RELATIONSHIPS AMONG SCIENCE TEACHER QUALIFICATIONS, INSTRUCTIONAL PRACTICES, AND STUDENT SCIENCE ACHIEVEMENT

By

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To my parents, who always said I could do anything I put my mind to.
And to my son, William, who never stops believing in me, nor I in him

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Research has shown that teacher effectiveness is a key to student achievement. Indicators of teacher effectiveness also referred to as teacher quality, have been described as years of experience and subject matter certification. As national and state mandates continue the practice of high stakes testing and place pressure upon schools to increase the rate of student achievement, few studies explored the relationships between achievement and teacher quality. The purpose of this study was to determine if there was a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT.

Eighth grade Science FCAT scores of over 13,000 students and the data from 127 teachers regarding their experience, certification status (temporary or professional), and subject certification was collected from two Central Florida counties. Student and teacher data was separated into two groups based upon each school's student socioeconomic (SES) data. High SES schools were designated as those that had 24% to 50% of their students on free and reduce priced lunch, whereas low SES schools had 55% to 85% of their students on free and reduce priced lunch. Data from each SES group was analyzed independently. A one-way ANOVA was

performed to compare the means of eighth grade student Science FCAT scores among teachers with 0 to 5 years of experience, 6 to 15 years of experience, and over 15 years of experience. Also compared were the eighth grade student mean Science FCAT scores among teachers with regular certification and temporary certification, and teachers with science subject certification or without science subject certification. Four eighth grade science teachers with varying years of experience, certification type, and science college coursework were interviewed and classroom instructional practices observed.

Results of this study showed that there was a significant difference at the low SES level in the eighth grade student mean Science FCAT scores among teachers with professional certification compared to teachers with temporary certification. There was no significant difference between professionally certified teachers and temporary certified teachers at the high SES level. No significant difference in eighth grade student mean Science FCAT scores was shown at either SES level among teachers with different years of experience or with science subject certification or without science subject certification. The findings suggest that when compared to high SES students, teachers without professional certification do not assist low SES students in realizing achievement in science. The differential impact of certification type on high and low SES students may be indicative of how achievement gaps are sustained in middle schools.

CHAPTER 1
INTRODUCTION

Student achievement is deeply dependent upon the teachers' experience, capacity and preparedness (Wayne & Youngs, 2003). Teachers are in a position to help students see the connections between discrete concepts and ideas and their relevance to their everyday lives. Darling-Hammond (2000) claimed that teacher quality is more closely related to student achievement than class size and school spending levels. From his study, Rockoff (2004) concluded that "A one standard deviation increase in teacher quality raises test scores by approximately 0.1 standard deviations in reading and math on nationally standardized distributions of achievement" (p. 247). Teacher quality accounts for an estimated 7.5% of total variation in student achievement as indicated by Hanushek, Kain, and Rivkin (1998). According to Sanders and Rivers (1996) teacher quality not only affects learning within the classroom but also influences future student learning. They observed that the impact of "both very effective and ineffective teachers were measurable two years later, regardless of the effectiveness of teachers in later grades" (p. 7).

What characteristics or qualities does a school principal consider when hiring a teacher? What prerequisites indicate that a potential candidate will be an effective teacher? The only thing researchers seem to agree on is that there is no single set of predictors for a quality teacher. "Researchers disagree on which characteristics constitute successful teaching, on how to categorize characteristics and on how to define them" (Ornstein, 2004, p. 54).

The No Child Left Behind Act of 2001 requires that as of 2005-2006 every classroom has a well-prepared teacher. According to the directive, a prepared teacher knows what to teach, how to teach, and has command of subject matter. This mandate, as well as other accountability measures such as Florida's A+ Plan for Education requires that principals will identify and hire

the best teachers to fill vacant positions. Typically, a principal will examine the individual's certification level in relation to the vacancy, their experience, and college coursework. Research suggests comparing certification level to these characteristics is likely to be indicative of teacher competence or quality (Darling-Hammond, 2000).

Hiring certified teachers in critical shortage subject areas such as mathematics and science, and recruiting teachers for schools located in poor urban areas to teach mathematics or science is a more difficult task. Research has shown that nearly one-quarter of all secondary teachers do not have a major or minor in their subject, including 30% of mathematics teachers and 56% of physical science teachers. Students in urban secondary schools have less than a 50% chance of getting a mathematics or science teacher who has at least a minor in that subject (NCTAF, 1996). According to the U.S. Department of Education, during the 1999-2000 school year almost half the middle school science teachers, and nearly two thirds of mathematics teachers did not have a major in their subject. Approximately 20% did not have certification in their subject (U.S. Department of Education, 2004). Recently, Laczko-Kerr and Berliner (2002) compared student achievement in regularly certified teachers' classrooms and in under-certified teachers' classrooms on the Stanford Achievement Test-9 (SAT-9). They found that "students of under-certified teachers make about 20% less academic growth per year" when compared to students of teachers with regular certification (Abstract, ¶ 1).

Across the nation many states have mandated that public schools demonstrate a common measure of student achievement. In Florida, the Florida Comprehensive Achievement Test (FCAT) is administered to all students in grades three through ten. The FCAT, a criterion referenced test, is based on the state's curriculum standards called the Sunshine State Standards. The graduation class of 2003 was the first cohort required to pass the tenth grade mathematics

and reading sections in order to graduate. Students who do not pass continue to retake the exam until they are successful, or they may elect to drop out or take the GED. During the 2002-2003 school year the state introduced a science achievement FCAT subtest for fifth, eighth, and eleventh graders. Attaining a passing score on the eleventh grade Science FCAT, as anticipated, is likely to become a graduation requirement for incoming high school freshmen.

In 2003, Florida voters approved a constitutional amendment to reduce class size that would ensure a fixed student per teacher ratio for grades kindergarten through twelve. To comply with this law, schools found it necessary to hire more teachers. William Hussar (1998) of the National Center for Educational Statistics projects that from 1998-1999 to 2008-2009, 1.7 to 2.7 million newly hired teachers will be needed due to teachers leaving the profession and increases in school enrollment. The report; *The Condition of Education 2008* (Planty, Hussar, Snyder, & Provasnik, 2008) states that at the end of the 2003-2004 school year 9% of the teacher workforce, or 333,000 teachers, left teaching to take jobs in other fields. In his most recent report Hussar (2007) predicts a 22.9% increase in Florida student enrollment between 2004 and 2016. The teacher shortage is most acute in critical subjects and urban areas. Howard (2004) states, "…the shortages are severe across the board in urban schools, they are more pervasive in math and science, subjects in which urban students already lag far behind their suburban counterparts" (p. 143). Many Florida principals, especially in high growth areas of the state, face the task of hiring science teachers even though there may not be an adequate pool of qualified candidates. This phenomenon is occurring at a time when the Science FCAT is impacting school grades and students' eligibility for graduation.

Statement of the Problem

Educational accountability and high stakes testing places enormous pressures on school districts and administrators. The No Child Left Behind Act of 2001 and the Florida A+ Plan for

Education place responsibility on schools and teachers to increase student achievement. Results of the Florida Comprehensive Assessment Test are used to calculate grades for each school, which then are used to make rewards or sanctions. Individual student FCAT results affect promotion and high school graduation. Reaching acceptable levels of student achievement is further complicated by a dearth of qualified teachers in critical shortage areas, such as science.

Several studies have indicated that students learn more from teachers who have more college coursework in their subject area (Goldhaber & Brewer, 2000; Monk, 1994). Thus, it has been shown that content knowledge is an essential component of a quality teacher. The purpose of this study was to determine if there is a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT.

Research Questions

1. What is the relationship among eighth grade students in their Science FCAT achievement sores, when compared by teachers with professional or temporary certification?

2. What is the relationship among eighth grade students in their Science FCAT achievement scores, when compared by teachers who have zero to five years experience, six to fifteen years experience, and over fifteen years of experience?

3. What is the relationship among eighth grade students in their Science FCAT achievement scores, when compared by teachers with subject certification in a science field, or without subject certification in a science field?

4. What are the similarities in instructional practice among highly qualified science teachers?

Statement of Hypothesis

1. There will be no significant difference among eighth grade students in their Science FCAT achievement scores, when compared by teachers with professional or temporary certification.

2. There will be no significant difference among eighth grade students in their Science FCAT achievement scores, when compared by teachers who have zero to five years experience, six to fifteen years, and over fifteen years of teaching experience.

3. There will be no significant difference among eighth grade students in their Science FCAT achievement scores, when compared by teachers with subject certification in a science field or without subject certification in a science field.

Significance of the Study

The purpose of this study was to determine if there was a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT. The findings of this study contribute to research on teacher characteristics and student achievement in science. Past studies showed a positive relationship between mathematics student achievement and teachers' subject certification, subject coursework, and years of teaching experience. However, findings from studies on teacher qualifications and student science achievement have been inconclusive (Goldhaber & Brewer, 2000; Fetler, 1999; Monk 1994). Previous studies relied on student achievement scores from norm-referenced tests; therefore the concepts tested may or may not have been taught explicitly within the curriculum. The Florida Comprehensive Achievement Test is a criterion referenced test comprised of questions linked to the curriculum standards. Thus, student achievement on the FCAT should represent a better measure of the written and taught curriculum and, potentially, a better indicator of teacher effectiveness than a norm-referenced test.

Based on these findings teachers may or may not decide to pursue further study in science content area or teaching methods to improve their ability to teach science. Students and parents may benefit from the results of this study by knowing how teacher qualities impact student achievement on the Science FCAT. Providing information on teacher characteristics that can lead to student achievement will be of practical use to school principals and school district recruitment personnel. The findings may hold practical value for state policymakers and state department of education leaders who are in charge of teacher certification. The results are likely to be of interest to those who monitor and design teacher preparation programs for colleges. Finally, school districts may gain insight about how to develop science teacher in-service programs.

Limitations

The conclusions drawn from this study may be of interest to educators within Florida and other states that administer a state mandated science exam. However, the results of this study can only be directly generalized to students, teachers, schools, and districts within Florida with similar demographics to those used in the study.

No baseline measurement for prior student achievement in science testing was used in this study. Only the effect of students' science teacher on student achievement for the 2006-2007 school year was measured. As an eighth grader, students have already had two years of direct science instruction in middle school, as well as science education throughout elementary school. Since the Science FCAT is new and only administered in fifth, eighth, and eleventh grades it is not possible at this time to compensate for the effects of prior teaching on student achievement on the Science FCAT.

In this study only the following indicators of teacher quality were measured, certification, experience, and science college coursework. Teachers in Florida are as varied as their students.

Other factors may influence the effectiveness of a teacher, such as professional development. However, they are not within the scope of this study.

Definitions

Criterion Referenced Test	compares student performance to a standard on clearly specified achievement domains (Grolund, 2003).
Highly Qualified Teacher	according to the U.S. Department of Education (2002): "…holds at least a bachelor's degree and has demonstrated a high level of competency in each of the academic subjects in which the teacher teaches (p. 5)". Subject competency can be demonstrated by passing a State academic subject test or successful completion of an academic major, graduate degree, or advanced certification or credentialing in the subject in which the teacher teaches.
Norm-Reference Test	compares student performance to that of other individuals and covers a broad area of achievement (Grolund, 2003).
Out-of-Field Certification	teachers who are fully certified to teach a particular subject but are instructing students in a subject in which they have not received certification.
Professional Certification	teachers who are fully certified in a subject area. They have met all requirements of content subject and education courses.
Temporary Certification	(under-certification) new teachers who have a bachelor's degree but lack some college coursework required for full certification. Teachers with temporary certificates often have a degree in a subject content area.

