachers and one that spent three years with highly ineffective teachers.

*High Achieving Students:* There was a difference of 17.5 NCE points between these two groups of high achieving students: one group that spent three years with highly effective teachers and one that spent three years with highly ineffective teachers.

*Answer:* The compounding effects of having highly effective or highly ineffective teachers for three years in a row affected all levels of learners (low, average, and high achieving students) (statistically significant based on a two-sample t-test).

Question 1a – Part (3): is the effect different for different achievement groups? For the final part of this question, I looked at whether the gaps for each student achievement level differed from each other.

*Answer:* Based on a two-way ANOVA test for a significant interaction, there was no statistically significant interaction in how each of the three student achievement levels (low, average, and high) was affected, when their gaps were compared to each other.

**Question 1b**

For the second quantitative question of this study, I looked for the measurable effects of teacher effectiveness on student achievement *beyond 8th grade math* when it
gets compounded by three years in a row of students being assigned to ineffective teachers versus those who get assigned to effective teachers (as indicated by their EVAAS value added measures). This question had two parts: (1) how did this experience effect the students’ projected Algebra I scores, and (2) how did this experience effect the students’ projected SAT Math scores? Formally, the research question was as follows:

1b. *Long-term effects:* Is there an effect on the students’ projected Algebra I NCE score? On their projected SAT Math scale score?

As with all portions of Phase I, the analyses was conducted under the direction of the EVAAS analytic team. The results of their analyses were reported above and are summarized here.

**Question 1b – Part (1): How did this experience effect the students’ projected Algebra I scores?** Regardless of the students’ achievement levels, those with LLL teachers had a projected Algebra I NCE score of just under 50, on average, and students with HHH teachers had a projected Algebra I NCE score of just over 67, on average.

*Answer:* This resulted in a difference of 17.43 NCE points between these two groups of students after spending three years with their respective teachers.

**Question 1b – Part (2): How did this experience effect the students’ projected SAT Math scores?** Regardless of the students’ achievement levels, those with LLL teachers had a projected SAT Math scale score of around 453, on average, and students with HHH teachers had a projected SAT Math scale score of around 526, on average.

*Answer:* This resulted in a difference of 73 scale score points between these two groups of students after spending three years with their respective teachers.

As noted above, the results for Question 1b regarding both Algebra I and SAT Math were significant. Clearly it made a difference in the short term (Algebra I) and the
long term (SAT Math) if the students spent three years in a row with highly effective teachers or three years in a row with highly ineffective teachers (as measured by their EVAAS value added measures).

**Discussion of the Major Quantitative Results (Phase I)**

The compounding effects of having highly effective or highly ineffective teachers for three years in a row affected all levels of learners (low, average, and high achieving students) (see Table 35 below). However, it is interesting to note that when the low achieving students were with highly effective teachers three years in a row (HHH), these students experienced the most gains (13.61 mean NCEs). And similarly, when the high achieving students were with highly ineffective teachers three years in a row (LLL), these students experienced the most loss (-14.88 mean NCEs).

**Table 35: Student Gains by Student Achievement Levels and Teacher Effectiveness Sequence**

<table>
<thead>
<tr>
<th>Student Achievement Level</th>
<th>Teacher Effectiveness Sequence</th>
<th>Number of Students</th>
<th>Percent of Students</th>
<th>Student Achievement Gains Mean (NCEs)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Achieving Students</td>
<td>HHH</td>
<td>208</td>
<td>49%*</td>
<td>2.70</td>
<td>10.72</td>
</tr>
<tr>
<td></td>
<td>LLL</td>
<td>46</td>
<td>11%</td>
<td>-14.88**</td>
<td>10.26</td>
</tr>
<tr>
<td>Average Achieving Students</td>
<td>HHH</td>
<td>78</td>
<td>18%</td>
<td>7.92</td>
<td>10.99</td>
</tr>
<tr>
<td></td>
<td>LLL</td>
<td>31</td>
<td>7%</td>
<td>-7.67</td>
<td>13.42</td>
</tr>
<tr>
<td>Low Achieving Students</td>
<td>HHH</td>
<td>44</td>
<td>10%</td>
<td>13.61**</td>
<td>13.36</td>
</tr>
<tr>
<td></td>
<td>LLL</td>
<td>19</td>
<td>4%*</td>
<td>-4.58</td>
<td>9.64</td>
</tr>
</tbody>
</table>

*Student groups representing the largest/smallest portion of this population

**Student groups exhibiting the most gains/losses**
Of all six student/teacher pairings displayed in Table 35 above, the most students (208, or 49 percent of this group) were high achieving and spent three consecutive years with highly effective teachers (HHH), and the least students (19, or 4 percent of this group) were low achieving and spent three consecutive years with highly ineffective teachers (LLL). One possible explanation for this could be the stability of these two populations (students and teachers): in order for students to be included in this study, they had to have math test scores from 3rd grade through 8th grade, yet low achieving students tend to miss more tests than high achieving students and have higher mobility rates (Sanders, 2000). In order for teachers to be included in this study, they needed to have EVAAS value-added scores in middle school math for three consecutive years. While this study did not look at teacher retention rates based on EVAAS teacher value added, these findings could indicate that ineffective teachers switch teaching assignment, or exit the profession, more frequently than their counterparts. Of course, more research would need to be conducted to verify or dispute that possibility. When looking at the current research on this subject, there appear to only be three studies that have examined the relationship between teacher mobility and attrition rates and teacher effectiveness (using direct measures of teachers’ effectiveness), and they all report that teacher effectiveness is in fact positively associated with retention in specific schools or the profession (Hanushek, Kain, O'Brien, & Rivkin, 2005; Krieg, 2006; and Goldhaber, Gross, & Player, 2007), essentially saying that effective teachers do stay in the profession – findings that could offer a rebuttal to the concern that public schools are losing their best teachers (West & Chingos, 2009).
The final result from the quantitative portion of this study assessed the long-term effects of this three-year experience for these students by looking at their projections to SAT Math: this resulted in a difference of 73 scale score points between these two groups of students after spending three years with their respective teachers. One study found that when controlling for high school grades and other test scores, a 100-point increase in SAT scores adds about 0.05 of a grade point to college freshman’s GPAs (Geiser & Studley, 2002).

