TEACHER TRAINING AND STUDENT PERFORMANCE ON THE END OF COURSE EXAM IN ALGEBRA 1

By

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To my family, without your support none of this would have been possible.

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Research studies have yielded inconclusive results about the relationship between teacher training programs and student achievement. With the implementation of end of course exams as a graduation requirement in the state of Florida; continual need to fill teaching positions, rising student enrollment, and legislated class size limits; the level of student performance may become dependent on the type of teacher training. The purpose of this study was to determine if there was a relationship between teacher training and student performance on the end of course exam in Algebra 1.

Algebra 1 end of course exam scores were collected from 790 students among 15 Algebra 1 teachers in one southwest Florida school district. Student gender, race/ethnicity, and socioeconomic status data were also collected to determine if these variables influenced student performance. Teacher variables were gender, race/ethnicity, college major, degree, teacher training program, certification, and years teaching mathematics and Algebra. Student data was stratified based on teacher training method: traditional program; alternative certification, and subject area testing. Frequency distribution, descriptive statistics, hierarchical linear modeling, Wilcoxon

signed-rank test, Wilcoxon Two Sample test, and Kruskal-Willis tests were conducted. There was no significant difference found on student's Algebra 1 EOC performance and type of training program of the teacher; or when comparing gender and race/ethnicity to mean test scores. There was a significant difference when comparing students on socioeconomic status. Lower socioeconomic status of student resulted in on average lower mean test scores. When comparing student performance based on teacher's major in mathematics or education mathematics major, there was no significant difference in the students' mean test score as well as no significant difference due to student gender, race/ethnicity, or socioeconomic status. The number of mathematics and educational methods courses taken by teachers showed no significant difference in mean scores. However, there was an increase in the number of mathematics courses females take compared to males. No difference was noted with teacher ethnicity.

These exploratory findings replicate some of the previous studies on student achievement and teacher training programs which showed inconclusive findings.

CHAPTER 1
INTRODUCTION

Teacher training programs have been a controversial topic for many years. However, because the need for teachers outnumbers the number of graduates from traditional teacher education programs, states have looked to alternative programs to provide teachers at a faster rate. As a result, researchers have raised concerns about the relationship between alternatively certified teachers and their relationship to student achievement (Darling-Hammond, 1999; Flores, Desjean-Perotta, & Steinmetz, 2004; Glazerman, Mayer, & Decker, 2006; Suell & Piotrowski, 2006). Studies also indicate that factors other than teacher quality or their training are linked to student achievement including student gender, race/ethnicity, and socioeconomic status. Findings from such studies suggest that student demographics should be considered when determining what type of teaching training program would be effective in reaching the needs of all students.

In 2007, the National Commission on Teaching and America's Future (NCTAF) sought input from leading educators to determine what was needed to "ensure that every American child has equal access to a high-quality, world-class educational opportunity" (p. 190). Meanwhile, researchers have stressed the idea that a certified teacher in the subject area that they are teaching should be provided to every child. With the shortage of certified teachers available, alternative programs have proliferated to ensure that teacher vacancies are filled. The National Center for Education Information (NCEI) reported as of 2008, 48 states and the District of Columbia provided at least one alternative option for certifying elementary and secondary teachers. School districts in Florida are required to offer a competency-based alternative certification

program, either through a web-based program developed by the state or one developed by the district and approved by the state (NCAI, 2010). According to the National Center for Alternative Certification (NCAI), approximately 500,000 teachers have entered the teaching profession through alternative programs since 1985 (as reported in NCEI, 2010). Darling-Hammond (1990) was one of the first researchers to point out inconsistencies in the definition of an alternative certification and that not all programs are equal in structure or requirements. The question whether or not alternative programs are equivalent to the traditional program and if they can provide students with a qualified teacher still lingers.

What makes a qualified teacher? The answer to this question varies and this is where the controversy begins. According to the No Child Left Behind Act of 2001 a highly qualified teacher meets three requirements: (1) holds a bachelor's degree or higher degree from an accredited or approved institution; (2) has a valid state certificate; and (3) has demonstrated subject matter competency for each core academic subject assigned. Some researchers report that only traditional programs produce "qualified" teachers (Darling-Hammond, 2002, Zientek, 2007). Others suggest alternative programs do not adequately prepare them to teach competently (Darling-Hammond, 1990; Wise & Darling-Hammond, 1992). Ballou and Podursky (2000) suggested there are multitudinous regulations and requirements preventing those that want to teach an opportunity to enter the teaching profession. Teachers are also required to have a broad knowledge of curriculum and standards; knowledge of discipline and classroom management techniques; identify and meet the needs of diverse learners; have good communication skills with students, parents, and colleagues; effectively use technology

as a teaching tool; and promote a classroom atmosphere of enthusiasm and motivation. Researchers have pointed out that these are some of the characteristics where alternatively certified teachers have difficulties (Darling-Hammond, 1996; Darling-Hammond, Chung, & Frelow, 2002; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005).

Goldhaber and Brewer (2000) compared the impact of alternative and traditional certification types on mathematics performance. They found “students of teachers with emergency certification in mathematics do no worse than students who have teachers with standard certification” (p. 139). However, they also found “teachers with subject-specific training (a mathematics degree or certification) outperform those without subject-matter preparation” (p. 141). Darling-Hammond, Berry, and Thoreson (2001) reviewed Goldhaber and Brewer’s findings and asserted that the researchers did not provide information on “what kinds of teacher preparation matter for student achievement. It reveals even less about whether certification requirements are valuable” (p. 31). In his report, the Secretary of Education Rod Paige (2002) asserted that “there is little evidence that education school course work leads to improved student achievement” (p. 19). He dismissed the importance of teacher preparation programs claiming that they were not being scientifically linked to teacher effectiveness. In their rebuttal, Darling-Hammond and Youngs (2002) indicated that Paige did not support many of his statements with scientifically based research. In their review of various studies on student achievement; Wilson, Floden, and Ferrini-Mundy (2002) found a positive relationship between teacher education and teacher effectiveness.

In the 1998 – 2000 Third International and Mathematics and Science Study Video Study (TIMSS Video Study) researchers assessed teachers and their teaching methods in seven countries to identify teacher characteristics and their impact on teacher quality and student achievement. When comparing the results, they found that student performance in the United States was lower than in the other countries studied and that many factors contributed to this. The National Center for Education Statistics (2003) summarized the findings as: compared to the teaching styles of teachers in other countries with higher student achievement, teachers in the United States were inferior in the "introduction of new content, coherence across mathematical problems and within their presentations, the topics covered and the procedural complexity of the mathematical problems, and classroom practices regarding individual student work and homework in class" (p. 4). Heibert *et al.* (2003) proposed that in order to improve systems of teaching in the United States, we must first establish specific learning goals and align teaching standards to these goals. They asserted that the United States spends too much time focusing on what to implement rather than how to implement when trying to make improvements.

Moyer-Packenham, Bolyard, Kitsantas, and Oh (2008) examined teacher qualities that have been used by the National Science Foundation's Math and Science Partnership (NSF MSP) Program toward identifying exemplary mathematics and science teachers. They reported "student performance is often attributed to the quality, or lack thereof, of K – 12 mathematics and science teaching" (p. 563). Findings concerning what makes an effective teacher and whether or not it matters if the teacher

has received training through the traditional program or by an alternative certification program are inconclusive.

The debate about whether or not mathematics teachers should be mathematicians or should be required to take a minimum number of mathematics courses in their education program of study continues. According to the 2008 Science, Technology, Engineering, and Mathematics (STEM) Education report, “a recent review of the research on teacher quality conducted over the last 20 years revealed that, among those who teach math and science, having a major in the subject taught has a significant positive impact on student achievement” (p. 13). Heaton and Lewis (2011) suggested that simply requiring teachers to take more mathematics courses was not the answer to the problem of inadequate preparation of teachers. They proposed that mathematicians and educators work together to develop a curriculum to help prospective teachers “learn both mathematics and how to teach mathematics” (p. 399). Again, what makes a highly qualified teacher of mathematics remains inconclusive.