CHAPTER 2
REVIEW OF LITERATURE

The purpose of this study was to determine if there was a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT. The purpose of this chapter is to present an overview of research related to this study. The following subsections comprise this chapter: (a) teacher effect and student achievement, (b) teacher quality and student achievement, (c) SES and achievement scores, (d) teaching science, and(e) the Florida Comprehensive Assessment Test (FCAT). The subsection on teacher quality will provide an overview of relevant research on teacher certification, teacher experience, teacher subject preparation, and teaching methods coursework

Teacher Effect and Student Achievement

Research on student achievement has focused on teacher qualifications such as education, training, and experience (Ingersoll, 2002). Researchers have reported that teacher preparation has a positive effect on student achievement. Based upon an analysis of the 1993-1994 Schools and Staffing Surveys (SASS) and the National Assessment of Educational Progress (NAEP), Darling-Hammond (2000) concluded that "the effect of well-prepared teachers on student achievement can be stronger than the influences of student background factors, such as poverty, language background, and minority status" (Conclusions and Implications, ¶ 6). Researchers have also shown that teacher experience and preparation have a positive, significant influence on achievement and pupil performance (Fetler, 1999; Rockoff, 2004; Wayne & Youngs, 2003).

In the discussion of their analysis of data from 79 Tennessee elementary schools that participated in Project STAR, Nye, Konstantopoulos, and Hedges (2004) stated that "…there are substantial differences among teachers in the ability to produce achievement gains in their students" (p. 253). Using matched panel data from the Harvard/UTD Texas Schools Project that

followed cohorts of students from third through sixth grade, Hanushek, Kain and Rivkin (1998) concluded that teacher quality accounts for more than 7% of the variation in student achievement.

Quality teachers, as indicated by certification, subject matter knowledge, and experience can lead to higher student achievement. Sanders and Rivers (1996) observed that the effects of effective and ineffective teachers can last for several years. Using data from the Tennessee Value-Added Assessment System, they conducted a longitudinal analysis on a cohort of students. Students were followed from grade two through five and teacher effects were analyzed using a statistical mixed model process.

> Groups of students with comparable abilities and initial achievement levels may have vastly different academic outcomes as a result of the sequence of teachers to which they are assigned. These analyses also suggest that the teacher effects are both additive and cumulative with little evidence of compensatory effects of more effective teachers in later grades. (p. 7)

Overall, previous research shows a positive relationship between teacher effect and student achievement. This study tested the theoretical proposition that there is a relationship between teacher effect and student achievement.

Teacher Quality and Student Achievement

Teacher Certification

"Teacher certification, at its core, is based on the need to ensure that every public school teacher has had rigorous screening and training and been judged qualified to teach. Certification is designed to protect the public from harm" (Laczko-Kerr & Berliner, 2002, p. 4).

Each state establishes its own requirements for teacher certification. The state of Florida grants two types of teacher certificates. The professional certificate, the highest educator certificate, is valid for five years and is renewable. Requirements for the certificate include completion of an application process, a bachelor's degree, and demonstrated mastery of: (a)

subject area knowledge for a subject as demonstrated by passing a state subject area test, (b) general knowledge, and (c) professional preparation and educational competence. The nonrenewable temporary certificate is valid for three years. Requirements for this certificate include completion of an application process, a bachelor's degree, and demonstrated mastery of subject area knowledge. Subject specialization can be demonstrated by meeting the degree or coursework requirements listed in the State Board Rule for the subject area with a 2.5 GPA, by passing a subject area exam, or holding a valid subject area standard certificate from another U.S. state. The temporary certificate is designed to permit full time teaching by individuals who have moved from another state or changed careers while they complete the requirements for a professional certificate (Florida Department of Education, 2003).

Researchers have explored the relationship between different levels of teacher certification and student achievement. For example, Laczko-Kerr and Berliner (2002) compared student Stanford Achievement Test, Ninth Edition (SAT-9) scores among under-certified teachers (those with emergency, temporary and provisional certification) with teachers who had met the state requirements for regular certification. Normal curve equivalents (NCE) were determined for fully certified teachers and under-certified teachers. The differences in the NCE were calculated for two years in the primary grades. The students of the fully certified teachers out scored the students of under-certified teachers in reading by 6 NCE points in 1998-99 and 3 NCE points in 1999-2000 with an effect size (ES) of .14-.28, mathematics by 3 and 5 points with an ES of .14-.24, and language by 4 and 2 points with an ES of .09 to .19. The researchers concluded:

> the average ES across all sub-tests of the SAT 9, across both years of testing, and across analyses, is around .20…one would conclude that during one academic year in the primary grades, the students of certified teachers would make approximately 2 months more academic growth than would students of under-

> certified teachers. The academic year is a 10-month year so the loss of two months or 2/10ths of a year is the loss incurred by students placed with under-certified teachers. That is, students pay approximately a 20% penalty in academic growth for each year of placement with under-certified teachers. (Laczko-Kerr & Berliner, 2002, p. 38)

Fetler (1999) found a similar positive effect in his study of high school mathematics teachers and students in California using the National Assessment of Educational Progress. "Higher percents of emergencies (emergency teacher certificates) were associated with lower scores" (p.12). A research study that linked fourth and fifth grade student achievement in reading and mathematics with teacher certification status in the Houston, Texas school district from 1995 through 2002 concluded that, "…uncertified TFA [Teach for America] teachers showed a significant negative effect on student achievement gains relative to standard certified teachers" (Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005, p. 20). These effects correlated to a grade equivalent of one-half month to 3 months lower than students of teachers with standard certification. However, Kane, Rockoff, and Staiger (2006) discovered contrary evidence when they analyzed teacher certification and fourth through eighth grade student achievement in reading and mathematics in the New York City public schools. They found that, "On average, the students assigned to teaching fellows [alternatively certified teachers] performed similarly to students assigned to certified teachers in mathematics, and slightly lower (-.01 standard deviations) in reading" (p. 41). Specifically, the TFA teachers in their study had slightly higher results (.02 standard deviations) with mathematics test scores and no difference in reading when compared to traditionally certified teachers.

Goldhaber and Brewer (2000) analyzed data from the National Educational Longitudinal Study of 1988, a survey of 24,000 eighth grade students, some of which were resurveyed at grades ten and twelve. The survey accumulated personal information about each student and

teacher characteristics such as degree level, experience, and certification. The students were given one or more subject area tests in mathematics, science, English/writing, and history at the time of the survey. Goldhaber and Brewer did not observe significant differences in student achievement among teachers with regular certification, probationary, or emergency certificates. However, they did report that there were significant differences between teachers with subject area certification in mathematics and science, and those without subject certification, who were teaching out-of-field. Mathematics test scores were at least 1.3 points higher in students of teachers with standard certification compared to the scores of students whose teachers were out-of-field, holding no mathematics subject certification.

Teacher Experience

Experts agree that experience is an important factor in teacher effectiveness. Teachers with three years experience are more effective that those with less than three years. However, roughly five to eight years are needed to accumulate the amount of skills and experience necessary to effectively adapt instruction to the variety of student needs and be considered a master (Darling-Hammond, 2000; Scherer, 2001; Stronge, 2002). Along with out-of-field teachers, inexperienced teachers (0-3 years of experience) are more prevalent in schools where there is a lower socioeconomic level of student (Haycock, 2000.

Research on teacher experience is sparse and the results are inconclusive. Hanushek, Kain, O'Brien, and Rivkin (2004) utilized a matched panel data set of students and teachers from a large district in Texas to estimate variations in teacher effectiveness. They discovered "…there is significant learning about the craft of teaching that goes on in the first few years of teaching. The largest impact is the first year of experience, and experience effects disappear quickly after the first year" (p. 32).

Another research study examined data from the Tennessee Class Size Experiment known as Project STAR (Student-Teacher Achievement Ratio). Project STAR included 79 elementary schools among 42 Tennessee school districts that followed students who were randomly assigned to classes of different types from Kindergarten through third grade. Nye, Konstantopoulos, and Hedges (2004) discovered that teacher experience produced statistically significant gains in student achievement for grade 2 reading and grade 3 mathematics.

Rockoff (2004) utilized a random effects meta-analysis approach in measuring differences in teacher effects on elementary students from two districts in a New Jersey county. He found "…evidence that teaching experience significantly raises student test scores…Reading test scores differ by approximately 0.17 standard deviations on average between beginning teachers and teachers with ten or more years of experience" (p. 248).

In a post-hoc study that compared high school mathematics teacher skill and student achievement, Fetler (1999) reported that, "Teacher experience, measured by the average number of years in service, is positively related to test results. Schools with well-prepared teachers tend to have higher mathematics scores" (p. 11).

Clotfelter, Ladd and Vigdor (2004) used data collected and maintained by the North Carolina Education Research Center to determine the relationship between teacher characteristics and fifth grade student achievement. The North Carolina state test is aligned with teaching standards, similar to the FCAT used in this study. The researchers determined that teacher experience and licensure test scores were the only teacher characteristics that predicted student achievement. "For the typical students, the benefit from having a highly experienced teacher is approximately one-tenth of a standard deviation on reading and math test scores" (p. 27).

A recent research study found teacher experience had no significant effect on student ninth grade mathematics achievement. Aaronson, Barrow, and Sander (2007) used matched student-teacher administrative data from Chicago public high schools to examine teacher effects on student achievement. They discovered an insignificant "…0.02 grade equivalent increase in quality over the first few years of experience that flattens and eventually recedes" (p. 131).

Teacher Subject Preparation

Studies have shown that a larger number of teachers teaching out-of-field are placed at low income, high minority schools when compared to more prosperous schools (Ingersoll, 1999; Ingersoll, 2002; Jerald, 2002). In his study of the practice of assigning teachers out-of-field, Ingersoll (1999) found about one third of all mathematics teachers, one fourth of all English teachers, one fifth of science teachers, and one fifth of all social studies teachers lacked a major or minor in their subject or a related field. "In each of the fields of English, math, and history, every year well over four million secondary-level students are taught by teachers with neither a major nor a minor in the field" (p. 29).

Most of the research on teacher content knowledge has been conducted in the subjects of mathematics and science in secondary schools. Using data from the Longitudinal Study of American Youth (LSAY), Monk (1994) concluded that, "…teacher content preparation as measured by the number of courses a teacher took in the subject area being taught is positively related to how much mathematics and science students learn at the secondary level" (p. 142). The LSAY began in the fall of 1987 and continued through the spring of 1990. The students that participated in the survey were from 51 randomly selected communities throughout the United States. The base sample of 2,829 students, their teachers and parents completed surveys and the students were given achievement tests that focused on mathematics and science knowledge. The achievement tests used test items from the National Assessment of Educational Progress.

The effects on achievement for students of mathematics teachers were stronger than students of science teachers (Monk, 1994). The greatest significance was noted in high school juniors, experiencing a 1.2% increase in test scores when the teacher attended an additional mathematics college course, if they took five or fewer college mathematics courses.