**Summary of the Major Qualitative Results (Phase II)**

For Phase II, I conducted interviews with ten middle school math teachers across the state of North Carolina in order to capture their thoughts on teaching and learning. I chose these teachers because they either profiled as highly effective or highly ineffective at helping students make academic progress as indicated by their EVAAS value-added scores, and I conducted the interviews with questions aimed at determining where the teachers sided within the math wars: two opposing views on what effective math teaching looks like. All of this was done in an attempt to determine if the beliefs differed between highly effective and highly ineffective teachers, and ultimately to determine if the winning side of the math wars, constructivism, is related to VAMs of effective teaching.

**Question 2a**

For the first qualitative question of this study, I looked for a relationship between teacher beliefs (traditional or constructivist) and teacher effectiveness (highly effective or highly ineffective as indicated by EVAAS value added measures). Formally, the research question was as follows:
2a. *Compared to research*: How do instructional practices and beliefs of effective/ineffective mathematics teachers relate to what research indicates are qualities of effective teachers?

Ultimately, there was some division between the five highly effective teachers and the five highly ineffective teachers as indicated by their EVAAS teacher value added measures based on their math wars views; the qualitative results (traditional versus constructivist views) aligned fairly well with the quantitative results (highly effective/ineffective based on EVAAS value added measures). The teachers who profiled as highly effective tended to be more constructivist and the teachers who profiled as highly ineffective tended to be more traditional.

Of the five teachers who profiled as highly effective at helping students make academic progress as indicated by their EVAAS value-added scores, their responses were constructive an average of 70 percent of the time, with three of them profiling as highly constructivist in their interviews (exhibiting the largest quantity of constructivist views of this group). Of the five teachers who profiled as highly ineffective at helping students make academic progress as indicated by their EVAAS value-added scores, their responses were traditional an average of 53 percent of the time, with three of these teachers profiling as highly traditional in their interviews (exhibiting the largest quantity of traditional views of this group).

*Answer*: The math wars provide some distinction, as constructivist beliefs were more prevalent in the highly effective teachers, and less prevalent in the highly ineffective teachers (based on their EVAAS value added measures).
Question 2b

For the second qualitative question if this study, I looked at the differences between these two sets of teachers without the math wars lens in order to provide some additional distinctions between these two groups. The research question was as follows:

2b. Compared to each other: How do instructional practices and beliefs differ among effective/ineffective mathematics teachers?

I divided these teachers up by their EVAAS value added measures and then looked at two things: (1) possible connections between the teachers’ effectiveness levels and their personal or school demographics, and (2) what these two distinct groups of teachers had to say about teaching and learning.

Question 2b – Part (1): Are personal/school characteristics related to teacher effectiveness levels? I captured numerous personal characteristics about each teacher including his/her race, gender, years of experience, and traditional versus lateral entry into the profession. Of the ten teachers interviewed, the five highly effective teachers consisted of four white teachers and one Asian teacher, all five were female, they had an average of 15.8 years teaching experience, and they all entered the profession through a traditional licensure route. The five highly ineffective teachers consisted of three white teachers and two African American teachers, two were female and three were male, they had an average of 10.4 years teaching experience, and three entered the profession through a lateral entry program.

In addition to the teachers’ personal characteristics, key qualities of their schools may influence their effectiveness in helping students make progress. These include each school’s student body demographics, the school’s size and Title I designation, and each teachers’ average amount of instructional time. For the five highly effective teachers, their
five school sites had an average size of 611 students with a student body that consisted of 37 percent minority students and 44 percent receiving free or reduced-price lunch. Furthermore, two schools among the highly effective teachers were not Title I schools. These teachers instructed an average of 92 students for the year, had approximately 29 students in each class, and had an average of 577 minutes of instruction per student. For the five highly ineffective teachers, their three school sites had an average size of 822 students with a student body comprised of 48 percent minority students and 51 percent receiving free or reduced-price lunch. Moreover, all of the schools among the highly ineffective teachers were Title I schools. These teachers instructed an average of 116 students for the year, had approximately 29 students in each class, and had an average of 427 minutes of instruction per student.

**Answer:** It is unclear, but some of these results are disheartening: neither of the African American teachers, nor any of the male teachers, nor either of lateral entry teachers were part of the effective group. The ineffective teachers worked in schools that were more racially and socioeconomically diverse than their more effective peers. School size and grade-level size for the ineffective teachers may have had an effect, as well may have the fact that these teachers were in Title I schools. Finally, the five highly effective teachers had fewer students for the year (92 vs. 116) and more instructional time per student (577 minutes vs. 427 minutes) than their less effective counterparts. These trends could indicate the presence of a school effect that directly impacts a teacher’s ability to be effective. Of course, this sample of ten teachers is too small for any conclusive indicators of any such relationships, or lack thereof (additional limitations and needs for further research are discussed below). Other studies have looked at some of these
relationships already, with mixed results (O'Neil, 1995; Kane, Rockoff, & Staiger, 2008; Leigh, 2010; Rice, 2003; Rivkin, Hanushek, & Kain, 2005).

**Question 2b – Part (2): Are there distinguishing characteristics of highly effective and highly ineffective teachers?** After combing the data for popular topics debated by the math wars, I went back through to look for any other themes to emerge and thus provide some indications of similarities and differences between these two distinct groups of teachers. I discussed three of the more prevalent themes above, including these teachers’ views on assessment, their descriptions of the teacher’s responsibilities, as well as their accounts of the role of the student. The summary of these findings is as follows:

**Distinguishing characteristic #1: assessment.** Ultimately, the divergent beliefs in assessment between these highly effective and highly ineffective teachers boil down to this: the *highly effective* teachers felt the *teachers were responsible* for the students’ learning, whereas the *highly ineffective* teachers felt the *students were responsible* for their own learning.

**Distinguishing characteristic #2: responsibilities of the teacher.** The distinctive beliefs in teacher responsibilities between these highly effective and highly ineffective teachers is summed up as this: the *highly effective* teacher’s primary responsibilities were promoting *student engagement* with the content, whereas the *highly ineffective* teacher’s primary responsibilities were maintaining *student attention* within the classroom.