Gender, race/ethnicity, and socioeconomic status also affect student performance especially in mathematics. Though gaps in student achievement in mathematics between males and females are relatively small, beginning in grade eight or nine, they continue to grow as students’ progress through high school resulting in females limiting their participation in higher level mathematics courses (Nagy, Trautwein, Baumert, Koller, & Garrett, 2006). Research has suggested this may be due to a lower mathematics self-concept for females (Crombie, Sinclair, Silverthorn, Bryne, DuBois, & Trinneer, 2005; Simpkins, Davis-Kean, & Eccles, 2005; Tsui, 2007; You, 2010). Females have always been judged as “inferior” to males in mathematical ability and this

message continues to be conveyed (Geist & King, 2008). Males tend to take higher level mathematics courses even though females tend to receive higher grades (Reigle-Crumb, 2006). However, on the 2006 mathematics section of the Scholastic Aptitude Test (SAT), males outperformed females by a mean difference of 34 points (Tsui, 2007). O'Shea, Heilbronner, and Reis (2010) found that mathematically talented women also scored lower than their male counterparts.

Research has shown that African American and Latino students enroll in lower level mathematics courses and do not usually progress to the more advanced courses regardless of their level of achievement (Reigle-Crumb, 2006). She attributed this enrollment pattern to a lack of confidence in their mathematical ability and being "less responsive to institutional feedback, whether positive or negative" (p. 117). She cited Ogbu (1978, 2003) whom suggested "that when African American students perceive they will receive lower returns to their educational investments or will receive unequal treatment" (p. 117), they reject the school's educational goals. This could explain why African American and Latino male students begin at the same educational level as their White male peers but do not reach the same level of mathematical coursework. Noguera (2008) maintained that in order to close the racial achievement gap educators must "continue to recognize that the sources of inequity typically lie outside of schools – in disparities in income and wealth, in inequity in parent education and access to health care, and in access to good paying jobs and vital social services" (p. 101).

Most of the research reported mathematics achievement using aggregated socioeconomic status (SES) of the school rather than individual students, thus, it is hard to pinpoint what specific factors might impact individual students' achievement. When

low SES students are enrolled in high SES schools they tend to feel socially isolated. Research suggests that this sense of isolation prevents them from meeting higher achievement in mathematics. This is especially true when the high SES school has a low race/ethnic population (Crosnoe, 2009).

All of these factors may become more salient in studies of student mathematics achievement with the passage of Florida Senate Bill 4. Beginning with students entering ninth grade in the 2011 school year, this bill will impact graduation requirements. For the first time in the history of the state, all students enrolled in Algebra 1 will be required to take an end of course (EOC) exam. At the time of this study, the EOC exam will only count for 30% of their final grade for ninth graders. However, in the future, students will be required to pass the exam to receive high school credit in Algebra 1. End of course exams in mathematics will replace the Florida Comprehensive Assessment Test (FCAT) mathematics test.

Statement of the Problem

With the implementation of the end of course exam in Algebra 1, teacher training may be a more important factor in student success than previously suggested. Given the number of teacher vacancies, the type of teacher training may influence the level of student performance. In future years, student achievement in mathematics will affect subsequent enrollment in mathematic courses and graduation status. Research has shown that teacher quality is an important factor in student achievement (Darling-Hammond, 2000; Darling-Hammond, *et al.* 2005; Dee & Cohodes, 2008; Goldhaber & Brewer, 2000). The purpose of this study was to determine if there was a relationship between teacher training and student performance on the end of course exam (EOC) in Algebra 1.

Research Questions

1. Is there a relationship between teachers who completed a traditional preparation program and those who received alternative certification on student performance on the end of course exam in Algebra 1? After adjusting for student gender, race/ethnicity, and socioeconomic status is there a relationship between teacher preparation method and student performance on the end of course exam in Algebra 1?

2. Is there a relationship between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics on student performance on the end of course exam in Algebra 1? After adjusting for student gender, race/ethnicity, and socioeconomic status is there a relationship between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics on student performance on the end of course exam in Algebra 1?

3. Is there a relationship between the number of mathematics courses taken by the teacher and preparation type, teacher gender, and teacher race/ethnicity?

4. Is there a relationship between the number of educational methods courses taken by the teacher and preparation type, teacher gender, and teacher race/ethnicity?

Statement of Hypothesis

1. There will be no significant difference in the relationship between teachers who completed a traditional preparation program and those who received alternative certification on student performance on the end of course exam in Algebra 1. There will be no significant difference in the relationship between teacher preparation method and student performance on the end of course exam in Algebra 1 after adjusting for student gender, race/ethnicity, and socioeconomic status.

2. There will be no significant difference in the relationship between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics by student performance on the end of course exam in Algebra 1. There will be no significant difference in the relationship between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics on student performance on the end of course exam in Algebra 1 after adjusting for student gender, race/ethnicity, and socioeconomic status.

3. There will be no significant difference in the relationship between the number of mathematics courses taken by the teacher and preparation type, teacher gender, and teacher race/ethnicity.

4. There will be no significant difference in the relationship between the number of educational methods courses taken by the teacher and preparation type, teacher gender, and teacher race/ethnicity.

Significance of Study

The purpose of the study was to determine the relationship between teacher training and student performance on the end of course exam in Algebra 1. The findings of this study will contribute to the research on teacher training and student achievement in mathematics. Up to this point, research findings in this area have been inconsistent. The results may foster the identification of criteria that educational leaders can use in hiring qualified mathematics teachers. These findings may also be useful in the state of Florida as well as other states that are moving to end of course exams instead of minimum competency based graduation tests.

Results of this study may also provide information to the directors of teacher preparation programs (both traditional and alternative) concerning where curricular deficiencies exist. The findings may also lead to the development of criteria that can be used to establish alternative programs so that both programs are of similar caliber.

Limitations

There was no pretest given to determine students' mathematics achievement before taking the EOC exam. Students enrolled in Algebra 1(regular and honors level) were level two or above on previous year Florida Comprehensive Assessment Test (FCAT) mathematics score, but the FCAT does not measure algebraic skills alone. This is a pre-experimental research design and students' scores were treated like cohort groups as they were attached to each teacher participant. Thus there was no random sampling or random assignment in this study.

When comparing the content area score of the EOC, it is important to remember that there are three forms of the test. Equating was used to ensure that the T-scores on the different test forms have the same meaning and are comparable, but a given

content area score should only be compared for a specific test form between schools. This study compared the T-scores for all forms between all teachers and did not investigate if one version of the test produced higher scores than another.

Another limitation is that the different sections of the test were not studied to provide information on how the students performed on each section. Doing this may have provided additional information regarding areas where students need further instruction. Such information might have pointed out to mathematics teacher training programs areas where extra instruction is needed for students.

Teachers in Florida come from all over the United States. Many of them have completed their degrees from a variety of traditional and alternative teacher education programs. A study conducted by Humphrey and Wechsler (2005) confirmed the many variations in the alternative certification route even within a given state and questioned the usefulness of comparing different programs. This study did not analyze each program to determine differences and their impact on student performance. However, a new category, subject area testing, was studied as a result of teacher survey responses. This category falls under alternative certification but warrants independent analysis.

The use of a survey is dependent upon the authenticity of the participants' responses. However, this study did not measure social desirability bias, a behavior that may occur when participants are responding to self-report measures. Since the study was conducted in one Southwest Florida district, the results may not be transferable to other school districts in Florida or other states.