Undergraduate mathematics education courses also had a significant impact of 0.4% in test score performance. Science results were inconsistent. For example, there was an insignificant relationship in science achievement between students of teachers who had varying amounts of life science undergraduate coursework. However, the relationship between student achievement for teachers with different amounts of preparation in the physical sciences was statistically significant, with a threshold effect at four courses. Monk reasoned that physical science constituted a larger portion of questions on a composite test of general science knowledge. "The fact that physical science covers three important areas of science (chemistry, physics, and earth science) in contrast to the one area covered by biology, may explain why teacher knowledge of physical science has a higher payoff" (Monk, 1994, p. 136).

Wenglinsky (2000) analyzed the 1996 results of the National Assessment of Educational Progress (NAEP) for eighth grade students in mathematics and science. The NAEP is administered every year or two in several subjects to students across the nation. Wenglinsky discovered that students with teachers who majored or minored in the subject they taught were 39% of a grade level ahead and had an impact of .09 on the achievement test compared to students of teachers who did not have a major or minor in their subject area.

Hawk, Coble and Swanson (1985) conducted a study to determine differences in middle school and high school student achievement for in-field and out-of-field mathematics teachers. Thirty-six teachers and their 826 students participated. Two teachers from each school were

chosen, one out-of-field teacher the other in-field. The teachers taught the same course to students with the same general ability. The pretest scores for the in-field teachers' students were not significantly different from the students of the out-of-field teachers. After five months, student achievement was measured by the Stanford Achievement Test for general mathematics and the Stanford Test of Academic Skills for algebra. Using analysis of variance tests the researchers determined, "…student achievement [was] greater in general mathematics and algebra when the students [were] taught by teachers certified in mathematics" (p. 14).

Recently, Dee & Cohodes (2008) examined middle school student achievement and teacher subject knowledge using data from the 1988 National Educational Longitudinal Study that provided content knowledge data from two of each student's teachers. Analyzing the matched pair teacher data allowed them to determine student performance when assigned to teachers with different subject qualifications. The researchers found that the effects of teacher subject certification were significant in mathematics and social studies. "Specifically, these results indicate that assignment to a subject-certified teacher increased achievement by 0.12 standard deviations in math and 0.08 standard deviations in social studies" (p. 21).

Teaching Methods Coursework

The Secretary of Education's 2002 report describes a highly qualified teacher as one who has full state teacher certification and demonstrates knowledge in their subject area through college coursework and/or passing a state test (U.S. Department of Education, 2002) This report has catalyzed debate between the political establishment whose goal is to deemphasize formal teacher education preparation programs and the educational establishment who is striving to professionalize teaching (Cochran-Smith & Fries, 2001). At the core of this debate is the question about whether or not teachers need formal pedagogical knowledge to be effective. Many experts agree that knowing how to teach is just as important as thorough subject content

knowledge for quality teaching (Darling-Hammond, 2000; Scherer, 2001; Stronge, 2002; Tell, 2001).

Lee Shulman (1986) defines pedagogical content knowledge (PCK) as: "subject matter knowledge for teaching" (p. 9) in contrast to subject content knowledge which is "the amount and organization of knowledge…in the mind of teachers" (p. 9). Grossman, Schoenfeld and Lee (2005) describe pedagogical content knowledge as

> the ability to anticipate and respond to typical student patterns of understanding and misunderstanding within a content area, and the ability to create multiple examples and representations of challenging topics that make the content accessible to a wide range of learners (p. 201).

According to Hill, Rowan and Ball (2005) much of the research on pedagogical content knowledge among assorted subject areas such as literature, social studies and mathematics has examined the effectiveness of teacher instruction but has not been able to link a teacher's pedagogical content knowledge expertise to student achievement.

There has been little empirical research that shows how student achievement among teachers with methods coursework compares to teachers who have content knowledge but lack formal training in teaching methods. In one of a few studies conducted, Monk (1994) reported that a mathematics undergraduate mathematics education course had a greater impact on student achievement gains than an undergraduate mathematics course. Ferguson and Womack (1993) concluded that, "…coursework in teacher education makes a positive difference in teaching performance and that education coursework is a more powerful predictor of teaching effectiveness than measures of content expertise" (p. 61).

Instead of counting how many college mathematics methods courses teachers completed Hill, Rowan, and Ball (2005) developed an instrument to measure teachers' pedagogical knowledge that included teacher logs and a questionnaire. They compared first and second grade

students' achievement as measured by the CTB/ McGraw-Hill Tera Nova Complete Battery and teachers' pedagogical content knowledge as based upon their measurement instrument. Hill, Rowan and Ball (2005) concluded that, "Teacher's content knowledge for teaching mathematics was a significant predictor of student gains" (p. 396).

Darling-Hammond & Youngs (2002) have asserted that educational methods coursework during pre-service teacher preparation impacts classroom teaching and teacher retention. They observed difficulties associated with programs designed for alternative route certification. These programs exist to entice teaching candidates from other careers. The alternative certification provides short-term teacher training to people who have a subject area college degree but lack education methods courses. "Ironically, these strategies exacerbate the problems of supply and demand and cost more in the long run than incentives for hiring well-prepared teachers" (Darling-Hammond, 2001, p. 14). Teachers who are certified through the short-term alternative certification programs have problems with curriculum planning, teaching methods, classroom management, and student motivation. Most of the alternatively certified teachers leave the profession by their third year. In comparison only one-third of the traditionally certified teachers and only 10% of those prepared in five year programs that include a year of student teaching leave by their third year.

Grossman (1989) interviewed and conducted classroom observations among three new secondary English teachers who had solid subject content knowledge but lacked teaching methods coursework. She observed that, "…the teachers found it difficult to reconceptualize the discipline of English for English as a secondary school subject, and … to make it more accessible to students. The teachers also found it difficult to anticipate students' knowledge and potential difficulties" (p. 193-194).

SES and Achievement Scores

The impact of socioeconomic status (SES) on the achievement of students has been a frequent topic of discussion and research since publication of *The Equality of Educational Opportunity Report* by Coleman, Campbell, Hobson, McPartland, Mood, and Weinfeld (1966). The Coleman Report determined that a student's social background had a larger impact on achievement than internal school factors (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, & York, 1966). Although many facets of the report were controversial and much debated, subsequent research still upholds that a student's socioeconomic status is a determining factor of success on standardized tests (Biddle, 2001; Books, 2004; Byrnes & Miller, 2006; Cunningham & Sanzo, 2002; Payne & Biddle, 1999).

Cunningham and Sanzo (2002) recently conducted a study that compared high school student test scores on Virginia's Standards of Learning Test in English, mathematics, science, and history to the percentage of students receiving free or reduced lunch. They ran a correlation regression analysis and found "An inverse relationship exists between the percentage of students receiving subsidized lunches and the adjusted pass rates on these tests. It can be concluded that students' SES is related to their achievement" (p. 4).

In a study designed to determine the effects of low school funding and child poverty on mathematics achievement, Payne and Biddle (1999) compared achievement of American students on the Second International Mathematics Study with students of other countries in relation to school funding and child poverty. They discovered that student achievement in the United States was affected by both school funding and child poverty.

> If American math achievement scores had been generated only by well-funded schools in districts with low levels of poverty, the United States would have earned an aggregate achievement score slightly better than the second-ranked nation in the study, the Netherlands. In contrast, had our country been represented only by miserably funded schools in high-poverty districts, our

> aggregate achievement score would have been below those of all other industrialized nations studied and nearly on a par with those of Nigeria and Swaziland! (p. 11)

Byrnes & Miller (2006) examined data from of the National Educational Longitudinal Study of 1988, attempting to determine how much effect distal factors that include student SES affect student achievement in high school mathematics and science. They concluded that these factors contributed to 41.7% of the variance in mathematics achievement and 29.8% of science achievement.

The aspects of poverty that influence student achievement are massive and varied. The effects of poverty on children can range from fewer cultural experiences, little academic support and encouragement in the home and a lack preparation in early childhood (Cunningham & Sanzo, 2002) to the fact that children who live in poverty suffer from hunger, homelessness, and chronic health conditions such as asthma and ear infections that affect their attendance in school (Books, 2004). The research demonstrates that socioeconomic status is a significant factor in student achievement.

Teaching Science

The ability to teach science effectively requires a thorough knowledge of how to teach science as well as content knowledge. When studying science achievement in students, Monk (1994) found a small effect (0.4%) for students of teachers with one additional science course. He also discovered that an additional course in science pedagogy had a larger effect of 0.8%, twice the magnitude of a content area course.

Science is a complex subject comprised of many fields such as biology, physics, astronomy, and earth science. New discoveries are being made every day that contribute to science knowledge. Although each science area is unique, they are all intertwined and dependent upon each other in the physical world. Facilitating the learning of science concepts requires not

just knowledge of content, but the ability to think using the scientific inquiry process. Pringle (2004) reported, "The standards recently adopted in science propose decreased emphasis on memorization and drill exercises and greater emphasis on inquiry, meaningful learning, and the development of critical thinking skills" (p. 2).

Students often enter the science classroom with previous knowledge that they acquired from their encounters with the natural world. Yet some of these preconceptions may be scientifically incorrect. For example, students may assume that a leaf falls more slowly than a rock because it weighs less. The science teacher needs to be able to override these misconceptions and bridge the students' previous knowledge to the science concept (Bransford, Brown & Cocking, 2000). They then help students discover for themselves the relationships between facts so that they can develop their own understanding of the concept. Pringle also notes that teachers need to know the content and the required standards, "but they must be aware of children's experiences and their preconceptions about the science content knowledge" (Pringle, 2004, p. 4).

Effective science teaching requires a delicate balance between teaching to required standards and building fluency. Students must have enough opportunities to explore and engage in inquiry-oriented activities (Trowbridge, Bybee & Powell, 2004).

> Students must be engaged in more than passive learning, and science course experiences must go further than conveying information. Students must acquire a broad and authentic sense of science, and science courses must provide them with useful attitudes, skills, and information to use in a modern world. (Collette & Chiapetta, 1994, p.41)

Science teachers can encourage students to develop and use high order thinking skills by generalizing their knowledge through activities such as problem solving, debate, and group projects (Trowbridge, Bybee & Powell, 2004).

Florida Comprehensive Assessment Test (FCAT)

The Florida Educational Reform and Accountability Commission began development of the FCAT in 1995. The passage of the A+ Plan for Education in 1999 required reading and mathematics tests for grades 3 through 10. The first state-wide results were issued in 1998 for the writing and reading test grades 4, 8, and 10, and mathematics test grades 5, 8, and 10. The FCAT is currently comprised of a writing test for grades 4, 8, and 10, reading and mathematics tests for grades 3 through10 and a science test for grades 5, 8, and 11 (Florida Department of Education, 2002).

The Florida Comprehensive Assessment Test (FCAT) is a criterion referenced test that is designed to assess students' ability as proscribed by the Sunshine State Standards. The Sunshine State Standards, approved in 1996 by the State Board of Education, were developed to provide expectations for student achievement in Florida. The Sunshine State Standards are broken into four grade level groups: PreK-2, 3-5, 6-8, and 9-12, and seven content areas: language arts, mathematics, science, social studies, health and physical education, foreign language, and the arts. Writing, reading, mathematics, and science are the only standards currently being assessed by the FCAT. The purpose of the FCAT assessment program is "1) to provide information that will be used to improve the public schools by maximizing the learning gains of all students, and 2) to inform parents of the education progress of their children attending public school" (Florida Department of Education, 2002, p. 3).