**Distinguishing characteristic #3: responsibilities of the student.** The conflicting beliefs in student responsibilities between these highly effective and highly ineffective teachers coalesces as this: for the *highly effective* teacher, students need to bring A and B
to the table, but if the students don’t have these traits, then the teacher will help the students learn these traits, whereas for the highly ineffective teacher, students need to bring X, Y, and Z to the table, and if the students don’t have these traits, then there is nothing the teacher can do about that. This clear distinction focuses around what the teachers are going to do about students missing certain skills, rather than the skills themselves.

**Answer:** Yes, there are distinct characteristics between highly effective and highly ineffective teachers’ beliefs. The highly effective teachers felt the teachers were responsible for the students’ learning, that the teacher’s primary responsibilities were promoting student engagement with the content, and finally, if students do not have certain required traits or skills, then the teacher will help the students learn these traits. The highly ineffective teachers felt the students were responsible for their own learning, that the teacher’s primary responsibilities were maintaining student attention within the classroom, and finally, if students do not have certain required traits or skills, then there is nothing the teacher can do about that.

**Discussion of the Major Qualitative Results (Phase II)**

There is much to discuss from the results above. First, there was some indication of a relationship between teacher effectiveness and traditional/constructivist views, such that the highly effective teachers were more constructivist (an average of 70 percent of their responses) and the highly ineffective teachers were more traditional (an average of 53 percent of their responses, or 59 percent without the outlier, Jeff). This might imply that a teacher needs to be more constructivist in order to be effective. It is important to note that while much of the literature argues for constructivist views based on the notion
that these characteristics will yield higher student outcomes, such direct connections are not claimed. Moreover, some research indicates that exclusively using one view over another (constructivist versus traditional) fails to promote increases in student learning outcomes (Kyriakides, Creemers, & Antoniou, 2009; Kirschner, Sweller, & Clark, 2006; Steffe & Gale, 1995). In fact, the highly effective teachers in this study did not profile as exclusively constructivist, but fluctuated between 64 percent and 78 percent constructivist, which might indicate that while both visions of instruction have merit, a weighted relationship leaning more toward the constructivist side yields higher student outcomes. This is certainly a significant finding from this study.

Another major point of discussion from the results summarized above is the differences between these two groups of teachers that were not related to the math wars. First, there is a constructivist paradigm of ‘student-as-worker, teacher-as-coach’ (Chion-Kenney, 1987), but that fails to identify who is responsible for the learning: teachers or students. The teachers in this study were clearly divided on this point, and equally divided on their effectiveness: the highly effective teachers felt the teachers were responsible for the students’ learning; whereas the highly ineffective teachers felt the students were responsible for their own learning. Furthermore, with the differences between these five highly effective teachers viewing assessment as an indication of what they would need to reteach, and the five highly ineffective teachers viewing assessment as an indication of which students need to retest, the presence of this important distinction in such a small sample size denotes a need to look into this trait further. In this case, the current literature of effective teaching does not go far enough to capture differences in how teachers respond to lack of student mastery.
The second distinguishing characteristic that surfaced in this study is actually related to constructivism: “all versions of constructivism call for students to be engaged more actively in learning” (Levin, 2000, p. 161). Increased student engagement is clearly a constructivist trait, but student attention (or proper student behavior) was the flipside of the results in this study: the highly effective teacher’s primary responsibilities were promoting student engagement with the content whereas the highly ineffective teacher’s primary responsibilities were maintaining student attention within the classroom. The sound of ‘maintaining student attention’ might call to mind thoughts of rote memorization or drill-and-kill practices, which are very traditional in nature, but student attention in the context of proper student behavior is actually promoted by both the constructivist and traditional camps. What was particularly interesting in this study is the highly ineffective teachers stressed the importance of this, and the highly effective teachers omitted it in their responses. This may indicate that for highly ineffective teachers, proper student behavior is at the forefront of their minds, and for the highly effective teachers, it is not. This is an interesting distinction in this study versus what current literature covers on this topic; facilitating proper student behavior, or what is more commonly referred to as employing good classroom management skills, is a pervasive topic in teaching literature regardless of constructivist/traditional views, as it is often touted that one of the teacher’s most important jobs is to effectively manage the classroom (Emmer, Sabornie, Evertson, & Weinstein (Eds.), 2013; Catalano, Oesterle, Fleming, & Hawkins, 2004; Marzano & Marzano, 2003; Emmer & Stough, 2001). The highly effective teachers in this study never mentioned topics of student behavior in the
classroom as did the highly ineffective teachers, but felt strongly about the need for student engagement with the content.

The third distinguishing characteristic in this study identified a divide between what teachers can do about students who are ill prepared for the current curriculum: if students do not have certain required traits or skills, then the highly effective teacher will help the students learn these traits; for the highly ineffective teacher, there is nothing the teacher can do about that. This sense of responsibility, or lack thereof, is not covered in the math wars literature, and yet is a very interesting distinction between the two groups of teachers in this study. In this case, the current literature in the field is lacking on this topic of responsibility for pre-requisite skills.

**Implications for Value-Added Models and Teaching Effectiveness**

In Chapter 6, I analyzed the case of Jeff, the outlier who profiled as highly constructivist yet rated as highly ineffective based on his EVAAS value added measure. This highlighted the potential fallibility in any one source of teaching effectiveness and it is because of these difficulties that over the past two decades, there has been a trend toward augmenting any one data source with other data sources of teaching performance in order to better assess teaching effectiveness (Berk, 2005). The use of multiple sources can serve to broaden and deepen the evidence base used to evaluate and assess teaching effectiveness (Arreola, 2000; Braskamp & Ory, 1994; Knapper & Cranton, 2001; Seldin & Associates, 1999). The case of Jeff’s conflicting results across multiple sources provides the perfect case to argue for triangulation in measures of teaching effectiveness. That is precisely what North Carolina policy dictates, which aligns with national standards on how teaching effectiveness should be measured – which directly point to the
use of multiple measures as well (American Educational Research Association (AERA), American Psychological Association (APA), National Council on Measurement in Education (NCME) Joint Committee on Standards, 1999). However, as I discussed in Chapter 6 above, it is important to note that policy may not always align with practice. Single indicators of teaching effectiveness (VAMs, student surveys, teacher observations, or otherwise) all have certain flaws, but can be compensated for when triangulated with other data points (Berk, 2005). This is further supported by the results in this study as well. It is also important to note that the lag time in the qualitative data (Jeff’s first three years of teaching) and the quantitative data (Jeff’s fifth year of teaching) might indicate his own growth as a teacher over time, and as such, teacher evaluation methods which are often conducted annually might miss such changes if not assessed longitudinally as well.