Definitions

ALTERNATIVE CERTIFICATION	designed to prepare individuals that have not pursued conventional or traditional routes to teacher certification through college or university training; programs vary from state to state.
END OF COURSE EXAMS	comprehensive tests taken during the second semester that covers the objectives of the curriculum.
PEDAGOGICAL CONTENT	an understanding of how particular topics, problems, knowledge or issues are organized, presented, and adapted to the diverse interests and abilities of learners, that are presented for instruction (Shulman, 1987)
QUALITY TEACHER	individuals who: hold a bachelor's or higher degree from an accredited college or university; valid state certificate; subject matter competency for each core academic subject assigned and; has a broad knowledge of curriculum and standards; knowledge of discipline and classroom management techniques; able to identify and meet the needs of diverse learners; has good communication skills with students, parents, and colleagues; and promotes a classroom atmosphere of enthusiasm and motivation.
SUBJECT AREA TEST	designed to assess subject matter knowledge and skills and is used to obtain subject area certification.
TRADITIONAL/CONVENTIONAL PROGRAMS	teacher training process utilizing an accredited program through a college or university requiring course work and student teaching.

CHAPTER 2
REVIEW OF THE LITERATURE

A review of the literature provides a framework studying the relationship between teacher training and student performance on the end of course (EOC) exam in Algebra 1. Chapter 2 includes an overview of the research relevant to this study: (a) impact of teacher training programs (both traditional and alternative) on teacher effectiveness, (b) teacher training and its effect on student achievement in mathematics, (c) end of course exams and student achievement, (d) gender and student achievement in mathematics, (e) ethnicity/race and student achievement in mathematics, and (f) socioeconomic status and student achievement in mathematics.

Impact of Teacher Training Programs on Teacher Effectiveness

For many decades traditional and alternative teacher training programs have been controversial. With the continual need to fill vacant teaching positions due to retirement and attrition, rising student enrollments, and legislated class size limits; schools, universities, and district administrators are looking for expedient ways to certify new teachers who can meet workforce demands in mathematics and science.

Studies have been conducted to determine which method of teacher preparation produces the most effective teacher, the alternative approach (AC) or the traditional/conventional approach (TC). However the findings are inconclusive (Cohen-Vogel & Smith, 2007; Darling-Hammond, 2000; Dee & Cohodes, 2008; Glazerman, Mayer, & Decker, 2006; Kane, Rockoff, & Staiger, 2006; Nunnery, Kaplan, Owings, & Pribesh, 2009).

Hess (2002) stated that “there is some agreement on what teachers should know but no consensus on how to train good teachers or ensure that they have mastered

essential skills or knowledge" (p. 169). He proposed creating an approach that would allow aspiring teachers to apply for a job if they "hold a college degree; pass an examination of essential skills and content knowledge that would obviously vary by grade level and academic discipline; and pass a criminal background check" (p. 170). He opposes the "conventional approach" which requires teachers to complete an accredited teacher education program and student teaching in schools. He disagrees with the assumption that only "conventionally certified" teachers are capable of effectively teaching.

Cohen-Vogel and Smith (2007) analyzed data obtained from the 1999 – 2000 administration of the Schools and Staffing Survey (SASS) of elementary and secondary teachers. They tested four core assumptions that have been used in arguments for expanding alternative certification programs (AC): "AC attracts experienced candidates from fields outside education; AC attracts top-quality, well trained teachers; AC disproportionately trains teachers to teach in hard to staff schools; and AC alleviates out-of-field teaching" (p. 732). Using *t* tests, they compared the "differences in the proportion of first year AC and TC teachers with education degrees who entered teaching either directly from college or university programs, from another job in education (e.g., teaching in a private school), or from non-education related occupations" (pp. 741 – 742). By comparing AC and TC teachers academic qualifications; whether or not they were placed in hard-to-staff schools; and whether or not they taught at least one course outside their major or minor field of study, they found four-core assumptions were false. Many of the teachers entering an alternative program already had a degree in education but were not certified to teach and used the AC

program as a means to obtain certification; the recruits did not come with better qualifications or attend selective undergraduate institutions; were not more likely to teach in hard-to-staff schools; and AC programs were not an effective way to solve the problem of out-of-field teaching problem.

Harrell (2009) conducted a study to determine if the results of teacher examinations accurately measure teacher quality. Using the results from the Texas Examinations of Educator Standards (TExES), the researcher examined traditional indicators of teacher content knowledge for candidates seeking certification in grades 8 through 12 life science or grades 8 through 12 mathematics. The indicators were: upper level content area coursework, upper level content area grade point average and the time elapsed between the TExES content examination and the completion of the last upper level course in the content area. Using descriptive data (mean, mode, and standard deviation), he found that forty percent of the 8 – 12 mathematics candidates failed the state content examination although an analysis of their transcript indicated strong content preparation, high grade point averages and recent coursework completed. Linear regression analysis revealed that upper-level content area coursework, grade point average and the time elapsed between the initial attempt on the TExES were statistically significant to the TExES content examination score; F (3, 81) = 3.076; p = .032. Harrell recommended that policy-makers re-examine how high stakes teacher testing relates to teacher content knowledge associated with the degree programs offered by colleges and universities and whether the current method of high stakes testing exacerbates the teacher shortage problems in high need fields such as science and mathematics (p. 65).

Goldhaber (2007) studied the relationship between teacher testing and teacher effectiveness. By examining learning gains from a data set in North Carolina, he found a positive relationship between some licensure tests and student achievement. However, he cautioned that the results of the tests allowed individuals to teach who were not highly effective in improving student achievement and denied those who could become effective teachers because of their failure on these tests (p. 767). He acknowledged that teacher tests are not the same across the country and what may be identified as meeting the criteria in one state may not be the same in another state. He found that there is little information available on whether or not school districts use the testing results in their selection process.

Kane, *et al*. (2006) measured teacher effectiveness by looking at student performance and differences in teacher certification within the same schools. They found “little or no difference in the average teacher effectiveness of certified, uncertified, and AC teachers” (p. 43). Strong, Gargani, and Hacifazlioglu (2011) used three types of experiments to determine if evaluators knew how to accurately evaluate teachers for effectiveness. In the first experiment tested evaluators were asked to correctly categorize teachers as highly effective versus low effective using student achievement as a basis for their effectiveness. They watched video excerpts of classroom lessons and were asked to place teachers in the high or low effectiveness groups and to explain their rational for the placement. In the second experiment an analysis of the criteria evaluators used when making their evaluations was undertaken. This experiment was conducted in another state with a larger selection of evaluators. The third experiment used highly trained evaluators, an established observational measure, and the

evaluators observed a full-length video (rather than excerpts) of presentations of classroom lessons. The evaluators used research questions based on agreement (did the individual evaluators agree with each other on categorizing the teachers), criteria (what did the evaluators use as criteria for teacher effectiveness when allowed to choose their own methods), confidence (how confident were the evaluators that they made accurate assessments), accuracy (how well the evaluators categorized the teachers correctly), replication (did they get the same results each time), and discrimination (did any items on the observation protocol effectively discriminate between high and low performing teachers). The researchers concluded that the evaluators "achieved relatively high levels of agreement but were absolutely inaccurate, leading us to question whether educators can identify effective teachers when they see them" (p. 378). The authors suggested developing an observational measure that could predict teacher effectiveness.