Science FCAT

Development for the FCAT in science began in 2000. It was field tested in 2002 and in March of 2003 issued statewide to grades 5, 8, and 10. Construction of the FCAT Science test began in 2002 when the Florida Department of Education developed a set of books, *FCAT Science Test Item and Performance Task Specifications*, one for each grade.

The *Specifications* accomplish two purposes:

1. Describe the test items and performance tasks found in the FCAT Science assessments.
2. Provide both general and specific guidelines for development of all test items and performance tasks at the grade level assessed by FCAT Science. (Florida Department of Education, 2002, p. 4)

The *Specifications* were based on the assistance and suggestions of Florida educators. The Florida Department of Education, FCAT Science Advisory Committee, 15-24 subject area specialists from schools, districts, and universities across Florida, and the University of South Florida worked together to assemble a test design, materials, and to recommend item specifications for each Sunshine State Standard benchmark. A contractor put together sample test items based on the recommendations. Statewide committees of Florida educators reviewed the sample items and tasks. Their recommendations were used in the final draft of the *Specifications* (Florida Department of Education, 2002).

The cognitive complexity of the FCAT, previously based upon Bloom's Taxonomy, as of 2004 is based on Dr. Norman L. Webb's levels known as "Depth of Knowledge". The Depth of Knowledge levels are specified for four different content areas; reading, writing, science, and social studies. There are three science knowledge levels; they are Level 1, Recall and Reproduction, which involves simple, one step processes or rote responses. Level 2, Skills and Concepts, require students to make decisions such as organize, classify, or estimate. Level 3, Strategic Thinking, necessitates multi-step tasks that are complex and abstract (Webb, 2002). "The rationale for classifying items by their level of complexity is to focus on the expectations of the item, not the ability of the student" (Florida Department of Education, 2006, p.4).

There are three levels of question complexity for FCAT question items. The eighth grade FCAT Science consists of 15% to 25% low level complexity questions, 40% to 60% moderate level complexity and 25% to 35% high level complexity. Low level items involve one-

step problems solved through recall and recognition of learned concepts. The skills required to answer these types of questions may include:

- identifying a common example or recognizing a concept;
- retrieving information from a chart, table, diagram, or graph;
- recognizing a standard scientific representation of a simple phenomenon;
- calculating or completing a familiar single-step procedure or equation using a reference sheet (Florida Department of Education, 2006, p. 4).

Questions of moderate complexity necessitate multiple steps. Some skills that will be needed to solve items of moderate complexity could include:

- applying or inferring relationships among facts, terms, properties, or variables;
- describing examples and non-examples of scientific processes or concepts; predicting or determining the logical next step or outcome;
- predicting or determining the logical next step or outcome;
- comparing or contrasting structures or functions of different organisms or systems;
- choosing the appropriate formula or equation to solve a problem, then solving it;
- applying and using concepts from a standard scientific model or theory (Florida Department of Education, 2006, p. 4).

High complexity requires students to analyze and synthesize information, and use more abstract thinking. Solving these problems that may involve skills such as:

- constructing models for research;
- generalizing or drawing conclusions;
- designing an experiment, given data and conditions;
- explaining or solving a problem in more than one way;
- providing a justification for steps in a solution or process;
- analyzing an experiment to identify a flaw and propose a method for correcting it;
- interpreting, explaining, or solving a problem involving spatial relationships; or
- predicting a long-term effect, outcome, or result of a change within a system (Florida Department of Education, 2006, p. 4)

The content focus of the FCAT Science is physical and chemical science, earth and space science, life and environmental science, and scientific thinking. The eighth grade science test

consists of 55 to 60 test items and four question types. There are 40-45 multiple-choice questions that are worth one point and should take one minute to answer. The three to five gridded-response questions are worth one point and should take an average of one and a half minutes to complete. Questions that require a gridded-response answer require numerical solutions but not necessarily a computation. An Example of a gridded-response question could be: "A baseball travels a distance of 90 meters (m) in 4.5 seconds (s). What is the average velocity, in meters per second (m/s), of the baseball?" (Florida Department of Education, 2002, p. 59). The question includes a diagram of a baseball with arrows representing it's trajectory to 90 meters. The numerical answer would be written into boxes, circles underneath the answer boxes that correspond with the digits of the number would be blackened. Short-response tasks should take 3 to 5 minutes to answer, and are worth 0, 1, or 2 points. Extended-response items should take 5 to 15 minutes to answer and are worth 0 to 4 points. The five to seven short and extended response questions are intended to provide the student with opportunities to demonstrate science knowledge and skills such as measuring, graphing, problem solving, designing and performing investigations, and applying scientific principals and laws (Florida Department of Education, 2002).

Students who are administered the eighth grade FCAT Science are given a calculator, reference sheet with formulas, and a periodic table of the elements. The test administrator reads directions to the students before the test begins. Students are given instructions about how to properly complete the different question types. Regular education students are given 120 minutes to complete the eighth grade science test. Specific special needs students such as exceptional education and limited English speaking students do not have a time limit.

General guidelines are specified for basic question format such as capitalization, the use of numerals and decimals. There are also specific guidelines for the different test item types. These guidelines are items 1 through 12 in the section on item style and format. Numbers 13 through 17 of the general guidelines identify the outlier and distracter rules for multiple choice questions:

> 13. Outliers (i.e., answer choices that are longer phrases or sentences than the other choices, or choices with significantly more/fewer digits than the other choices) should not be used.
> 14. Distractors should relate to a common context. Each distractor should be a believable answer for someone who does not know the correct answer. Rationale for these choices must include explanation for these errors.
> 15. Distractors should be as short and clear as possible. Opposite distrators should be avoided whenever possible.
> 16. Distractors such as "None of the Above," All of the Above," and "Not Here" should not be used.
> 17. Distractors such as "Not Enough Information" or "Cannot Be Determined" should not be used unless they are part of the benchmark being assessed. They should not be used as distractors for the sake of convenience. (Florida Department of Education, 2002, pp. 11-12)

Developing the FCAT had involved a complex process. Test items were individually designed, piloted, reviewed, and tested before becoming operational. Persons selected as item writers have teaching experience and attend a training session. Test items were reviewed. Next, items were edited and pilot tested by small groups of students outside of Florida to assess the students' reactions to the test items. "Students are interviewed after the pilot test administration to identify any vocabulary that may be unfamiliar or confusing, graphics that may be unclear, or other concerns" (Florida Department of Education, 2005, p. 43).

Test items accepted after pilot testing were then scrutinized by several committees. The Bias Review Committee, composed of educators from Florida school districts and universities, examined the items looking for anything that might cause a student to be at a disadvantage due

to their ethnicity, gender, religion, disability, or socioeconomic status. The Community Sensitivity Committee, Florida citizens drawn from statewide organizations such as religious, parent, and cultural groups along with school boards, school advisor committees, business and industry, considered "whether the subject matter and language of test items, writing prompts, samples, or reading passages will be acceptable to students, their parents, and other members of Florida communities" (Florida Department of Education, 2005, p. 44). Florida teachers and administrators from the targeted grade level and subject and school district subject area specialists composed the Item Content Review Committee. They determined whether the test items were grade level appropriate and capable of measuring the benchmarks. They also ensured if the multiple choice questions had only one correct answer, examined the cognitive complexity level and determined if the item was of reasonable grade level difficulty. The Science Expert Committee, a panel of university-level and practicing scientists, assessed test items for scientific accuracy.

Test items approved by the committees proceeded to the field testing stage. Some of the test items written on the FCAT were being field tested. However, these items did not count towards the students' scores. The statistics obtained on the field tested items determined whether they were approved for placement into the operational test item bank for possible use on future administrations of the FCAT. The summer prior to testing, items were selected from the operational test item bank according to the test construction specifications along with test items to be field tested. These items constitute the final version of the FCAT (Florida Department of Education, 2005).

Statistical analyses were performed on the FCAT test items after they are field tested and again after each operational test to verify that they performed as expected. The items are

analyzed for difficulty level, item discrimination, guessing, freedom from bias, adherence to universal design principles, and then fit to the Item Response Theory. Content validity, assuring that the test item addressed a particular Sunshine State Standard benchmark was monitored through the training of the item writers, the Item Content Review Committee, and the Department of Education.

Several reliability measures are used to determine whether the FCAT test truly assesses student achievement. They are (a) standard error of measurement (SEM) which describes the error associated with different levels of overall achievement, (b) marginal reliability index measures the reliability of the test based on the average SEM for all students, and (c) Cronbach's alpha, a traditional measure of reliability, in which the degree of error is assumed to be the same at all levels of student achievement (Florida Department of Education, 2005).

> In statistical terms, reliability is a ratio of the variation in true achievement (that the test seeks to estimate) to variation in observed test scores, which are subject to error. If the error is minimal, the ratio will be close to 1, and the test can be said to be reliable. (p. 106

Summary

The purpose of this study was to determine if there is a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT. Previous research has demonstrated that teacher experience and preparation have a positive, significant influence on achievement and pupil performance, particularly mathematics (Fetler, 1999; Monk, 1994; Wayne & Youngs, 2003). The effects of effective and ineffective teachers can last for several years (Saunders & Rivers, 1996). Previous research has focused primarily on measuring students' mathematics achievement using normed-referenced tests such as Fetler's (1999) study of California high school student mathematics achievement on the National Assessment of Educational Progress. Studies that have measured

student achievement in science with teacher characteristics have been inconclusive. This study compares Florida student science achievement on a criterion referenced test, that could more directly reflect the relationship between teacher qualifications and student achievement in science. The findings from this study provided more information regarding teacher characteristics and their possible impact on student achievement in science than previous studies.

CHAPTER 3
METHODOLOGY

This chapter is to present an overview of the quantitative and qualitative methods that were used in conducting this study. The subsections that comprise this chapter include participants, quantitative data collection, and quantitative data analysis. The qualitative methods section includes the researcher subjectivity statement, qualitative reliability and validity, and qualitative data analysis.

Participants

The participants of this study were eighth grade science teachers and their students within two Central Florida counties. There is a wide range of socioeconomic levels and ethnic diversity as well as an array of urban, suburban, and rural communities within these counties. Data from forty middle schools, 127 teachers, and the Science FCAT scores for approximately 13,000 students were collected for this study. Teacher participants in this study taught regular education eighth grade science classes during the 2006-2007 school year.

Quantitative Data Collection

After receiving approval from the University of Florida Institutional Review Board, and the individual school districts, data were collected at the school district level. Information on the eighth grade teachers' certification status, years of experience, and subject certification was collected from the county school board records and the Florida Department of Education website. Teacher data was coded by county, school and teacher. Teachers' names are anonymous and known only to the researcher. Students' Science FCAT scores were aggregated by teacher; no individual student names or personal information was used. Researcher records of teacher and student data were compiled on computer disk. A paper copy was also kept in a secure location. Approval from each county's school district office to access the teacher data

and students' Science FCAT scores was obtained. Data were coded so they could be clustered for analysis by county, school, and teacher (e.g., code 4901A: 49 represents the county, 01 the school, and A an eighth grade science teacher within a particular school). School socioeconomic (SES) data was also complied. Schools were coded as high or low SES based on the number of students who received free and reduce priced lunch. The schools' SES data ranged from 24% to 85% of the students in a school receiving free or reduce priced lunch. A gap in the data between 50% and 55% provided a natural dividing point for determining the low and high SES. High SES schools had 24% to 50% of their students receiving free and reduce priced lunch. Low SES schools had 55% to 85% of their students receiving free and reduce priced lunch.