Importance of the Study

From quantitatively seeking to determine the short- and long-term impacts of teaching effectiveness when compounded over multiple years, to qualitatively vetting out the differences between teachers who profile at dichotomous levels of effectiveness, this study supports, challenges, and adds to the current literature on teaching effectiveness. Supportively, the results of this mixed-methods study verified smaller research that three years of effective or ineffective teaching has a significant impact on student outcomes (Rivers-Sanders, 1999), that multiple measures of effective teaching are needed rather than just one measure, and supports the notion that effective teachers profile as more constructivist than traditional in their views on teaching and learning (though this was done with a very small sample size). This study raises concerns about a potential relationship between personal or school demographics and teacher effectiveness, calling
into question the support our system offers male teachers, lateral entry teachers, and teachers of color, and the amount of instruction time our teachers are afforded (though again, these possible connections were detected with a very small sample size). Finally, the results of this study adds to the current field of effective teaching by identifying the long-term implications of teacher effectiveness on student outcomes (with SAT math projections), as well as distinct characteristics of highly effective and highly ineffective teachers. All of the results across this study have implications for policy makers, K-12 teacher professional development and support programs, and teacher preparation programs (to be discussed within the conclusions below).

**Limitations of the Study**

In Phase I, the quantitative study was limited by the availability of data at the time of the study. In ideal circumstances, teacher effectiveness with a VAM would be identified based on a three-year average, but statewide data was not available far enough back to accommodate this, and so adjustments needed to be made such that the teachers were identified as effective/ineffective based on only two years of data. Furthermore, students needed to have six straight years of mathematics assessment results (in 3rd through 8th grade) in order to be included in this study, and that requirement significantly reduced the number of students used from the population across the entire state.

While many factors affect student achievement, including lack of opportunity, parent socio-economic status, and government interventions as discussed above, none of these factors were controlled for in this study. In this study, I used a narrowly defined definition of teacher effectiveness as measured by an EVAAS teacher value added
measure. This definition does not account for these factors or others, including school effects, which further limits this study.

The EVAAS analytic model does not directly adjust for student demographics, including student socioeconomic status and ethnic background. As noted above, the founder of EVAAS, Dr. William Sanders, asserts that a better estimate of teacher effect on student achievement is attained when students serve as their own control. To do this, EVAAS uses multiple prior assessment scores, thereby alleviating the need to directly control for student demographic variables as those factors are already present in the data when each student takes an assessment. Specifically, any impact that student demographic data has on student achievement is already captured in the test score itself, especially when multiple test scores are utilized for the same student to dampen the effects of measurement error. While the EVAAS model can incorporate these variables, Sanders maintains that their inclusion would not provide the most accurate findings available and therefore strongly advocates for the omission of demographic variables from the analyses (Carter, 2008). Some might argue that there are still limitations with this method of analyses.

In Phase II, interviews were used to collect data on the teachers’ perceptions of their instructional practices and beliefs, which can be potentially problematic: teachers may articulate their intended practices and beliefs, which might be quite different from their observed practices and beliefs. Limitations on time and resources prohibited the inclusion of classroom observations in this study. I recognized this limitation and have cautiously reported the interview findings as perceptions of practice, rather than demonstrated practices. Furthermore, the qualitative data was collected from single
interviews with each participant, and as such it is possible that the teachers were answering in a manner that they perceived as ‘expected,’ or in some way putting on a performance. Time and resource constraints limited any repetition of interviews or the inclusion of any other sources of data, such as classroom observations, for triangulation purposes. These constraints further limited the size of the participant pool in the qualitative component of the study, restricting its findings to represent just the pool of candidates themselves and is therefore not generalizable under these conditions. The purpose of the qualitative portion of this study was to begin to explore possible relationships between teacher practices and beliefs with teaching effectiveness as measured by student achievement growth. The qualitative findings are useful for this purpose.

It is also important to note that across the entire study, the focus was just on middle school mathematics. This focus limits these results for implications in this field only. The quantitative and qualitative findings might look very different across other subject areas and other levels within K-12 education. Furthermore, nowhere in this study did I account for additional factors that may impact the effectiveness of middle school mathematics teachers, including but not limited to the teachers’ pedagogical content knowledge. Many researchers have stressed the importance of this factor in teacher effectiveness (Ball, Thames, & Phelps, 2008; Hill, Rowan, & Ball, 2005; Shulman, 2006), and as such, this factor should be considered among others already discussed above as an important consideration in future research endeavors.
Implications for Future Research

Both phases of this study have implications for future research needs. In the quantitative portion, it is interesting to note the highly disproportionate numbers of students who were assigned to highly effective teachers versus those assigned to highly ineffective teachers for three years in a row. Of the 18,705 students available with sufficient testing data, 426 students were used in this study: 96 spent three years in a row with highly ineffective teachers and 330 students spent three years in a row with highly effective teachers. The second group of students is over three times larger than the first group of students; further investigation would be needed to figure out why this was the case.

In the qualitative portion of the study, one of the factors I examined was the possible connections between the teachers’ effectiveness levels and their demographics or characteristics, such as race, gender, years of experience, or lateral entry, as well as school characteristics including student demographics, school size, Title I designation, or each teacher’s average instructional minutes per student. Though it was interesting (and perhaps alarming) to see that most of these teacher and school characteristics seemed to be related to effectiveness in some way, it is important to note that this small sample size of just ten teachers is certainly too small to offer any real conclusions. Furthermore, some of the data was based on self-reported information (such as the data used to calculate the average instructional minutes per student) and conflicted with other sources – thus creating a warning for future research when considering self-reported measures. That being said, these initial trends do indicate much need for more research in these areas to determine any possible impacts on teacher effectiveness.
As noted above, future researchers will want to consider more robust definitions of teaching effectiveness using triangulated methods of determination, for the use of multiple sources can diversify the evidence base used to evaluate and assess teaching effectiveness (Arreola, 2000; Braskamp & Ory, 1994; Knapper & Cranton, 2001; Seldin & Associates, 1999). Triangulated data sources can provide a more accurate, reliable, and comprehensive assessment than just one source when measuring such a complex concept as teaching effectiveness (Berk, 2005), though determining exactly the right mix of which sources to use might differ depending on local availability, resources, and values. In this study, due to limitations of time and other resources, I used only one source: the teachers’ EVAAS value added measure. Additional measures could include student and parent surveys; formal teacher observations by an administrator, instructional coach, or peer; informal classroom walkthroughs by an administrator; teacher knowledge or skills assessments; teacher participation in professional development, committees, or mentoring; and analysis of lesson plans, assignments, student learning objectives, or student work samples (Rand Corporation, 2012). While I did not utilize multiple measures to triangulate teaching effectiveness in this study, further research should consider this option to provide more robust results.