Tournaki, Lyublinskaya, and Carolan (2009) conducted a study to determine if the certification pathway influenced teacher efficacy and effectiveness. Teacher candidate studies followed three different routes: conventional method that allowed teachers to be employed as the teacher of record in the classroom while completing their master's degree; entrance into a master's program without completing undergraduate teaching requirements; and completion of the alternative certification program "New York City Teaching Fellows" an extensive student teaching model with few course requirements. All three groups were placed in high schools in the same school district. The participants took surveys designed to measure teacher efficacy and teacher effectiveness in their last semester of studies. Two prearranged classroom observations

were conducted during the spring semester of the school year. Observers completed Danielson's Observation Scale after each observation. The results indicated that there was no significant difference in efficacy and effectiveness between the participants in the three pathways to certification.

Flores, Desjean-Perrotta, and Steinmetz (2004) found that teacher efficacy was affected by type of certification. When compared to alternative certification teachers, teachers who completed traditional programs reported having greater confidence in their teaching ability. Without time to observe other teachers, experience mentoring, or practice their skills before becoming the teacher of record, alternatively certified teachers were less likely to try new instructional methods as compared to the traditional teachers whom were given this opportunity.

Scribner and Akiba (2010) found that alternatively certified teachers whom had a deeper content knowledge and prior experience in related fields to the subject they were teaching did not make them better teachers. This was reinforced when Boyd, Goldhaber, Lankford, and Wyckoff (2007) studied the research available on the effect of certification and preparation on teacher quality. They questioned whether "requiring teachers to have more subject-area knowledge in math could enable them to teach more effectively, and improve student assessments in math" (p. 55).

One study compared Florida teachers certified by the traditional approach and an alternative program established by the University of West Florida (UWF). This program focused on the Florida Department of Education's 12 Educator Accomplished Practices. First year teachers in a northwest Florida school district (both traditionally certified, the UWF program, and other alternative programs) were evaluated using a Likert scale

rating form based on Florida's Accomplished Practices Survey. The results indicated that alternatively certified teachers expressed similar levels of competencies as traditionally certified teachers. The UWF alternatively certified teachers stressed the use of mentors and in-service support functions as important components, whereas the traditionally certified teachers acknowledged that their internships provided the support they needed to increase their proficiency (Suell & Piotrowski, 2006). A similar study conducted by Wayman, Foster, Mantle-Bromley, and Wilson (2003) concluded that teachers trained through alternative certification routes expressed similar levels of competencies as traditional certified teachers. The use of self-reporting mechanisms and a lack of empirical data were limitations of both studies.

Piccolo (2008) reviewed the research on how mathematics content should be effectively presented to students. She concluded that "the framework for effective mathematics teaching comprises these three components: general pedagogy, content knowledge for teaching mathematics, and pedagogical content knowledge" (p. 47). Teachers must be able to effectively plan lessons and motivate students (general pedagogy), have both "essential algorithmic and procedural knowledge necessary for computing mathematical solutions" and "the skills, procedures, and competencies needed for teaching mathematics to students" (content knowledge), and a "nexus of both content and pedagogy into a form of knowledge that comprises representations of analogies, illustrations, examples, explanations, and demonstrations so that the content is understandable to students" (pedagogical content knowledge – a term phrased and defined by Lee Shulman in 1987) (pp. 46 – 47). Capraro, Capraro, Parker, Kulm, and Raulerson (2005) as cited in Piccolo (2008) believe pedagogical content knowledge is

learned during teacher preparation programs and initial teaching experiences. Ball, Thames, and Phelps (2008) concurred that pedagogical content knowledge was important and concluded that more research is needed to understand how to improve the content preparation of teachers.

Using results from the National Educational Longitudinal Study of 1988 (NELS:88) as their source for determining the relationship between subject-specific teacher certification and academic degrees, and teacher quality, Dee and Cohodes (2008) concluded that “what makes a teacher effective for a particular type of student may make him or her ineffective for others” (p. 29). Laczko-Kerr and Berliner (2002) believe that teachers need extensive training in order to develop a deeper knowledge of subject matter and the ability to teach this subject matter to a diverse student population. Wenglinsky (2002) asserted that a link between teacher quality and student achievement is dependent on the classroom practices of the teacher. He concluded that “regardless of the level of preparation students bring into the classroom, qualitative research asserts, teachers’ decisions made about classroom practices can greatly facilitate student learning or serve as an obstacle to it” (p. 5).

Some researchers argue that the differences lie in the interpretation of the research results. Darling-Hammond (2000) disagreed with Ballou and Podgursky (2000) interpretation of the 1996 National Commission on Teaching and America’s Future (NCTAF). Ballou and Podursky asserted that teacher education makes no difference in teacher performance and student learning and students would be better off without state regulations on how much training teachers must receive before entering the classroom (p. 6). However, Darling-Hammond suggested that a lack of preparation leads to high

teacher attrition rates and lower levels of learning (p. 53). Darling-Hammond cited Ferguson's (1991) findings that a "large influence of teacher qualifications on student achievement at the district level" (p. 31) to defend her position. She used this example to clarify the importance of enacting "policies that aim to enhance teachers' abilities" (p. 31). Ballou and Podursky disregarded these findings.

Selko and Fero (2005) reviewed the criteria used to define alternative certification programs. They found that there was no common definition. As a result of their work on creating a new alternative pathway to teaching they urged educators to look closely at alternative programs and to distinguish "between 'shortcut' alternative programs and high-quality alternative paths to certification programs that hold candidates responsible for meeting the same standards and performance expectations as traditional programs" (p. 34). Since alternative certification programs are here to stay, it is important for state and national standards be established to meet the needs of students entering into these programs. Study results suggest that whether or not the type of teacher training program has had a positive or negative effect on teacher effectiveness is inconclusive.

Teacher Training and Student Achievement in Mathematics

Darling-Hammond, *et al*. (2005) examined the relationship between student characteristics and achievement with teachers' certification route, experience, and degree levels using a data set from Houston, Texas. Students enrolled in a traditional teacher education program that led to certification were compared to individuals participating in the Teach for America (TFA) program and other alternative certification programs. Using regression analysis of 4th and 5th grade student achievement gains in reading and mathematics over a period of six years, traditionally certified teachers

produced significantly stronger student achievement gains than the participants who were alternatively certified through TFA.

A study conducted in Florida measuring the effects on student achievement of an alternative program Troops to Teachers (TTT) produced opposite results. An analysis of covariance (ANCOVA) showed a “statistically significant relationship between TTT status and student mathematics scores after controlling for course taught, grade level, prior achievement, and student demographics” (Nunnery, *et al*. 2009). The TTT teachers showed a significant positive effect on student achievement in mathematics when compared to all other teachers teaching the same subject at the same grade level in the same schools (d = +0.05) (p. 262). While comparing TTT teachers to other teachers within the same school, same grade level, and years of experience they found “a moderately large, statistically significant positive effect on student achievement in mathematics was associated with TTT status” (p. 262). Students with TTT teachers “performed about one quarter of a standard error of estimate higher than students served by comparison teachers with similar experience” (p. 262).

The difference between the TFA and TTT programs lies in how the teachers are trained. TFA recruits hold a bachelor’s or higher degree from an accredited college or university and are placed in an all-expense paid five week intensive training program which includes coursework and student teaching prior to being placed in the classroom. They also receive ongoing support from TFA. TTT programs also require a bachelor’s or higher degree from an accredited college or university and a separated or retired military service requirement. The potential recruits are eligible for financial aid assistance and are required to find an alternative program or traditional program in the

state they wish to be employed. They must also sign a three year commitment to teach at a public school within a high-need district. It is possible the TTT teachers went through a traditionally certified teacher curriculum which may account for the positive effect they had on student achievement.

Glazerman, *et al*. (2006) also found that alternatively certified teachers impacted mathematics achievement. Using TFA teachers for their data source they found a positive impact on mathematics achievement when compared to certified teachers. They reported a difference equivalent to 15 percent of a standard deviation, equivalent to one month of instruction (p. 84).