Quantitative Data Analysis

Descriptive statistics were calculated on the Science FCAT scores for the students of each teacher. The Science FCAT mean student scores for each teacher was categorized by the teacher characteristics of professional or temporary certification, years of experience, and subject certification (in or not in a field of science). The mean Science FCAT scores were then compared by: (a) professional and temporary certification, (b) years of teaching experience, 0 to 5 years, 6 to 15 years, and over 15 years experience, and(c) teacher's subject certification in a science field or not a science field. Data were analyzed using one-way analysis of variance. The test for significance was set at 0.05 to determine if there was a significant difference in student achievement when compared by teacher characteristics (type of certificate, years of experience, and subject certification in a field of science) and school SES level.

Qualitative Methods

Patton (2002) suggests that quantitative and qualitative methods of research design can be combined and complement each other. Combining methods is a form of triangulation that can strengthen a study. The quantitative component of this study determined if there is a relationship

between eighth grade student mean Science FACT scores and teacher qualities such as certification type and length of teaching experience. The qualitative part of this study adds a dimension that looks beyond the numerical data, into the culture of instruction within different science classrooms. Observations of science classroom instruction were intended to corroborate or refute the quantitative results. Four eighth grade science teachers participated in the study. Data sources included interviews, document analysis, observations, and field notes. Each teacher was observed four times within a semester. An initial interview was executed before the observations begin. Documents such as lesson plans, tests, and samples of student work were also collected. The researcher observed the science teachers as a passive participant observer, one who is present within the classroom but who does not interact with the students or teacher, while they provided classroom instruction (Spradley, 1980). An observation protocol, as shown in Table 3-1 found at the end of this chapter, was followed. Field notes were taken during the observations. The initial interview questions for each participant are provided in Table 3-2.

An emergent research design was used, which means that data was analyzed as it was collected (Patton, 2002; Maykut & Morehouse, 1994). Information gained from the ongoing analysis guided the focus of future teacher observations. The emergent research design cannot specify all questions and observation focus in advance.

Researcher Subjectivity Statement

Researcher bias is a concern in qualitative research since the researcher is the instrument of measure. The data collection of interviews and observations, along with the analysis of the data, is subjective. The researcher brings individual values and prior experiences into the observations, note taking, and analysis of data. Thus, the researcher needs to acknowledge his or her own values and biases to reduce his/her influence on the data collection and analysis. Glesne (1999) states, “awareness of your subjectivities can guide you to strategies to monitor those

perspectives that might, as you analyze and write up your data, shape, skew, distort, construe, and misconstrue what you make of what you see and hear" (p. 109).

I have extensive life experiences and education that influenced what I saw and heard during the data collection and analysis of this research study. Ten years as a science teacher impacted my views of observations in the science classrooms. Having earned a previous master's degree in curriculum and instruction and current doctoral studies in educational leadership affected my opinions about the science curriculum and the teaching methods utilized in the classroom. Three years working as a dean of students caused me to pay particular attention to the classroom management methods used. The training and practices related to my current position as a reading coach have also given me insight into the instruction of reading comprehension strategies. For example, I was cognizant of the teaching methods used to assist below grade level readers in their efforts to access information within textbooks and other printed materials used in their instruction, such as graphic organizers, questioning techniques, and differentiated instruction. These experiences could have influenced perceptions. However, recognizing these biases and employing research methods that increase the credibility of the data analysis, such as triangulation and member checks, reduced the impact of these biases on the overall research study. Patton (2002) recognizes that value-free research is impossible, therefore "you wrestle with your values, try to make any biases explicit, take steps to mitigate their influence through rigorous field procedures, and discuss their possible influence in reporting findings" (p. 93). Glesne (1999) also suggested that a researcher's subjectivity could also be an asset to an investigation. "Seen as virtuous, subjectivity is something to capitalize on rather than to exorcise" (p. 109).

Qualitative Validity and Reliability

The validity and reliability of qualitative research is often described within the realm of trustworthiness (Lincoln & Guba, 1985). As Kirk and Miller (1986) explained, "reliability is the extent to which a measurement procedure yields the same answer however and whenever it is carried out; validity is the extent to which it gives the correct answer. These concepts apply equally well to qualitative observations" (p. 19). However in qualitative research there are "no straightforward tests [that] can be applied for reliability and validity. In short, no absolute rules exist except perhaps this: Do your very best with your full intellect to fairly represent the data and communicate what the data reveal given the purpose of the study" (Patton, 2002, p. 433).

This study employed several methods identified by Lincoln and Guba (1985) that contribute to the trustworthiness of a qualitative research study. Multiple methods of data collection, or triangulation, enhanced the credibility or trustworthiness of a study by "strengthening confidence in whatever conclusions are drawn" (Patton, 2002, p. 556). This study included analysis of teacher observations, interviews, and documents such as lesson plans for triangulation and prolonged engagement in the field. Member checks or having participants review the study results and provide feedback as to the accuracy of the observations and interviews also increased reliability. Makut and Morehouse (1994) found that "…members' feedback is very valuable and sometimes helps us see or emphasize something we missed" (p. 147).

Qualitative Data Analysis

Data collected via observational notes, interviews, and documents, were analyzed using the constant comparative method. This method, described by Maykut and Morehouse (1994) consists of coding the data according to the participant, data type such as interview or observation, and item number. For example, the second (2) page of the third (3) observation (O)

of Susan (S) would be coded in the top right corner with O-3/S-2. Next, the data were analyzed to identify units of meaning. The units of meaning were then grouped into categories, and further examined for patterns and trends. Analysis of initial data in the emergent research design drove the focus of later observations and interviews.

Summary

The purpose of this study was to determine if there is a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT. The purpose of this chapter was to describe the quantitative and qualitative methodology that was used in conducting this study.

Table 3-1. Observation protocol

1. What is the instructional focus or objective of the lesson?
2. What methods did the teacher use to introduce the lesson?
3. What tasks (instructional activities) did the teacher ask students to undertake?
4. What instructional roles did the teacher assume during the lesson?
5. What were the teacher's responses to students' questions and answers?
6. How did the teacher utilize instructional supports during the lesson?

Adapted from Anusavice (1999)

Table 3-2. Initial interview protocol

1. How long have you been teaching? How long have you taught at this school? How long have you taught eighth grade science?
2. What type of certification do you have? What steps did you take (or are taking) to gain certification.
3. What college did you go to? What was your major? What college science courses did you take?
4. Do you feel your pre-teaching coursework and experience prepared you to teach eighth grade science?
5. What has been your biggest challenge to teaching eighth grade science?
6. Describe the process you go through to design a unit of instruction and individual class lesson?
7. How does the Sunshine State Standards influence the development of your instruction?
8. What instructional support materials do you regularly use?
9. How do you feel students respond to your instruction? Why?
10.What assessment measures do you use to determine if students grasped the objective of your lesson?

Adapted from Peabody (2005)

CHAPTER 4
RESULTS AND ANALYSIS

This chapter presents the findings and analyses of the quantitative and qualitative research data. Research questions 1, 2, and 3 are addressed in the quantitative analysis section. The chapter concludes with a discussion of the results pertaining to research question 4, which is addressed within the qualitative analysis section.

Quantitative Analysis

The quantitative results for research questions 1-3 are presented below. Tables 4-1 and 4-2 at the end of the chapter provide a more detailed depiction of the results.

Research Question 1: What is the relationship among eighth grade students in their Science FCAT achievement scores, when compared by teachers with professional or temporary certification?

A one-way ANOVA was performed to compare the mean Science FCAT achievement scores among eighth grade students between teachers who held professional certification and temporary certification. Teacher and student data were divided into two groups: high socioeconomic status (SES) schools with 24% to 50% free and reduce priced lunch students, and low SES schools with 55% to 85% free and reduce priced lunch students. Each SES group was analyzed separately. The results differed, depending upon the school's SES. For example, no significant difference was found among the eighth grade student Science FCAT mean scores between professionally certified teachers and temporary certified teachers at schools with a high SES student population - 24% to 50% free and reduce priced lunch. The student Science FCAT scores ranged from 243 to 386 for professionally certified teachers and 271 to 330 for temporary certified teachers. The mean for the students of the professionally certified teachers was 308.41 with a standard deviation (SD) of 25.18. The mean for the students of the temporary certified teachers was 304.50, SD 20.34.

A significant difference was found between professionally certified teachers and temporary certified teachers among the eighth grade student Science FCAT mean scores at schools with low SES student populations. The student Science FCAT scores ranged from 242 to 353 for professionally certified teachers and 221 to 297 for temporary certified teachers. The mean for the students of the professionally certified teachers was 284.48, SD 24.782. The mean for the students of the temporary certified teachers was 263.63, SD 30.24. The mean Science FCAT scores for students in low SES schools with professionally certified teachers was significantly higher than those students who had temporary certified teachers. Therefore the findings fail to reject hypothesis number one.

Research Question 2: What is the relationship among eighth grade students in their Science FCAT achievement scores, when compared by teachers who have zero to five years experience, six to fifteen years, and over fifteen years of teaching experience?

A one-way ANOVA was performed to compare the mean eighth grade student Science FCAT scores of teachers with 0 to 5 years experience, 6 to 15 years, and over 15 years of teaching experience. Teacher and student data were divided into two groups: high SES schools of 24% to 50% free and reduce priced lunch students, and low SES schools with 55% to 85% free and reduce priced lunch students. Each SES group was analyzed separately. No significant difference was found among the eighth grade student Science FCAT scores due to teachers' length of experience (0 to 5 years, 6 to 15 years, or over 15 years) at either the high SES or the low SES schools. For high SES schools the mean student Science FCAT score for teachers with 0 to 5 years experience was 310.12, SD 22.75. The mean student score for teachers with 6 to 15 years of experience was 312.00, SD 30.12. The mean student score for teachers with over 15 years of experience was 299.21, SD 25.77. For low SES schools the mean student score for teachers with 0 to 5 years experience was 287.82, SD 26.960. The mean student score for

teachers with 6 to 15 years of experience was 286.33, SD 21.09. The mean student score for teachers with over 15 years of experience was 275.91, SD 24.517. Based upon the findings; hypothesis number two is accepted.

Research Question 3: What is the relationship among eighth grade students in their Science FCAT achievement scores, when compared by teachers with subject certification in a science field, or without subject certification in a science field?

A one-way ANOVA was performed to compare the mean eighth grade student Science FCAT scores between teachers with a subject certification in a science field, or without subject certification in a science field. Teacher and student data were divided into two groups: high SES schools (24% to 50% free and reduce priced lunch students), and low SES schools (55% to 85% free and reduce priced lunch students). Each SES group was analyzed separately. No significant difference was found in the eighth grade student Science FCAT mean scores of teachers with subject certification in a science field or without subject certification in a science field, at either high or low SES student population. For high SES schools the mean student Science FCAT score for teachers with science subject certification was 308.97, SD 23.77. The mean student Science FCAT score for teachers without science subject certification was 306.54, SD 24.87. For low SES schools the mean student Science FCAT score for teachers with science subject certification was 283.36, SD 31.55. The mean student Science FCAT score for teachers without science subject certification was 279.27, SD 19.90. Based upon the findings; hypothesis number three is accepted.

Qualitative Analysis

Research Question 4: What are the similarities in instructional practice among highly qualified science teachers?