Conclusions

If student learning is important then so is teaching, for teaching matters for learning (City, Kagle, & Teoh, 2007). When policies mandate student achievement based on the assumption that students are solely responsible for their own educational outcomes, these policies subsequently ignore the influences of teaching and overlook the need for equitable access to effective teachers. Linking effective teaching with student
achievement will help combat such assumptions, and while initial studies have indicated this relationship, a large-scale study will further expand the breadth and depth of such preliminary findings. Furthermore, understanding what actually happens within effective classrooms is vital if we want to improve the effectiveness of others. The practices of highly effective teachers desperately need to be studied further (Rivers-Sanders, 1999; Carter, 2008), and since teacher beliefs influence their practices (City, Kagle, & Teoh, 2007), then the practices and beliefs of highly effective teachers can greatly inform educational improvement efforts as well. With this study, I set out to do both: (1) further examine the relationship between effective teaching and student achievement and (2) gather insights into the practices and beliefs of highly effective teachers.

The results from this study are discussed above, and an abbreviated version of these results is summarized in the table below to illustrate the components that are perhaps most informative to teacher preparation programs, policymakers, and to schools themselves.

**Table 36: Abbreviated Summary of Results**

<table>
<thead>
<tr>
<th>Highly Effective Middle School Math Teachers</th>
<th>Highly Ineffective Middle School Math Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>70% constructivist 30% traditional</td>
<td>41% constructivist 59% traditional*</td>
</tr>
<tr>
<td><em>Teachers were responsible for the students’ learning.</em></td>
<td><em>Students were responsible for their own learning.</em></td>
</tr>
<tr>
<td>The teacher’s primary responsibilities were promoting student engagement with the content.</td>
<td>The teacher’s primary responsibilities were maintaining student attention within the classroom.</td>
</tr>
<tr>
<td>If students do not have certain required traits or skills, then <em>the teacher will help the students learn these traits.</em></td>
<td>If students do not have certain required traits or skills, then <em>there is nothing the teacher can do about that.</em></td>
</tr>
</tbody>
</table>

*Values exclude Jeff as an outlier*
For teacher preparation programs, the focus should be on either recruiting or growing highly effective teachers. In terms of recruitment, these programs could specifically look for applicants who demonstrate a commitment to student engagement as well as a responsibility for student learning through such means as admissions interviews, essays, or surveys. For those teachers-in-training who are already in the program, it is important that the institution find ways to grow these traits within these teachers. For example, courses can focus on such traits as the 70/30 constructivist/traditional split, and instilling the kinds of beliefs inherent in the highly effective teachers. Furthermore, the traits of highly effective teachers should be essential traits of all educators who work with pre-service teachers, including the collaborative teacher the pre-service teachers are placed with during their field experiences and faculty members teaching coursework.

For policymakers, three primary takeaways from this study are the importance of triangulation of teacher evaluation methods, ensuring equitable access to highly effective teachers across all schools, and protecting students’ time to learn within each class. The case of Jeff as an outlier in this study highlights that different data sources may different things about teachers, and what is important is identifying common pieces of data that come from multiple sources. This study also demonstrated the academic gains lost when students are not exposed to highly effective teachers. Lastly, my finding that there is a potential relationship between the amount of growth made by students and the amount of time they spend in each class should lead policymakers to protect classroom instructional time. Given the small sample size of this study, it should not be used as the sole basis for any policymakers, but rather as thought-provoking information to guide their decisions.
For schools themselves, the takeaways are similar to those discussed above: recruit teachers with highly effective traits whenever possible, and grow the current staff’s highly effective traits by properly identifying and exploiting the skills your staff already has, and providing targeted supports for those who need it. Schools will also want to consider the impact of time-to-learn when making decisions about the school schedule, and monitor student-to-teacher class assignment practices to ensure equitable access to highly effective teachers.

If academic outcomes are to improve, all parties involved – administrators, teachers, students, parents, and communities (DeShano da Silva, Huguley, Kakli, & Rao, 2007) – must take aggressive action to address the opportunity gaps that students encounter (Darling-Hammond, 1997). One of the largest opportunity gaps that students face might be access to effective teachers, year after year. But as just noted, it is going to take the entire system (teacher preparation programs, policy makers, and K-12 teacher professional development and support programs) to help teachers develop their craft of teaching into something truly effective. There is no formula for effective teaching; rather, it takes a village to raise an effective teacher.
APPENDIX A: EVAAS PREDICTOR SETS

EVAAS student predictor sets for each test (for the purposes of this study, only).

Note: A student must have a minimum of 3 predictors in order to receive a prediction to
the given test.

<table>
<thead>
<tr>
<th>TEST</th>
<th>PREDICTOR SET</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOG 6th Grade Math</td>
<td>EOG Math 2nd through 5th grade</td>
</tr>
<tr>
<td>EOG 7th Grade Math</td>
<td>EOG Math 2nd through 6th grade</td>
</tr>
<tr>
<td>EOG 8th Grade Math</td>
<td>EOG Math 3rd through 7th grade</td>
</tr>
<tr>
<td>EOC Algebra I</td>
<td>EOG Math 6th through 8th grade</td>
</tr>
<tr>
<td>SAT Math</td>
<td>EOG Math 6th through 8th grade</td>
</tr>
</tbody>
</table>
APPENDIX B: INTERVIEW PROTOCOL

This Interview Protocol (adapted from Boyce & Neale, 2006) provides the rules that guide the administration and implementation of the interviews conducted for this study. These instructions are to be followed for each interview to ensure consistency between interviews and thus increase the reliability of the findings.