Laczko-Kerr and Berliner (2002) compared certified teachers who had completed a minimum of 45 hours of coursework in education with uncertified teachers from Teach for America, provisional teachers, emergency teachers, and those holding bachelor's degrees with little or no education coursework. Using the Stanford Nine (SAT-9) to analyze student achievement in grades 3 – 8; they concluded that students who had certified teachers scored higher than the uncertified teachers.

Using NELS:88 as their primary source of data, Goldhaber and Brewer (2000) examined the relationship between 12th grade students' performance in mathematics and science and teacher certification. They found the following relationships:

> 1. Students of teachers with mathematics degrees and/or certification in mathematics achieved better than students of teachers without subject matter preparation.
>
> 2. Student test scores in mathematics were higher when the teacher of record held professional or full state certification, relative to the students' scores when taught by a teacher who was certified out of field or held private school certification,

> 3. Students taught by teachers with bachelor's and/or master's degrees in mathematics outperformed the students taught by teachers who were not credentialed in the same field.
>
> 4. Students taught by an uncertified science teacher or a teacher who held a private school certification showed lower scores.
>
> 5. Measurement of student achievement growth revealed no significant differences between mathematics or science student test scores for teachers with emergency certification and those traditionally certified (p. 145).

Using the same data source, Dee and Cohodes (2008) also concluded that teachers who were subject certified demonstrated gains in students' mathematics achievement.

Darling-Hammond (1999) examined how teacher qualifications and other state policies such as teacher recruitment and professional development affect student achievement. She concluded that "the most consistent significant predictor of student achievement in reading and mathematics in each year tested is the proportion of well-qualified teachers in a state: those with full certification and a major in the field they teach (r between .61 and .80, $p < .001$)" (p. 29). She reported that states with rigorous teaching standards for teachers and rarely hire unqualified teachers have the highest student achievement gains (p. 18).

Moyer-Packenham, *et al.* (2008) examined the different types of instruments used to identify mathematics and science teacher quality characteristics in 48 nationally funded mathematics and science education awards. The six characteristics were teacher behaviors, practices, and beliefs; subject knowledge; pedagogical knowledge; experience; certification status; and general ability. The study revealed that the following characteristics were more likely to be assessed: (a) teacher's behaviors, practices, and beliefs (85.4%); (b) subject knowledge (81.3%); and (c) pedagogical knowledge

(77.1%). (p. 584). These teacher characteristics are most likely to be associated with student achievement.

Clotfelter, Ladd, and Vigdor (2010) studied teacher credentials and their effect on student achievement in North Carolina. Teachers are certified through the regular/traditional route and by an alternative program. North Carolina's alternative certification route is a lateral entry program requiring individuals to have at least a bachelor's degree and the equivalent of a college major in the area in which they are assigned to teach. The teachers are required to enroll in a teacher education program to complete the required class work and must complete at least six semester hours of coursework each year. A lateral entry license is issued for two years, and may be renewed for a third year (p. 670). A regular license includes both initial (completion of state-wide approved teacher education program, 10 weeks of student teaching, and passing scores on applicable Praxis II tests), and continuing license (after three years of successful teaching). The authors analyzed the achievement scores on the EOC's of four cohorts of tenth grade students in school years 2000 through 2003. The final sample included only students that could be matched with teachers on at least three EOC tests. The results revealed that "students taught by teachers with a lateral entry license averaged 0.06 standard deviations lower than those taught by teachers with a regular license" (p. 670).

However, they found that when lateral entry teachers continue teaching they are no less effective than teachers with a regular license. The authors attribute this to their training and also selection. Since many lateral entry teachers leave the profession this suggests that perhaps those that remain are more effective than those that leave. The

study also revealed that students taught by teachers certified in math increased their achievement on average by about 0.11 standard deviations (p. 671).

In a 2008 final report of the National Mathematics Advisory Panel, educational policy observers reported concerns about the difficulties students have with mathematics achievement beginning in late middle school where for most students, algebra coursework begins. They supported the notion that “teachers’ knowledge of mathematics as a factor in students’ achievement” (p. 37). They made the following recommendations:

> 1. Teachers must know in detail the mathematical content they are responsible for teaching and its connections to other important mathematics, both prior to and beyond the level they are assigned to teach. However, because most studies have relied on proxies for teachers’ mathematical knowledge (e.g., course work as part of a certification program), existing research does not provide definitive evidence for the specific mathematical knowledge and skill that are needed for teaching.
>
> 2. More precise measures should be developed to uncover in detail the relationships among teachers’ knowledge, their instructional skill, and students’ learning, and to identify the mathematical and pedagogical knowledge needed for teaching.
>
> 3. The mathematics preparation of elementary and middle school teachers must be strengthened as one means for improving teachers’ effectiveness in the classroom. This includes pre-service teacher education, early career support, and professional development programs. A critical component of this recommendation is that teachers be given ample opportunities to learn mathematics for teaching. That is, teachers must know in detail and from a more advanced perspective the mathematical content they are responsible for teaching and the connections of that content to other important mathematics, both prior to and beyond the level they are assigned to teach (pp. 37 – 38).

The panel suggested that students need better preparation in the basic principles of arithmetic in order to be successful in Algebra.

Again, the findings regarding the impact of traditional/conventional programs versus alternatively certified programs on student achievement in mathematics remain inconclusive.

Mathematician versus Mathematics Education Major

Another factor that determines the effect on student achievement is whether the teacher received a degree in mathematics or is an education major with an emphasis in mathematics. Proulx (2008) contradicts the statement “the more a teacher knows mathematics the better his teaching. He feels strongly mathematical knowledge does not imply strong teaching knowledge, and vice versa” (p. 345). Goulding, Rowland, and Barber (2002) as cited in Proulx (2008) hypothesized that “teaching knowledge could feed back in and enrich subject matter knowledge” (p. 345).

Bass (2005) studied the relationship between mathematics, mathematicians, and mathematics education and found that there are “conflicts between mathematicians and educators over the content, goals, and pedagogy of the curriculum” (p. 417). He wrote that “mathematics education is not mathematics” (p. 418) to illustrate that while education uses mathematical knowledge this can be viewed as applied mathematics. He asserts that for mathematicians to contribute to education they must understand what is useful and usable to the mathematics educator. Bass pointed out that the changes that have come about in mathematics education are the result of educators not mathematicians. Mathematicians have criticized the National Council of Teachers of Mathematics new national standards for mathematics education.

Wagner, Speer, and Rossa (2007) followed a mathematician through the delivery of an undergraduate course on differential equations and found that mathematicians may need assistance in curriculum delivery because they lack exposure to teacher

education programs. Even though they possess the curricular content knowledge of the subject matter they have not acquired the instructional practices to present this knowledge to their students. Wagner, *et al*. (2007), also used the term ‘pedagogical content knowledge to “represent knowledge that is unique to mathematics instruction yet not obtained merely through the study of mathematics subject matter itself” (p. 249). They stated that the traditional forms of teacher preparation including general courses in mathematics and courses in pedagogy were insufficient for preparing quality mathematics teachers. They suggested that more research was needed to determine precisely what other forms of knowledge would benefit the preparation of mathematicians for the classroom and insure mathematics education majors have adequate subject content knowledge.

Ferrini-Mundy and Findell (2010) debated the following two perspectives that have influenced the design of programs for the preparation of secondary school mathematics teachers.

> 1. Prospective high school teachers should study essentially whatever mathematics majors study – because this will best equip them with a coherent picture of the discipline of mathematics and the directions in which it is heading, which should influence the school curriculum.
>
> 2. Prospective high school teachers should study mathematics education – methods of teaching mathematics, pedagogical knowledge in mathematics, the 9 – 12 mathematics curriculum, etc. (p. 31).