Participants

The participants in this portion of this study were four eighth grade science teachers from a central Florida county. All of the schools at which they worked were populated by students from low socioeconomic families. At least 50% of the students were on free or reduce priced lunch. More than 50% of the students were of Hispanic heritage. The four teachers were each observed on five different occasions for one class period during the spring semester of the 2006-2007 school year for a total of 20 observations. Pseudonyms are used to protect the confidentiality of the teachers. Table 4-3 at the end of this chapter contains a summary of the participating teachers' qualifications.

The selection of the participating teachers was based on convenience due to the necessity of close proximity for observations. Purposive sampling was then used because the schools at which the participating teachers taught needed to have similar socioeconomic parameters. The study required teachers with varied qualifications of teaching experience, professional certification, temporary certification, and science certification content subjects as well as teachers without science subject certification. There are 27 eighth grade science teachers amongst seven middle schools and three kindergarten through eighth grade schools in the county in which I work. Three of the middle schools have similar low SES parameters. Teachers who best fit the variety of experience and certification outlined in the proposal were asked to participate in this study.

Cathy

Cathy was observed during her first year teaching eighth grade science. Previously she had taught sixth grade science for six years, and prior to that she taught elementary school. She took one college science course in teaching elementary science. According to Cathy her coursework did not prepare her to teach eighth grade science. She reported being self taught

through reading. She stated that her biggest challenge was "… learning the science concepts before teaching them to the students." Cathy shared that her master's in mathematics helped her teach physical science. However, she also explained that she had to remember her experience while taking high school physics for the science knowledge.

Cathy planned an instructional unit by first examining the Florida Sunshine State Standards and objectives. "I search for labs that are related, I really believe that the labs are needed to keep students interested." Initially she taught students basic concepts and the definition of key terms, held whole class discussion and presented examples. Cathy explained that she tried to help students relate to the science concept by using guided questions.

Cathy also explained that she only used the important parts of the textbook that related directly to the objectives. She also used ancillary materials such as the study guide: however, as she explained, students needed to be instructed in its use. She used the internet to locate mini laboratory activities and hands-on learning activities. Cathy shared that students responded positively to labs, and connected to the concepts more easily. She "believe[d] strongly in teaching for kinesthetic learning… [and]…the labs [were] the most important method for demonstrating learning." Cathy assessed student learning, through discussions, questions, and exams.

Diane

Diane was confident that she was well prepared to teach eighth grade with her pre-teaching coursework. When asked about her biggest challenge in teaching eighth grade science Diane stated: "getting the students interested in science… [because of]… the physical and emotional changes adolescents go through during eighth grade."

Diane explained that she did a lot of research while planning a lesson unit. She used the Florida Sunshine State Standards as a guideline to choose focus topics for instruction. Diane

described that she, “started with the topic and objectives of the lesson, including many activities and visuals, at least two labs a week… [that]… assist[ed] students in understanding the science concepts covered in a unit.” She used the textbook and support materials, including the note taking guide and lab manual. Diane also required students to have a separate composition notebook for labs in addition to the textbook and lab manual. According to Diane,

> Physical science is a hard topic, the students did not respond easily to my instruction at the beginning of the year. I found out that I had to relate the science concepts to the students and make connections to everyday life to help their understanding. If a strategy does not work well, I try a new approach next time.

To assess student learning, she primarily used the chapter tests that accompanied the textbook. She also tested students orally and asked them to write stories that took them out of the primary content area and also showed the concepts that they have learned. An example of a story assignment that she used was to have students write about a day in the life of an atom, utilizing chapter vocabulary.

Linda

During this study Linda was observed during her first full year teaching middle school science. Last year she became a long term substitute when she took over an eighth grade science class near the end of the school year. She also had experience teaching college courses in environmental science. She held a temporary teaching certificate in Biology 6 through 12 and planed to earn a permanent professional certificate while teaching science this year. Linda explained that she felt her pre-service coursework prepared her well to teach eighth grade science. “My biggest challenge has been to differentiate the instruction towards students with varied learning styles. I also wish that I had more materials for hand-on activities.”

Linda reported that she believed that the Florida Sunshine State Standards were learning goals. She reported that the textbook had clear objectives and were based upon the state

standards. "I begin each unit lesson with chapter vocabulary and then teach the math concepts. Then I try to put the two together and apply them to examples so the students can make connections to the real world." Linda began each chapter with a demonstration that typically included hands-on activities and provided a review at the conclusion of a unit. She mentioned that it was difficult to manage student behavior during lab activities. Linda primarily used the textbook and supporting materials when presenting lessons. She used lower grade level practice materials to help students who had trouble understanding the textbook. Quizzes and verbal feedback were used to assess student understanding. She believed that students responded well to her instruction. Linda shared, "…the beginning of the year teaching was very hard and the students did not understand the material I taught. I realized that they needed much more practice and repetition so I changed my teaching strategies and was more successful."

Rosa

When asked to identify her biggest challenge is teaching eighth grade science, Rosa stated: "… engaging students in science and mathematics at the same time and helping them understand that science includes everything in their world. Everything around us has something to do with science." She shared that her pre-service coursework prepared her to teach eighth grade science.

She based her instruction on the Florida Sunshine State Standards (FSSS) and wrote the FSSS on the board for each lesson. She used the textbook along with additional materials provided by the textbook company. She also used the internet to find additional activities. The county eighth grade science curriculum map determined which chapters should be used and in what order topics are to be taught.

Rosa explained that she tried to be flexible during instruction. "I use different strategies such as lecture, labs, and hands-on activities to engage students and attempt to connect the

science being taught to different careers. I explain how science is used in everyday life." Students' lab reports were used to indicate students' understanding of a lesson. Questions, tests, quizzes, and observation were the other ways that Rosa assessed learning.

Observations

Two themes emerged from the observations: curriculum practices and instructional practices. Curriculum practices were comprised of the procedures that teachers used, the assignments and verbal directions that were given. Instructional practices were comprised of the types of questions teachers asked, their responses to student questions, the ways they assisted students, tried to help them make connections to concepts and application, and how they monitored students' engagement and comprehension.

Curriculum

Physical science topics such as physics and chemistry were observed. During this study, it was the first year that physical science was taught in the eighth grade county-wide. A county-wide curriculum map, prescribing the order and indicating the specific topics to be taught, served as a guideline for planning instruction for the participants.

The county adopted textbook, *Physical Science* published by McDougal-Little, was the primary source of information for students. The textbook was accompanied by ancillary materials including a teacher's guide, tests, a note taking guide, and lab book. Three of the teachers reported using the internet to find labs and activities to supplement the textbook. Linda used supplementary practice worksheets that were at grade levels 4–8, (lower than the 8th grade textbook) because they "…help[ed] the students who are not able to understand the textbook."

Written student assignments were similar across all four classrooms. All of the participants used the textbook and note taking guides. The three most experienced teachers used

labs or hands-on activities to help students see the relevance of the topic. The least experienced teacher assigned students primarily seat work and worksheets.

Examples of teacher use of hands-on activities follow. Diane modeled the way elements fit together using nuts and bolts. She used nuts and bolts of different sizes, including some that were to fit together and others that did not, to demonstrate how some elements did or did not bond together. Cathy's students completed a lab activity that resulted in producing a chemical reaction by using salt, vinegar, and pennies. Rosa's students experimented with magnets, to consider how the poles reacted to each other, while Linda's students worked on note-taking and fill in blank worksheets.

Two of the teachers required students to present projects during an observation. Linda assigned students to write reports about scientists who created inventions and careers, and asked them to explain how that person used science. She told students that she would observe their presentations and grade them on "oral presentation, knowledge of topic, and response to questions." The students presented reports on scientists such as Leonardo DaVinci, Garrett Morgan and Gustave Eiffel. The teacher asked each student, "Why did you choose that scientist?" and "What was important about their invention(s)?" Some of the students included posters with pictures of the scientist and their invention.

Cathy formed student groups and instructed each group to create a game that would review a concept that they had studied during the semester. She stated:

> I already told you what order you will follow and the key points for grading were stated on your assignment sheet. Stand in front of the class, tell what the game is going to teach, how to win the game, what are all of the pieces, and play a round of the game. The class will be allowed to ask questions after the presentation.

Several of the games were about the periodic table, while another was on force and motion. The teacher took notes during the presentations and asked questions such as: "How do you know the

correct answer?" and "How many spaces do you get to move for a correct or wrong answer?"

Each teacher had developed procedures that governed acceptable classroom behavior. For example, the researcher observed students line up outside the classroom door. They entered when the teacher indicated, and sat in assigned seats. In most classes there was a bell-work activity written on the board, or a worksheet that was distributed. Students seemed to know what was expected. They worked quietly while the teacher took attendance and completed daily routine tasks. Cathy's class was well disciplined in procedures. The students knew exactly how to collect materials for activities and return them when finished. Her students were on task from the beginning of class until after the bell rang. They knew not to get out of their seats until she dismissed them. Diane only had to count, "1…2…3" and students knew it was time to settle down and begin to work. Linda's class had procedures for passing out the textbooks while Rosa's class had established routines for starting and ending the class period.

Instructional Practices

The participants generally introduced daily lessons with a question/answer and discussion session to review previous subject matter. Most teachers asked guided questions that led students step by step until they understood a concept.

For example, Cathy was observed teaching her students how to calculate the half-life of radioactive elements. She wrote the key parts of a problem on the board, such as 500 grams, half-life of 27 minutes, asked to compute how much would be left after 54 minutes. Then she gave the students time to work out the solution. She asked "In 27 minutes what is going to happen to the amount of atoms?" A student responds, "There will be half." The teacher asks, "How much of the 500 grams is left after 27 minutes?" She called on a student who replied, "250 grams." Cathy agreed and asked: "What is the relationship between 27 minutes and 54 minutes?" Another student responded, "Half." The teacher replied, "So there will be half as

much, how much of the 500 grams is left after 54 minutes?" A student correctly responded, "125 grams." Cathy placed a new problem on the board and encouraged her students by stating, "We'll keep working on them until you get it!"

In one of Diane's classes she was teaching the concept of charge separation in lightning. She asked students, "What is charge separation?" A student responded and Diane affirmed the answer. The teacher asked a question about charge build up and lightning; however, none of the students responded. Subsequently, Diane helped students come to find the answer by asking questions whereby incrementally correct responses led to an answer for her initial question.

Linda was observed reviewing electrons, orbits, and the information provided on the periodic table of elements. She explained the group number and period number of elements in the periodic table, and then asked a student, "What is the group number of sodium?" He was unable to provide the correct response. Instead of providing prompts to assist him, she explained the makeup of sodium and wrote it on the board.

All of the teachers stated that it was important to help the students connect the information in science class to the students' everyday life, to present real world examples of the science concepts. In Linda's class they discussed the metal mercury, which has liquid properties. A student compared mercury to the movie character The Terminator. Linda agreed and also shared an experience she had cleaning up mercury contamination while working for a water company in Puerto Rico. She explained how the material was hazardous and was dangerous to clean up. Cathy helped students conceptualize the difference between elements and compounds by comparing them to the ingredients that make up a meal. She likened the elements as comprised of individual ingredients such as flour and sugar, suggesting that the compound, bread or cake, was made of the combined ingredients. Diane facilitated an activity on balancing

equations using colored clay and balance beams. The students were able to visualize how the different pieces have to be the same on both sides for an equation to balance.