Setting up the Interview

- Recruitment Letter (see Appendix C)

Conducting the Interview

- Follow the Interview Guide below for starting, conducting, and concluding the interview.
- Bring audio recorder, tapes, batteries, paper, and pens.
- Bring 2 copies of Consent Form (in the introduction below), 1 signed and kept, 1 for participant’s records.
- Record the interview.
- Take notes during the interview.

Interview Guide

<p>| Introduction | I want to thank you for taking the time to meet with me today. My name is Jenn Persson and I would like to talk to you about your teaching practices. |
| Key Components: | |
| • Thank you | The interview should take less than an hour. I will be taping the session because I don’t want to miss any of your comments. Although I will be taking some notes during the session, I can’t possibly write fast enough to get it all down. Because we’re on tape, please be sure to speak up so that we don’t miss your comments. |
| • Your name | |
| • Purpose | |</p>
<table>
<thead>
<tr>
<th>Confidentiality</th>
<th>All responses will be kept confidential. This means that your interview responses will not be shared with anyone and I will ensure that any information I include in my write-up does not identify you as the respondent. Remember, you don’t have to talk about anything you don’t want to and you may end the interview at any time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td></td>
</tr>
<tr>
<td>How interview will be conducted</td>
<td></td>
</tr>
<tr>
<td>Opportunity for questions</td>
<td></td>
</tr>
<tr>
<td>Signature of consent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are there any questions about what I have just explained?</td>
</tr>
<tr>
<td></td>
<td>Are you willing to participate in this interview?</td>
</tr>
<tr>
<td></td>
<td>___________  ________________  ___________  ________________</td>
</tr>
<tr>
<td></td>
<td>Interviewee  Witness  Date</td>
</tr>
<tr>
<td>Questions</td>
<td>You are welcome to answer these questions from the perspective of most or all of your classes if possible, or just focus on your most challenging class if need be.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. What grades and courses did you teach this year?</td>
</tr>
<tr>
<td></td>
<td>a. How long have you been teaching?</td>
</tr>
<tr>
<td></td>
<td>b. These courses?</td>
</tr>
<tr>
<td></td>
<td>2. Can you describe the range of students that are typical in your courses?</td>
</tr>
<tr>
<td></td>
<td>3. How would you describe your teaching style?</td>
</tr>
<tr>
<td></td>
<td>4. How do you assess students?</td>
</tr>
<tr>
<td></td>
<td>a. What is the purpose of those assessments?</td>
</tr>
<tr>
<td></td>
<td>b. How do you decide what to assess?</td>
</tr>
<tr>
<td></td>
<td>5. How would you define a student’s “poor performance” on an assignment?</td>
</tr>
<tr>
<td></td>
<td>a. How do you address mistakes made by students?</td>
</tr>
<tr>
<td></td>
<td>6. How do you feel about this statement: Mathematics involves mostly facts and procedures that have to be learned?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROBES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Sub-Questions</td>
</tr>
<tr>
<td>----------</td>
<td>--------------</td>
</tr>
<tr>
<td>• Would you give me an example?</td>
<td>a. How much to do you focus on math facts versus problem solving skills?</td>
</tr>
<tr>
<td>• Do you have another example?</td>
<td>b. What role do word problems play in your instruction, if any?</td>
</tr>
<tr>
<td>• Can you elaborate on that idea?</td>
<td>7. How do you feel about students who find their own way to solve a problem?</td>
</tr>
<tr>
<td>• Can you say something more about that?</td>
<td>8. How would you describe the environment of your classroom?</td>
</tr>
<tr>
<td>• Would you explain that further?</td>
<td>a. How much autonomy do students have in your classroom?</td>
</tr>
<tr>
<td>• I’m not sure I understand what you’re saying.</td>
<td>b. Do you use group work with your students? If so, how do you choose to group students? Are groups differentiated in any way? Within groups?</td>
</tr>
<tr>
<td>• Is there anything else?</td>
<td>9. What do you hope students get out of being in your class?</td>
</tr>
<tr>
<td>10. What methods of instruction do you use with your students?</td>
<td>a. Why do you teach the way you do?</td>
</tr>
<tr>
<td>11. From my years in the classroom as a teacher, I remember students often saying “I’ve just never been able to do math.” Do you think math ability is something that remains relatively fixed throughout a person’s life, or could students be good at math if they worked hard at it?</td>
<td>a. Of your students?</td>
</tr>
<tr>
<td>12. What are your expectations in the classroom?</td>
<td>b. Of yourself?</td>
</tr>
<tr>
<td>13. How would you describe your feeling toward teaching?</td>
<td>c. Of anyone else?</td>
</tr>
<tr>
<td>14. If you could change anything, what would it be and why?</td>
<td>a. Have these changed since you first started teaching?</td>
</tr>
</tbody>
</table>

**Closing**

**Key Components:**

* Additional comments

Is there anything more you would like to add?

I’ll be in touch if I have any additional questions regarding your responses today.

Do you have any questions for me at this time?
<table>
<thead>
<tr>
<th>Next steps</th>
<th>Thank you for your time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thank you</td>
<td></td>
</tr>
</tbody>
</table>

**Following the Interview**

- Record immediate notes of my impressions and observations.
- Summarize key data.
- Check audio tape for clarity.
APPENDIX C: RECRUITMENT LETTER

Dear (Teacher First Name),

Hello, my name is Jenn Persson and I am a graduate student at the University of North Carolina at Chapel Hill. I am conducting a research study about teacher practices and beliefs in the middle school math classroom. I am contacting you to ask whether you would be willing to participate in this research study.

Participation would involve three things:

1. Contacting me via phone or e-mail to indicate your interest in participating.
2. Reading and signing a consent form that provides information about the research study and your rights as a participant.
3. Meeting with me to be interviewed for less than one hour at a time and place that is convenient for you.

I will be giving you a copy of the consent form to read and sign, and a second copy of the consent form for you to keep for your records.

Your participation will be completely confidential. I will never use your name in any kind of publication or presentation.

If you decline to participate, this will have no impact upon you in any way. In order to decline participation, simply discard this letter and do nothing further. I’d like to thank you for the consideration and will miss having you participate in the study.

If you choose to participate in the research study now and choose to leave the research study before your interview has occurred, there is no penalty for doing so.