The authors found two problems with requiring the same mathematical preparation for mathematics teaching as for mathematics majors. First, the mathematical demands of teaching are completely different than conducting mathematical research. Teachers with a major in mathematics “may have too little mathematical preparation of the kind they will need” (p. 33). Second, by separating content from pedagogy, perspective teachers

may fail to acquire pedagogical content knowledge. Education courses in pedagogy help prospective teachers actively engage their students in learning, making the subject matter meaningful, building on what the students know, and relating this information to other academic areas. Mathematics majors do not receive this instruction.

There was no consensus on whether or not a mathematician makes a more qualified teacher because of their content knowledge or whether an education major is more qualified. As many researchers indicate, more collaboration between mathematics departments and education departments are needed to develop more qualified mathematics teachers in both mathematics subject content and pedagogy (Bass, 1997, 2005; Ferrini-Mundy & Findell, 2010; Nebres, Cheng, Osterwalder, & Wu, 2006; Wu, 2011).

End of Course Exams and Student Achievement

End of course exams are used in many countries to measure student success and teacher effectiveness. According to the Center on Education Policy (2008) many states are adopting end of course exams to “improve overall accountability, increase academic rigor, and improve alignment between state standards and curriculum” (p. 2).

History of End of Course Exams

One of the first researchers to study the effects of curriculum-based external exit examinations (CBEEE) on achievement was Bishop (1997). It had been hypothesized that “CBEEEs based on world class standards would improve teaching and learning of core subjects” (p. 2). A CBEEE has the following traits:

1. Produces signals of student accomplishment that have real consequences for the student;

2. defines achievement relative to an external standard, not relative to other students in the classroom or the school;

3. is organized by discipline and keyed to the content of specific course sequences;

4. signals multiple levels of achievement in the subject; and

5. covers almost all secondary school students (p. 3).

He found that colleges and employers look at the CBEEE scores and “give greater weight to academic achievement when they make admission and hiring decisions; so the rewards for learning should grow and become more visible” (p. 3). The author explained that when CBEEEs are used the incentives available to students, parents, teachers, and administrators are improved. Students are not pressured to outperform their colleagues (rank in class), teachers do not feel they are required to give higher grades than students deserve, and administrators can use results of CBEEEs to challenge teachers to raise standards in their classroom.

When looking at Canadian schools, Bishop, Moriarty, and Mane (1997) learned that “public school students in the exam system provinces were 21 percent of standard deviation better prepared in mathematics and 15 percent of a standard deviation better prepared in science than comparable students from provinces lacking exams” (p. 5). Using data from the National Association of Education Progress (NAEP), Bishop (2005) concluded that the introduction of Universal CBEEEs in New York and North Carolina during the 1990s was associated with large increases in math achievement on NAEP tests” (p. 27). He noticed the “the remarkable ability of European style Universal CBEEEs to substantially increase academic achievement without decreasing school enrollment and graduation rates” (p. 28). The reasons for their success were:

1. They signal the full range of student achievement to universities and to employers, so all students get increased rewards – better jobs and access to preferred university programs – if they study harder.

> 2. Doing poorly on a European Universal CBEEE means you graduate with a record of modest accomplishment.
>
> 3. End of course exams pressure individual teachers to improve their teaching.
>
> 4. The component exams of the Universal CBEEEs are more challenging and higher in quality than the minimum competency test (MCT) and standards based exams (SBE) that dominate student accountability in the U.S. (p. 28).

Bishop, Mane, and Bishop (2001) examined the differences between minimum competency exams and curriculum based external exit exams and their relationship to student achievement and learning conditions. They concluded that students are made more aware of their achievement level and have the incentive to do better on CBEEEs. Because the exams usually contain more difficult material, teachers spend more time on cognitively demanding skills and strategies and it encourages them to set higher standards in the classroom. To determine the success of curriculum based external exams, the researchers' analyzed data collected from the Third International Mathematics and Science Study (STEMS) and the International Assessment of Educational Progress. They found that "13 year old students from countries with curriculum based exit exam systems are ahead of students from other countries at a comparable level of economic development – including the United States – by 0.67 – 2 grade levels in mathematics, science, geography, and reading" (p. 59).

Bishop (1997) also concluded that curriculum based end of course exams had an impact on school policies and instructional practices. Higher minimum standards were set for becoming a teacher, higher teacher salaries (30 – 34 percent higher for secondary teachers) were noted, and more teachers majored in the subject they are assigned to teach.

Algebra 1 EOC

With the implementation of Senate Bill 4, Florida has moved to end of course exams to measure student achievement. Students entering high school in school year 2011 were required to take an end of course exam in Algebra 1.

According to the Florida Department of Education, “the Algebra 1 EOC assessment measures achievement of students enrolled in Algebra 1, or equivalent course, by assessing student progress on the benchmarks of the Next Generation Sunshine State Standards (NGSSS) (see Table 2-1) that are assigned to Algebra 1 course descriptions” (FLDOE, 2010, p. 1). The exam is given in one 160 minute session with a 10 minute break after the first 80 minutes. Students that did not finish in the allotted time were allowed to continue testing; however testing must be concluded within one school day. The Algebra 1 EOC assessment was administered via a computer-based testing platform. There were three forms of the test, each form containing questions common to all three forms, questions unique to each form, and field-test questions. Each form included 35 – 40 multiple choice (four answer choices given) and 25 – 30 fill-in responses (solve a problem and record a numerical answer). Each form contained 54 questions that contributed to the students’ score. There were three reporting categories with different numbers of questions within a test form; however each reporting category comprised the same percentage of the students’ final scores across all test forms. The reporting categories were: *Functions, Linear Equations*, and *Inequalities* (55%), *Polynomials* (20%), and *Rationals, Radicals, Quadratics, and Discrete Mathematics* (25%). Students received a T- score using a scale of 20 – 80. On the T-score scale, 50 was the statewide average and all interpretations were norm-

referenced interpretations. Each school district was responsible for assigning a letter grade to the scale score and using this grade as 30% of the final grade for the course.

Gender and Student Achievement in Mathematics

For many years males have been identified as being superior to females in mathematical ability on standardized tests (Beller & Gafni, 1996; Campbell & Beaudry, 1998; Kimball, 1989). Recent studies indicate that these findings are no longer valid (Geist & King, 2008; Georgiou, Stavrinides, & Kalavana, 2007; Tsui, 2007). Additional studies indicate that any gender gaps that continue may be related to affective and sociological factors (Ai, 2002; Kimball, 1989; Nagy, *et al*. 2006).

Jacobs, Lanza, Osgood, Eccles, and Wigfield (2002) studied perceptions of self-competence and task values in children across grades 1 through 12 in mathematics, language arts, and sports domains. Using Hierarchical Linear Modeling (HLM) they determined that males and females begin school "with significantly different perceptions of their math competence, and significant gender effects for slope and acceleration emerged by grade six" (p. 517). The researchers attribute this to gender role socialization in the home and society by parents, peers, media and role models they see around them. Boys start out with higher perceptions of their math competence in mathematics at first grade, but their competence beliefs decline at a faster rate than girls. "As a result of differential rates of decline, boys and girls had similar beliefs about their math abilities by high school" (pp. 517 – 518). Task values for males and females also declined revealing a negative intercept meaning there was a "slight increase in the rate of decline over time" (p. 519). The study also revealed that the respondents value math more when they felt competent in the subject.