Rosa provided an activity that involved decoding 0's and 1's into a picture to computer processors and electronic devices such as phones and television. She instructed her students to draw a simple picture onto a small piece of graph paper. Then they were to write down a 0 for each square that was empty and a 1 if a square was filled. The teacher collected the codes of 0's and 1's and passed them to different students who were given the task of deciphering the code by competing the design on another sheet of graph paper. The decoded designs and original pictures were compared for accuracy.

Monitoring student progress and understanding of the concepts was also a priority for all of the teachers. As three of the teachers walked around the classroom, they frequently answered individual students' questions, encouraged students to stay on task, checked students' answers or lab activities, and asked questions to assess student knowledge. The fourth teacher frequently walked throughout the classroom answering questions and monitoring student behavior. After presenting an example or explanation, she asked students to: "Please raise your hand if you do not understand."

During an activity on coding, Rosa walked around the room and checked students' decoded designs. One student did not arrive at the correct design. She asked him "Is it a mistake in decoding the design or are the 0's and 1's in the wrong position?" She reviewed the decoding with him square by square, and helped him determine the origin of the mistake.

While students were taking a quiz, Cathy circulated throughout the classroom and walked over to students who raised their hands, and then helped each one with questions. She assisted them without answering the quiz questions for them. She read aloud the quiz problem for one

student and explained what the question was asking, gave him clues, showed him where to look in their book. Occasionally she affirmed a student's answer with a nod of her head.

Diane also monitored student and group progress during activities, by checking their work and responding to questions. Occasionally she explained something in Spanish to a student with limited knowledge of English.

Student behaviors were closely supervised by the teachers most of the time. The teachers quietly addressed misbehaviors while they were walking around the classroom and monitoring student progress, often they redirected students to tasks, told them to be quiet or reminded them of an established procedure. Rosa was helping a group with an activity when another student asked for her help. She responded in a soft voice: "Please wait your turn." Linda used a point system with her students. When students continually talked out of turn she said; "I'm ready to take points away from those that are talking without permission."

Diane was not always consistent in responding to task behavior. She allowed some off task behaviors such as students chatting with one another or working on something other than the current activity. During one instance, Diane instructed the students to follow along in their lab manuals while she read aloud directions to an activity. While she was reading most students were silent and appeared to be looking at their books. However, one student, right in front of her, was writing something, while several others were playing with an eyedropper that was to be used with the lab activity.

Cathy prevented some potential discipline problems by assigning a student with attention deficit disorder to pass out papers and organize the lab materials. I asked her why he was her helper. She replied that he was very smart and always completed his work quickly and that: "Giving him tasks keeps him constructively busy."

Several teachers encouraged positive behaviors by praising students. Cathy said to a student, "Thank you, Anna, for following my directions." Rosa gave out JAG coupons when students gave correct answers to questions. Students were able to use the coupons to buy pencils and other items from a reward store.

Summary of findings for Research Question 4

All four teachers observed utilized the same textbook, worksheets, and lab notebooks. They held several instructional practices in common:

1. All of the teachers introduced daily lessons by beginning with a question and answer review prior to instruction.
2. The teachers helped students see the relevance of the concepts that were taught by showing and explaining their application to daily living.
3. Most of the teachers monitored student behavior in a proactive manner by walking around the classroom and intercepting potential problems as they occurred.

The three teachers who held professional teaching certificates and had more teaching experience presented hands-on activities and experiments, while the teacher who held a temporary certificate and was in her first year of teaching relied much more heavily on seatwork and worksheets. The more experienced teachers asked probing questions when students were having trouble answering a question or understanding a concept. They asked guided, step-by-step probing questions until the student was able to identify the right answer.

Differences were observed in the ways that teachers monitored student progress and students' understanding of concepts. For example, the more experienced teachers performed formative assessments while they walked around the classroom. During this time they observed student behaviors, checked their work, and also asked and answered questions. The inexperienced teacher relied heavily on quizzes.

Summary

The purpose of this chapter was to describe the quantitative and qualitative results of the data analysis of this study. The findings showed that:

1. Significant differences were found among eighth grade student Science FCAT mean scores at low SES schools between professionally certified teachers and temporary certified teachers. On average, students with professionally certified teachers scored significantly higher that those students who had temporary certified teachers at the low SES level.
2. No significant differences were found among the eighth grade student Science FCAT mean scores at high SES schools between professionally certified teachers and temporary certified teachers.
3. No significant differences appeared among eighth grade student achievement scores on the Science FCAT test when compared by teachers' length of experience at either high or low SES student populated schools.
4. No significant differences were found among eighth grade student Science FCAT scores between teachers with subject certification in a science field and teachers without subject certification in a science field at either high or low SES student populated schools.

Table 4-1. Descriptive statistics

High SES 24% to 50% free-reduced lunch	N	Mean FCAT	SD
Certification			
Professional	58	308.41	25.18
Temporary	14	304.50	20.34
Subject certification			
Science subject	33	308.97	23.77
No science subject	39	306.54	24.87
Experience			
0-5 years	33	310.12	22.75
6-15 years	13	312.00	30.13
16+ years	14	299.21	25.77

Low SES 55% to 85% free-reduced lunch	N	Mean FCAT	SD
Certification			
Professional	46	284.48	24.78
Temporary	8	263.63	30.24
Subject certification			
Science subject	28	283.36	31.55
No science subject	26	279.27	19.90
Experience			
0-5 years	22	287.82	26.96
6-15 years	12	286.33	21.09
16+ years	11	275.91	24.52

Table 4-2 One-way ANOVA results

High SES 24% to 50% free-reduced lunch	Sum of squares	df	Mean square	F	Sig.
Certification					
Between Groups	172.75	1	172.75	.291	.591
Within Groups	41517.57	70	593.11		
Total	41690.32	71			
Subject certification					
Between Groups	105.66	1	105.66	.178	.675
Within Groups	41517.57	70	594.07		
Total	41690.32	71			
Experience					
Between Groups	1437.11	2	718.56	1.135	.329
Within Groups	36093.87	57	633.23		
Total	37530.98	59			

Low SES 55% to 85% Free-Reduced Lunch	Sum of squares	df	Mean square	F	Sig.
Certification					
Between Groups	2963.48	1	2963.48	4.527	.038*
Within Groups	34037.35	52	654.56		
Total	37000.83	53			
Subject certification					
Between Groups	225.29	1	225.29	.319	.575
Within Groups	36775.54	52	707.22		
Total	370000.83	53			
Experience					
Between Groups	1094.40	2	547.20	.878	.423
Within Groups	26164.85	42	622.97		
Total	27259.24	44			

* denotes significance at $p<.05$

Table 4-3 Observed teachers' qualifications

Participant Names	Teaching Experience	Bachelor's Degrees	Master's Degree	Certification Type	Subject Certifications
Cathy	19 years	Elementary	Mathematics	Professional	Elementary Education Middle integrated
Diane	5 years	Nursing Management	None	Professional	General Science 5-9 Health 6-12
Linda	1 year	Biology	Environmental Science	Temporary	Biology 6-12
Rosa	16 years	Biology Secondary Education	None	Professional	Biology 6-12 General Science 5-9

CHAPTER 5
DISCUSSION

Educators across the country have been mobilized to increase the rate of student achievement by national and state mandates such as the No Child Left Behind Act and Florida's A+ Plan for Education. Florida's primary measurement for student and school achievement is the FCAT (Florida Comprehensive Achievement Test). Many researchers agree that high quality teaching is the key to student achievement (Darling-Hammond, 2000; Hanushek, Kain & Rivkin, 1998; Rockoff, 2004). Principals shoulder the responsibility of hiring quality teachers for their schools. Teacher characteristics that principals can consider in making the decision to hire a teacher are certification, experience, and subject coursework. The purpose of this study was to determine if there was a relationship between teacher qualities (experience, certification type, and science coursework) and student achievement on the eighth grade Science FCAT. This chapter presents a summary of the findings of this study and an overview of the study's implications and recommendation for future study.

Summary of results

Using a One-Way ANOVA, a significant difference was found in the mean Science FCAT scores among low income (SES) eighth grade students between teachers with a temporary teaching certificate in comparison to a professional certificate. Students of teachers who hold a professional certificate outperformed students of teachers holding temporary certificates. Conversely, no statistical differences were found in the mean Science FCAT scores among high income (SES) students of teachers who hold temporary or professional teaching certificates.

The findings also showed no significant difference for either low or high SES levels in the eighth grade mean Science FCAT scores of students taught by teachers with varying years of experience, or between teachers with science subject certification and those without science

subject certification. Overall, the findings from this study support the theoretical proposition that there is a relationship between teacher effect and student achievement.

Discussion

Several factors make this study a contribution to previous research, Table 5-1, at the end of this chapter, summarize major research findings, and compares them to this study. This study is one, if not the first, study to assess science achievement scores by teacher characteristics and/or SES, and possibly the first study to examine these relationships in the context of the Science FCAT test. This study used a measure of student achievement that relied upon the use of a criterion-referenced test and a comparison of schools and student groups into low and high SES. Previous studies that have attempted to determine teacher effectiveness based upon the characteristics of certification, experience, and subject content knowledge used norm-referenced measures of student achievement such as the Stanford Achievement Test (Hawk, Coble, & Swanson, 1985; Laczko-Kerr & Berliner, 2002) and the National Assessment of Educational Progress (Fetler, 1999; Monk, 1994; Wenglinsky, 2000). The student achievement measure used in this study, the FCAT, is a criterion-referenced test designed to measure student progress on content standards that were prescribed for teachers' instructional use. Norm-referenced tests such as the Stanford Achievement Test compare student knowledge with a "normed" group of students across the country; however, they may ask content-based questions that students have not been explicitly taught. Clotfelter, Ladd and Vigdor's (2004) North Carolina research was the only previous study that mentioned using a criterion-referenced achievement measure.

Many researchers agree that socioeconomic status greatly impacts student achievement on standardized tests (Biddle, 2001; Books, 2004; Byrnes & Miller, 2006; Cunningham & Sanzo, 2002; Payne & Biddle, 1999). Experts have also noted that urban schools with a large portion of low-income students typically have more teachers with less content knowledge and fewer years

of experience (Haycock, 2000; Ingersoll, 1999; Ingersoll, 2002; Jerald, 2002). This study provides new insight about the impact that teacher qualifications have on student achievement in relation to student SES that previous studies on quality teacher characteristics did not take into account.

This study found that low income students need more highly qualified teachers in order to match the achievement of students with higher income families. Professionally certified teachers, who typically have more pedagogical knowledge and teaching experience than temporary certified teachers, are able to provide low income students with more successful instruction. This quantitative result is supported by the qualitative observations of science classroom teacher instruction. Linda, the teacher with temporary certification was observed during her first full year of teaching. Although she had extensive college coursework in science, she had not yet taken the teaching methods course required for regular certification. Linda acknowledged the challenge she had in managing student behavior and presenting hands-on activities. Her instructional methods relied heavily on worksheets and textbook note-taking. When responding to student answers she lacked an ability to enhance students' thinking by using probing questions. Often she simply corrected students and gave them answers to questions, instead of asking simpler, probing questions to guide them toward higher order thinking, leading to the correct answer. Professionally certified and experienced teachers enhanced classroom instruction with extensive hands-on activities and experiments that provided students with visual and kinesthetic methods for learning concepts. They were adept at asking students probing questions to illicit correct answers and guide students towards building conceptual understandings.