TO PARTICIPATE:

If you are willing to participate in this study, please contact me at your earliest convenience. My contact information is included below.
I will connect with you to set up a time and place that is convenient for you to conduct the interview. This should take less than 1 hour of your time.

Thank you for your willingness to consider being in my research study.

Jenn Persson
PhD Candidate
UNC Chapel Hill
School of Education
perssonj@email.unc.edu
919-414-8758
## APPENDIX D: QUALITATIVE CODES USED TO ANALYZE THE INTERVIEWS

### MATH WARS CODES (developed prior to analyses)

The Comparison between Two Different Sets of Teacher Beliefs and Student Evaluation Practices

<table>
<thead>
<tr>
<th>Teachers who hold...</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Beliefs (teacher control)</td>
<td>Constructivist Beliefs (inquiry-oriented)</td>
</tr>
</tbody>
</table>

...about education tend to exhibit the following characteristics when conducting student evaluations...

<table>
<thead>
<tr>
<th>Code</th>
<th>Description of Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.Alternate_Method</td>
<td>Support student attempts of multiple strategies</td>
</tr>
<tr>
<td>C.Math_Exploration</td>
<td>Encourage exploration of math problems</td>
</tr>
<tr>
<td>C.Group_Work</td>
<td>Value social interaction among students</td>
</tr>
<tr>
<td>C.Partial_Credit</td>
<td>Acknowledge student effort and creativity</td>
</tr>
<tr>
<td>C.Peer_Teaching</td>
<td>Employ scaffolding by fostering interactions between the learner and a more knowledgeable peer or adult</td>
</tr>
<tr>
<td>T.Extrinsic_Motivation</td>
<td>Utilize extrinsic motivation strategies</td>
</tr>
<tr>
<td>T.No_Partial_Credit</td>
<td>Focus on the correctness of the answer</td>
</tr>
<tr>
<td>T.Procedures</td>
<td>Promote the learning of specific procedures to get the correct answer</td>
</tr>
<tr>
<td>T.Student_Independence</td>
<td>Value student independence (as evident by those who do not ask questions or ask for help)</td>
</tr>
</tbody>
</table>
### The Comparison between Two Different Sets of Teacher Beliefs and Classroom Learning Environments

*Teachers who hold...*

<table>
<thead>
<tr>
<th>Traditional Beliefs (teacher control)</th>
<th>Constructivist Beliefs (inquiry-oriented)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...about education tend to exhibit the following characteristics when fostering their classroom learning environments...</td>
<td></td>
</tr>
<tr>
<td>- Emphasize student performance and efficiency (speed)</td>
<td>- Emphasize effort and understanding</td>
</tr>
<tr>
<td>- Express to students that mistakes were to be avoided (creating a high-risk environment)</td>
<td>- Express to students that mistakes are a natural part of learning (creating a low-risk environment)</td>
</tr>
<tr>
<td>- Be relatively controlling of the students’ mathematics activities</td>
<td>- Allow some student autonomy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description of Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.Emphasize_Effort</td>
<td>- Emphasize effort and understanding</td>
</tr>
<tr>
<td>C.Encourage_Mistakes</td>
<td>- Express to students that mistakes are a natural part of learning (creating a low-risk environment)</td>
</tr>
<tr>
<td>C.Student_Choice</td>
<td>- Allow some student autonomy</td>
</tr>
<tr>
<td>T.Emphasize_Speed</td>
<td>- Emphasize student performance and efficiency (speed)</td>
</tr>
<tr>
<td>T.Discourage_Mistakes</td>
<td>- Express to students that mistakes were to be avoided (creating a high-risk environment)</td>
</tr>
<tr>
<td>T.Teacher_Directed</td>
<td>- Be relatively controlling of the students’ mathematics activities</td>
</tr>
</tbody>
</table>
The Comparison between Two Different Sets of Teacher Beliefs and Teachers’ Instructional Plans

*Teachers who hold...*

<table>
<thead>
<tr>
<th>Traditional Beliefs (teacher control)</th>
<th>Constructivist Beliefs (inquiry-oriented)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...about education tend to exhibit the following characteristics when developing their instructional plans...</td>
<td></td>
</tr>
<tr>
<td>- Incorporate less word problems into instruction, if any at all</td>
<td>- Incorporate more word problems into instruction</td>
</tr>
<tr>
<td>- Present mathematical operations and procedures in discrete units</td>
<td>- Focus on developing students’ strategies before teaching the facts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description of Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.Embrace_Word_Problems</td>
<td>- Incorporate more word problems into instruction</td>
</tr>
<tr>
<td>C.Value_Strategies</td>
<td>- Focus on developing students’ strategies before teaching the facts</td>
</tr>
<tr>
<td>T.Avoid_Word_Problems</td>
<td>- Incorporate less word problems into instruction, if any at all</td>
</tr>
<tr>
<td>T.Topics_as_Unrelated</td>
<td>- Present mathematical operations and procedures in discrete units</td>
</tr>
</tbody>
</table>
Common Characteristics of Teachers who hold an Entity Theory of Student Ability

Teachers who hold...

- An Entity Theory (the belief that mathematics ability is something a student has or doesn’t have and a teacher cannot do much to change that)  
  (Dweck, 1986; Dweck & Bempechat, 1983)

  ...about education tend to exhibit the following characteristics that demonstrate their views about student ability...

- An entity theory may minimize a teacher’s effort and persistence with students whom they have identified as low in ability.  
  (Dweck, 1986; Dweck & Bempechat, 1983)

- A focus on individual differences in ability undermines a teacher’s attention to subject-matter learning. Instead of concentrating on students’ understanding related to a particular math problem in a particular context, teachers who hold an entity theory of ability may focus primarily on the students’ overall skill level. They may be more likely to use ability grouping and adjust assignments and teaching between groups but not within groups. The teachers’ attention would be more on how much students knew in general, relative to other students, rather than on students’ interpretations and understandings of particular math concepts. Prawat (1992)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description of Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET.Yes</td>
<td>- Teacher holds an Entity Theory</td>
</tr>
<tr>
<td>ET.No</td>
<td>- Teacher does NOT hold an Entity Theory</td>
</tr>
</tbody>
</table>

FINAL SET OF CODES USED (including those that emerged during the analyses)

Constructivist Codes

C1.Alternate_Method Support student attempts of multiple strategies to solve problems