While past research has indicated that males reach higher mathematical levels than females, current research revealed that females are reaching the same level in mathematical ability. Georgiou, *et al*. (2007) found no significant differences between eighth grade boys and girls in math achievement. Using data obtained from self-report scales of Attitudes Towards Mathematics Scale, Maths Achievement Attribution Scale, a math achievement test (TIMSS) and the Affective Reactions Scale, the authors concluded the following:

> 1. The mean scores of boys and girls in mathematics achievement were not significantly different (boys mean score = 4.07, SD = 2.1 and girls' mean score = 3.82, SD = 1.8, t = .78, p > .05);
>
> 2. High achieving boys had significantly higher mean scores in ability attributions than all other groups (X = 3.42). However, high achieving girls did not have significantly higher mean score in effort attributions than high achieving boys;
>
> 3. High achieving boys and girls do not differ significantly in their attitudes towards mathematics (i.e. they both find it to be an attractive subject). This was not true for low achieving boys and girls;
>
> 4. Students who do well in mathematics find the topic challenging, while those who do not do well find it threatening;
>
> 5. High achievement could predict a positive attitude towards mathematics, but such an attitude could not predict good achievement (pp. 336 – 338).

From data collected internationally, Else-Quest, Hyde, and Linn (2010) also concluded that males and females differ very little in mathematics achievement. They also found that the more positive attitudes toward mathematics held by males may influence their enrollment in more advanced courses and navigation towards careers with an emphasis in mathematics suggesting that affective and sociological factors play a huge role in gender gaps that may exist.

O'Shea, Heilbronner, and Reis (2010) conducted a qualitative, comparative study of females who were identified as gifted and had scored in the 95th percentile on the quantitative section of the SAT. Their goal was to determine whether academic experiences (teacher interactions, curricula, and test-taking strategies) or home strategies (parental teaching and expectations) were instrumental in their mathematics achievement. Prior test results showed that males continually score higher than females on the SAT math (M). According to College Board (2007) "only 36.5% of students scoring at or above 700 on the SAT – M were female, compared to 63.5% who were male" (p. 237).

The study involved twenty-three females from different rural and suburban high schools in Northwestern United States. There were interviewed in four categories: school/math related questions; future plans; learning behaviors; and personal questions. Additional information was collected such as report cards, teacher comments, and standardized test scores. The results indicated that more than half attributed their success to their abilities which challenges previous research that indicated female success in mathematics was due to luck or hard work. These students also felt that mathematics was useful in their lives, were persistent when faced with difficult concepts, that parental influence played as an important reinforcement, and that acknowledgement from their teachers for their success reinforced their mathematical self-concept. They did not feel their teachers treated them differently from their male classmates and the enthusiasm the teachers had for the subject helped challenge them to achieve.

Ai (2002) also found that the effect of girls attitude toward mathematics on math scores was related to “mathematics teacher encouragement and parent encouragement, whereas boys’ attitude toward mathematics was independent of influences from teachers and parents” (p. 18). Teacher encouragement had a positive effect whereas parent encouragement had a negative effect on girls’ attitude toward mathematics.

Nagy, *et al.* (2006) identified 10th grade students attending academically oriented schools in Germany. They compared their test scores, self-concepts of ability for math and biology, and interest in the subject (intrinsic value) at the end of 10th grade and then again in the middle of 12th grade. They found that “Males reported higher math self-concepts (d =.52, p < .01) and higher math intrinsic value (d = .21, p < .05) than females, whereas females reported higher biology self-concepts (d = -.15, p < .05) and higher biology intrinsic value (d = - .51, p < .01) – despite being outperformed by the males on the biology achievement test” (p. 332). Males were twice more likely to take more advanced mathematics courses than females and vice versa for biology.

Van de gaer, Pustjens, Van Damme, and De Munter (2008) reinforced this conclusion in a study that determined the relationship between mathematics participation and mathematics achievement in high school. They administered mathematics achievement tests to Flemish students in equivalent US grades of 7, 8, 10, and 12 to determine if the number of classroom hours spent in mathematics equated to student achievement. They reported a reciprocal relationship between mathematics participation and mathematics achievement in grades 10 and 12. The Flemish system does not allow for flexibility in academic courses based on the academic plan a student

has chosen after eighth grade. They found that females tend to spend more classroom time in mathematics than their male counterparts in grades seven and eight resulting in only a slight variation in achievement. As they progress through school females tend to spend less classroom time in mathematics resulting in lower achievement scores. Borrowing from research by Eccles and Wigfield (2002), the authors suggested that mathematical self-concept, parent and teachers perception of the students' ability may influence the participation rate.

The first study to compare students' mathematics self-concept development in the secondary years was conducted in three distinct cultural settings: Australia (Sydney), the United States (Michigan), and Germany by Nagy, Watt, Eccles, Trautwein, Ludtke, and Baumert (2010). Studying students in grades 7 through 12; they concluded the following:

> 1. A general decline in mathematics self-concept was evident in all three countries;
>
> 2. gender differences in mathematics self-concept were found in all settings;
>
> 3. males score higher than females at the beginning of grade 7 in all contexts, but the magnitude of these gender differences varied;
>
> 4. there was no evidence for gender differences in self-concept change (pp. 499 -500).

Marks (2008) reviewed the research from 31 countries and found that the gender gaps in mathematics have continued to decrease in recent years. He found no relationship in achievement gaps due to affective and sociological factors as reported by Ai (2002); Else-Quest, *et al*. (2010); Nagy, *et al*. (2006).

Beilock, Gunderson, Ramirez, and Levine (2010) found that many female teachers have anxiety toward mathematics and this may provide negative consequences for

them. Their anxiety endorses stereotyping that boys are better at mathematics and girls are better at reading (p. 1860).

Clotfelter, *et al*. (2010) studied the effects of teacher gender on student achievement. They found that when both teacher and student were female as compared to a male teacher and female student there was a negative effect of -0.105. However, female teachers were equally effective in teaching both male and female students. Male teachers are as effective teaching male students as female teachers are teaching female students.

Additional studies show mixed results. Using NELS:88 data, Dee (2006) found that same-gender teachers/students had a positive effect on student achievement. Contradicting this finding was Krieg (2005) who concluded that regardless of gender, students taught by female teachers perform better than those taught by males. However, other studies conclude that teacher gender has no effect on student achievement (Dreissen, 2007).

Ethnicity/Race and Student Achievement in Mathematics

Research has shown that Blacks (37.7 percent) and Hispanics (33 percent) take lower level mathematics courses more often than Whites (26 percent) (Finn, Gerber, & Wang, 2002). Given this information begets the question, what effect did this have on level of achievement in the courses they do take?

In a study using national data from Adolescent Health and Academic Achievement (AHAA), Reigle-Crumb (2006) studied high school mathematics patterns of minorities and Whites in relation to their gender. He found that when African Americans and Latino males take Algebra 1 during ninth grade (usually they begin high school in a lower mathematics class then their White peers), it does not improve their chances of

reaching higher level or more advanced mathematics courses although this was not true for females. The findings showed that academic performance was not predictive of whether or not they would be successful later.

Klopfenstein (2004) studied the racial differences in Advanced Placement (AP) course participation rates in Texas. Using predicted probability of enrolling in at least one AP course she found that minorities enroll at lower rates than comparable Whites and recent migrant Hispanic students were least likely to enroll even when they were actively considering applying to a four-year college. Black males are predicted to participate at “least half the rate of White males and Black females fare slightly better but still participate at between 60 and 70 percent of the white female. On average, Hispanic females are even less likely to take an AP course than Black females, while Hispanic males are slightly more likely than Black males to enroll” (p. 121). When Black and Hispanic students were given White traits (attitude and behavior) the participation gap closed by “approximately 36 to 40 percent for Hispanics and by 40 to 46 percent for Black students. When high income was included as a coefficient, the participation gap closes by approximately 90 percent or more for Hispanic students and by 98 percent for Black students” (p. 130). The implications of these findings indicated that income was an important factor in whether or not minorities participate in AP courses which may be due to lack of resources such as parental support, limited academic role models at home, and knowledge about possible educational advantages that are available to them.