Findings from other analyses in this study contribute to previous research concerning the importance of teacher experience and content subject coursework. However, the only sure statement that can be made regarding the characteristics of quality teachers is that, so far, educators and researchers cannot agree on the components that make a good teacher (Ornstein, 2004). The findings in this study for example, that teacher experience and science subject coursework were not significantly related to students' science achievement, indicate that other teacher characteristics must be at play and interact to impact instructional effectiveness and student achievement. The utilization of effective instructional methods by the professionally certified teachers observed during the qualitative portion of this study point towards traits other than those analyzed in this study that may also contribute to student achievement. For example, effective classroom management, the use of hands-on activities and experiments to provide kinesthetic and real life experiences of concepts for students, and the ability to ask probing questions that guide students to the understanding of concepts. Teachers can learn these types of skills through staff development, mentoring, and a personal openness and willingness to consistently study and improve methods of classroom instruction.

Implications

The implications of this study for principals and policy makers is that using less qualified temporary certified teachers in schools with a low income student population may contribute to the "achievement gap." More highly qualified teachers can better address the lack of background knowledge among low SES students. Students from low-income families often have fewer life experiences such as vacations, are exposed to a smaller amount of vocabulary, and generally read less. Therefore, they tend to have less background knowledge about the concepts being taught and fewer concept related memories to connect with the new information they are attempting to learn. Professionally certified teachers who have more knowledge about pedagogy

are more likely to be better able to adapt their instructional practices and to meet the learning needs of low-income students.

Another implication from this study is that credentials such as those examined in this study, teacher experience, certification, and subject content knowledge are not the only elements that encompass a quality teacher. Principals and school districts need to probe beyond those basic qualifications and look more deeply into teacher applicant information. Other qualities that this study suggests reflect teacher effectiveness include (a) the knowledge of varied instructional methods that meet the needs of different types of learners, (b) effective classroom management, and (c) skillful questioning techniques.

There are implications from the findings for colleges of education and induction programs that prepare new teachers. Pre-service students need a sufficient amount of instruction in pedagogy and adequate practical training. Teacher education program directors must ask: What are the colleges of education doing to ensure that prospective teachers have this type of preparation?

Recommendations for Further Study

Research must continue to search for the characteristics that comprise quality teachers. Identifying factors that lead to successful instruction and measurable student achievement are complex, and are not easily quantified. Future research should include:

1. Qualitative observations of teachers who have experienced success in improving achievement among low SES students to determine instructional practices that lead to student achievement.
2. This study's results showed a significant difference in the achievement of low SES students between temporary certified teachers and professionally certified teachers. What are the real differences between temporary and professionally certified teachers? Do temporary certified teachers lack classroom management skills that affect their ability to effectively instruct low SES

students? What skills do professionally certified teachers acquire that influence their ability to more successfully instruct low SES students in science?

3. The findings in this study suggest that the difference between the teacher groups may be knowledge of pedagogy. One area of research that is weak in empirical study is the role that learning pedagogy plays in teacher effectiveness.

4. This study points out that student SES level may be a factor when measuring student achievement. Future studies on teacher effects should take into account student socioeconomic status.

5. What other characteristics of teachers (other than teacher experience, professional or temporary certification, and science subject certification) affect student science achievement? Can student science achievement be influenced by: (a) teachers' willingness to learn, (b) teachers' perceptions of science content, (c) teacher efficacy, (d) teachers' perception of student ability, or (e) student efficacy?

6. The results from this study that determined low SES students of temporary certified teachers had mean Science FCAT scores lower than the students of professionally certified teachers begs the question, do all teachers need to hold professional certification?

7. Were there other factors not addressed in this study that could affect low SES student science achievement of temporary certified teachers, such as student English language skills or teacher access to professional development opportunities, science equipment available for hands-on activities and laboratory experiments?

Summary

The purpose of this study was to determine if there was a relationship between teacher qualities (experience, certification, and science subject certification) and student achievement on

the eighth grade Science FCAT. The purpose of this chapter was to discuss the results and implications of this study and to recommend further research.

Table 5-1 Findings of major research compared to Zuelke (2008)

Major research	Key findings
	Teacher certification
Laczko-Kerr and Berliner (2002)	Primary reading and mathematics Students of certified teachers made more academic growth than students of under-certified teachers
Fetler (1999)	High school mathematics Students of teachers with emergency certification had lower test scores.
Darling-Hammond, Holtzman, Gatlin, & Heilig, (2005)	Fourth and fifth grade reading and mathematics Uncertified teachers showed a significant negative effect on student achievement gains relative to standard certified teachers.
Kane, Rockoff, and Staiger (2006)	Fourth through eighth grade reading and mathematics Uncertified teachers in their study had slightly higher results with math test scores and no difference in reading when compared to traditionally certified teachers
Goldhaber and Brewer (2000)	Eighth grade mathematics and science No significant differences in student achievement among teachers with regular certification, probationary, or emergency certificates.
Zuelke (2008)	Eighth grade science At low SES schools, students with teachers that held temporary certification had lower 8th grade Science FCAT scores than students of teachers with professional certification.
	Teacher experience
Nye, Konstantopoulos, and Hedges (2004)	Elementary reading and mathematics Teacher experience produced statistically significant gains in student achievement for grade 2 reading and grade 3 mathematics.
Rockoff (2004)	Elementary reading Teaching experience significantly raises student test scores. Reading test scores differ by approximately 0.17 standard deviations on average between beginning teachers and teachers with ten or more years of experience.
Fetler (1999)	High school mathematics Teacher experience, measured by the average number of years in service, is positively related to test results.
Clotfelter, Ladd and Vigdor (2004)	Fifth grade reading and mathematics The benefit from having a highly experienced teacher is approximately one-tenth of a standard deviation on reading and math test scores
Aaronson, Barrow, and Sander (2007)	Ninth grade mathematics Teacher experience has an insignificant effect, a 0.02 grade equivalent increase in quality over the first few years of experience that flattens and eventually recedes
Zuelke (2008)	Eighth grade science No significant differences were found in student achievement on the 8th grade science FCAT based upon teacher years of experience

Table 5-1. Continued

	Teacher subject certification/coursework
Goldhaber and Brewer (2000)	Eighth grade mathematics and science There were significant differences between teachers with subject area certification in mathematics and science, and those without subject certification.
Monk (1994)	High school math and science Teacher content preparation positively related to student achievement in mathematics and science. Science results were inconsistent: An insignificant relationship in science achievement based on teacher coursework in life science. Student achievement for teachers with different amounts of preparation in the physical sciences was statistically significant.
Wenglinsky (2000)	Eighth grade mathematics and science Students with teachers who majored or minored in the subject they taught were 39% of a grade level ahead and had an impact of .09 on the achievement test compared to students of teachers who did not have a major or minor in their subject area.
Hawk, Coble and Swanson (1985)	Middle school and high school mathematics Student achievement was greater in general mathematics and algebra when the students were taught by teachers certified in mathematics.
Dee & Cohodes (2008)	Middle school mathematics and social studies Results indicate that assignment to a subject-certified teacher increased achievement by 0.12 standard deviations in math and 0.08 standard deviations in social studies
Zuelke (2008)	Eighth grade science No significant differences were found in student achievement on the 8th grade science FCAT based upon teacher holding science subject certification or without science subject certification

APPENDIX A
IRB APPROVAL

UNIVERSITY OF FLORIDA

Institutional Review Board

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September 8, 2006

TO: Laurie Zuelke
538 Hunter Circle
Kissimmee, FL 34758

FROM: Ira S. Fischler, PhD, Chair
University of Florida Institutional Review Board 02

SUBJECT: UFIRB Protocol #2006-U-0790
Science Teacher Qualification, instructional practices, and student achievement in science

FUNDING: None

Because this protocol involves research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or clasroom management methods {45 CFR 46.101(b)(1)}; and only existing data will be used in this protocol, as no human participants are involved in this research. It is understood that information will be recorded by the investigator in such a manner that individuals cannot be identified, directly or through identifying links {45 CFR 46.101b(4)}. Therefore, it is exempt from further review by this Board.

Should the nature of your study change or you need to revise this protocol in any manner, please contact this office before implementing the changes.

IF/dl

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APPENDIX B
DISTRICT CONSENT FORM

Dear School District Superintendent,

My name is Laurie Zuelke and I am a graduate student in Educational Administration and Policy at the University of Florida under the supervision of Dr. Behar-Horenstein. I am conducting research on the relationship between eighth grade student achievement on the Science FCAT and the teacher characteristics of certification, years of teaching experience, and science college coursework.

I would appreciate permission to use information from the district files on your eighth grade science teachers and their student FCAT scores during the 2006-2007 school year. The data collected will include: teacher's certification level, number of years teaching, and if they have a college major or minor in a science field. Only my supervisor and I will have access to the personal information obtained. Teacher data collected will be coded and kept confidential; no names or any identifying information will be reported. Student data will be collected as a mean FCAT score for each teacher; no student names will be accessed or recorded in this process.

If you have any questions please feel free to contact me at (407) 846-2268 or my faculty supervisor, Dr. Behar-Horenstein, at (352) 392-2391, ext 299.

I will be contacting your office within the next two weeks to confirm your approval.

Sincerely,

Laurie A. Zuelke

Graduate Student in Educational Leadership

APPENDIX C
TEACHER CONSENT FORM

Dear Science Teacher,

My name is Laurie Zuelke and I am a graduate student in the Department of Educational Administration and Policy at the University of Florida under the supervision of Dr. Behar-Horenstein. I am conducting research on the relationship between eighth grade student achievement on the Science FCAT and the teacher characteristics of certification, years of teaching experience, and science college coursework.

I would appreciate your permission to observe you teaching five times during the school year. Notes will be taken during these observations then compared with other notes from observations of other science teachers with differing characteristics of certification type, years of experience and science college coursework. Only my supervisor and I will have access to the personal information obtained. Teacher data collected will be coded and kept confidential; no names or any identifying information will be reported. If you have any questions please feel free to contact me at (407) 846-2268 or my faculty supervisor, Dr. Behar-Horenstein, at (352) 392-2391, ext 299.

Sincerely,

Laurie A. Zuelke
Graduate Student in Educational Leadership

I have read the procedure described above. I voluntarily agree to participate in this study and I have received a copy of this description.

_____ _____
Signature of participant Date

I would like to receive a copy of the final manuscript

_____ _____
Signature of participant Date

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BIOGRAPHICAL SKETCH

Laurie Ann (Ruzich) Zuelke .was born in Chicago, IL, in 1957. She went to high school at Mount Assisi Academy in Lemont, IL. She attended St. Mary's College (which became St. Mary's University) in Winona, Minnesota, with a major in biology, graduating cum laude in 1979 with a liberal arts degree. Ms. Zuelke worked for Waldenbooks as a store manager from 1979 to 1989. She then attended the University of Central Florida to obtain the education classes necessary for teacher certification. Her education career began in1989 at Osceola County Schools' Alternative Programs as a dropout prevention instructor for Project C.O.P.E., the teen parenting center, teaching high school science and mathematics courses. Ms. Zuelke earned her master's in education in curriculum and instruction from National Lewis University, Tampa, FL, in 1995. She has worked at Discovery Intermediate School since 2001 as a science teacher, dean of students, and currently, reading coach. In 2002 she received her Education Specialist degree in educational leadership from the University of Florida.