C2.Partial_Credit Acknowledge student effort and creativity when solving problems by accounting for the parts of the problem that they did get right, allow assessment retakes

C3a.Social_Interaction Value social interaction among students as part of the learning process, utilize ‘math talk’ between peers
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3b.Peer_Teaching</td>
<td>Employ scaffolding by fostering interactions between the learner and a more knowledgeable peer or adult</td>
</tr>
<tr>
<td>C4a.Internal_Motivation</td>
<td>Utilize intrinsic motivation strategies (learn for the sake of enjoyment, interest, excitement)</td>
</tr>
<tr>
<td>C4b.Student_Self_Assurance</td>
<td>Promote student confidence, success, values encouragement</td>
</tr>
<tr>
<td>C5a.Internal_Understanding</td>
<td>Encourage exploration of math problems to promote internal understanding, demonstrate understanding with by talking about the math</td>
</tr>
<tr>
<td>C5b.Emphasize_Effort</td>
<td>Emphasize effort and understanding; quality is highly valued; provide opportunities for students to engage with the material</td>
</tr>
<tr>
<td>C6.Encourage_Mistakes</td>
<td>Express to students that mistakes are a natural part of learning (creating a low risk environment)</td>
</tr>
<tr>
<td>C7a.Student_Autonomy</td>
<td>Allow some student autonomy in deciding what, when, where, or how concepts are learned</td>
</tr>
<tr>
<td>C7b.Student_Choice</td>
<td>Students can select from pre-defined choices</td>
</tr>
<tr>
<td>C8.Embrace_Word_Problems</td>
<td>Incorporate more word problems into instruction</td>
</tr>
<tr>
<td>C9a.Critical_Thinking</td>
<td>Focus on developing students’ strategies before teaching the facts</td>
</tr>
<tr>
<td>C9b.Make_Connections</td>
<td>Present content as connected to other content; link new learning to prior learning; connect concepts to real world situations, apply concepts</td>
</tr>
</tbody>
</table>

**Traditional Codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1.Procedural</td>
<td>Promote the learning of specific procedures to get the correct answer</td>
</tr>
<tr>
<td>T2.No_Partial_Credit</td>
<td>Focus on the correctness of the answer; it's either right or wrong</td>
</tr>
<tr>
<td>T3.Student_Independence</td>
<td>Value student independence (as evident by those who do not ask questions or ask for help); students learn individually</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>T4.External_Motivation</td>
<td>Utilize extrinsic motivation strategies (earn a reward or higher grade, avoid a punishment, compete against others)</td>
</tr>
<tr>
<td>T5.Emphasize_Speed</td>
<td>Emphasize student performance and efficiency (speed); quantity is highly valued</td>
</tr>
<tr>
<td>T6.Discourage_Mistakes</td>
<td>Express to students that mistakes were to be avoided (creating a high risk environment)</td>
</tr>
<tr>
<td>T7.Teacher_Directed</td>
<td>Be relatively controlling of the students’ mathematics activities</td>
</tr>
<tr>
<td>T8.Avoid_Word_Problems</td>
<td>Incorporate less word problems into instruction, if any at all</td>
</tr>
<tr>
<td>T9.Discrete_Facts</td>
<td>Present mathematical operations and procedures in discrete units; disconnected facts</td>
</tr>
</tbody>
</table>

**Other Codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1.Assessment</td>
<td>Uses assessment to inform instruction, discusses testing, grades</td>
</tr>
<tr>
<td>O2.Role_of_Teacher</td>
<td>Describes the role of the teacher, including classroom management</td>
</tr>
<tr>
<td>O3.Differentiation</td>
<td>Alters instruction to meet the needs of diverse learners</td>
</tr>
<tr>
<td>O3b.Differentiated_by_Class</td>
<td>Students are tracked into classes based on ability level, which makes differentiation automatic/unnecessary</td>
</tr>
<tr>
<td>O4.Math/Academic_Ability</td>
<td>Discusses the math/academic/reading/ writing/literacy ability of students</td>
</tr>
<tr>
<td>O5.Role_of_Student</td>
<td>Describes the role of the student</td>
</tr>
<tr>
<td>O5a.No_Motivation</td>
<td>Students have no motivation, exhibit self doubt, display a sense of apathy</td>
</tr>
<tr>
<td>O6.Parents</td>
<td>Describes the role of the parent, or state of the parental/home situation</td>
</tr>
<tr>
<td>O7.Teacher's_Past</td>
<td>Discusses how their own past influences their teaching/views</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>O7b</td>
<td>Discusses how their students' futures influence their teaching/views</td>
</tr>
<tr>
<td>O8</td>
<td>Concepts learned individually at home, then practiced/explored together in class</td>
</tr>
<tr>
<td>O9</td>
<td>Is self-reflective, discusses future improvements to their teaching, or areas of perceived weakness</td>
</tr>
<tr>
<td>O10a</td>
<td>The teacher instructs a student in a one-on-one situation</td>
</tr>
<tr>
<td>O10b</td>
<td>The teacher instructs the students in small group settings (different from group work)</td>
</tr>
<tr>
<td>O10c</td>
<td>The teacher instructs the entire class at one time</td>
</tr>
<tr>
<td>O11</td>
<td>Students expect instant satisfaction or gratification</td>
</tr>
<tr>
<td>O12</td>
<td>Discusses the relationship between society or culture and education</td>
</tr>
<tr>
<td>O13</td>
<td>Uses research (or books, etc.) to inform their teaching</td>
</tr>
<tr>
<td>O14</td>
<td>Discusses the impact of time on teaching, planning, etc. (not having enough)</td>
</tr>
<tr>
<td>O15</td>
<td>Incorporates/promotes the use of technology</td>
</tr>
<tr>
<td>O16</td>
<td>Students need to memorize content/concepts/procedures</td>
</tr>
<tr>
<td>ET.Yes</td>
<td>Teacher holds an Entity Theory</td>
</tr>
<tr>
<td>ET.No</td>
<td>Teacher does NOT hold an Entity Theory</td>
</tr>
<tr>
<td>A.Achievement</td>
<td>Discusses student achievement (test scores, grades, etc.)</td>
</tr>
<tr>
<td>G.Growth</td>
<td>Discusses student growth (stretch, improvement, etc.)</td>
</tr>
</tbody>
</table>
REFERENCES