Asian American students have continually performed well in mathematical achievement. Zusho, Pintrich, and Cortina (2005) studied the relationship between

achievement motives, achievement goals, and motivational outcomes on a math test given to Asian Americans and Anglo American college students. Using a 5-point Likert scale on all measures except the mathematics achievement test, the following was observed. There were no significant differences between the Anglo and Asian samples on need for achievement, goal orientations – mastery goal orientation (focus on learning and understanding), performance- approach orientation (tendency to focus on outperforming other students), perceptions of competence (students' assessment of their performance after taking the mathematics test), interest (personal interest as well as enjoyments of task). There were significant differences on fear of failure – alpha for the Anglo sample of .78 and an alpha for the Asian sample of .83 ($p < .001$ significant difference); performance-avoidance goal orientation (defined as student focus on not looking dumb or stupid relative to other students) alphas, .86 Anglos and .85 Asians ($p < .01$ significant difference); mathematics achievement - ($p < .05$ significant difference); anxiety (nervousness and tenseness before, during, and after the mathematics test) alphas, .76 Anglo and .80 Asian ($p < .05$). The researchers concluded that even though Asian Americans have a heightened fear of failure they do not let this interfere with their subsequent motivation or performance in mathematics. They felt that additional research should be conducted to determine how "motives and goals are shaped and socialized by parental, school, and general cultural factors" (p. 154).

Research has also been conducted on how teacher race impacts student achievement. Dee (2004) asked if teachers were more effective with students who share their ethnicity. Using data obtained from Tennessee's Project STAR (Student Teacher Achievement Ratio), Dee examined the relationship between students'

performance and their assignment to teachers of their own race (this was not the intent of the project but allowed for Dee's study to be conducted). Following a cohort of students from 79 schools for four years (grades K – 3), student achievement was measured each spring using the Stanford Achievement Tests in math and reading. Because of the limited number of Hispanic, Asian, and Native American participants they were taken out of the data. Two-thirds of the students remaining were White with 94 percent of them having White teachers and for the remaining Black students only 45 percent had Black teachers. There was a wide distribution variation in the different schools: city schools – 97 percent of the students and 50 percent of the teachers were Black; urban/rural schools – 93 percent of the students and 97 percent of the teachers were White; and suburban schools contained 38 percent Black students and 26 percent of the teachers were Black. The results indicated: Black students that have a Black teacher for a year showed a 3 – 5 percentile-point increase in math scores; and Black students with Black teachers had a 3 – 6 percentile-point increase in reading scores. White students (male and female) with a White teacher scored 4 – 5 percentile-points higher in math, however only male students had scores 2 – 6 percentile-points higher when learning from a White teacher. Females showed no significant difference. The researcher cautions that these results may not be attributed to race but to differences in teacher quality that could not be directly observed, such as for Black students in predominately Black schools there is a tendency to attract and retain high quality Black teachers but lower quality White teachers, and for White students the opposite could be a factor (predominately White schools attracts more qualified White teachers and less qualified Black teachers). Dee proposed that schools recruit teachers based on the level

of disadvantaged students in the school and that schools that have predominately more of one race than another are unable to recruit highly qualified teachers of the other race. Using socioeconomic status and whether the school was segregated with a higher number of one race or another, Dee found that among White students, being assigned a White teacher had similar effects regardless of school type, however the opposite was true for Black students. The advantages of having a Black teacher in a school that had a high level of disadvantaged and racial segregation were consistent with the belief that lower quality White teachers were assigned to the school. Finally a comparison was made within the classroom and the results indicated that students still performed better when taught by teachers from their own race. Dee cautions using this data as an avenue to segregate students and teachers for the purpose of increasing student achievement due to the adverse social consequences this could create.

Socioeconomic Status and Student Achievement in Mathematics

Much of the research concerning socioeconomic status (SES) has concentrated on how the SES characteristics of the school population affect student achievement (Chiu, 2010; Crosnoe, 2009; Yang, 2003). Using mathematics test scores and questionnaires obtained from the Organization for Economic Cooperation and Development Program for International Student Assessment (OECD) to assess 15 year old students from 41 countries, Chiu (2010) looked at how country, family and school characteristics were linked to student achievement. Previous research revealed that when students come from a two parent home, they will typically have higher SES, more communication with parents, and more educational resources available to them compared to students that come from divorced or separated parents who face more challenges in caring for them. There is usually a difference in the type of school they

attend. Higher SES students tend to have better educational resources available to them based on the location of the school. Richer countries also provide a better educational environment for their students that can place them at an advantage compared to those living in poorer nations.

Using stratified sampling of the original participants and fitting the data with a graded response Rasch model, measurement error was reduced. The results indicated "about 31 percent of the difference in students' mathematics scores occurred at the country level, 25 percent at the school level, and 44 percent at the student level" (p. 1657).

> Students in richer or more equal countries had higher mathematics scores, with country gross domestic product per capita showing the largest country-link to mathematics achievement. Students with higher SES, who were native born, speaking the national language at home, living with two parents, without residual grandparents or with fewer siblings (especially older ones) scored higher in mathematics than other students. Students with more advantageous schoolmates (higher SES) or more school resources (class time, educational material, and mathematics teachers with university degrees) had higher mathematics scores (p. 1666).

Chiu's findings confirmed what was previously determined in study conducted by Yang (2003).

Crosnoe (2009) studied the effect of socioeconomic desegregation and the effect on low income students. He wanted to determine if the frog pond perspective; "a variant of social comparison theories, contends that students evaluate themselves relative to those in their specific contexts, often regardless of how that context "ranks" in the larger world" would prove valid (p. 711). In this theory, low income students may find themselves at a disadvantage from a curriculum and social perspective since as the SES level of their school rises they are being compared to students that are better

prepared for high school, have had access to better educational resources, and the high SES parents are usually more educated. All of these factors could predict future educational attainments.

He found that low income students in higher SES schools could have demonstrated higher achievement gains if not for the unintended side effects such as feeling socially isolated. Low-income minority students also faced psychosocial disadvantages when placed in high SES schools with low minority populations. When measuring school SES in terms of family income rather than parent education, minority low-income students are again at a curricular and psychosocial disadvantage. Alexander, Entwisle, and Olson (2007) and Lareau (2004) stated “that high SES students are typically better prepared for high school, enjoy greater standing with school personnel, and have parents who know more about how to work the system” (As cited in Crosnoe, 2009, p. 711). Crosnoe indicated that as the number of high SES students rises in a school there is more competition for the low income students for coursework and grades. These students can become labeled as academically and socially inferior to their peers even though this finding would be unlikely in lower SES schools. Crosnoe (2009) proposed basing desegregation on parent education and not income.

Using multilevel analysis, Opdenakker and Van Damme (2001) studied Belgium (Flemish) secondary education to determine the relationship between school composition (e.g. mean school ability level, mean school SES, school ability heterogeneity) and characteristics of school process and their effect on mathematics achievement. They found that “within each SES group, high ability students are more sensitive to school composition than low ability students, and that high ability students

from low SES families are most sensitive to the school composition context" (p. 424). In a later study by Opdenakker, Van Damme, Fraine, Landeghem, and Onghena (2002) they noted this level of sensitivity was probably due to poorer family resources. They also stated that "for high achieving student from high SES families it is important to find like-minded people and enough opportunity to learn; perhaps more is at stake for high achieving students from low SES families" (p. 421).

The Secondary Education Institutional Exam is an important exam taken by students in Turkey and is used to determine which selective schools they can attend. Yavuz (2009) used the results of this exam to determine what effect parent's educational level had on their mathematics achievement. The mother's educational level had a positive impact on achievement. Children of highly educated mothers mature more quickly in school and study more efficiently. The father's educational level played an important role, too. "The higher his educational level, the higher the income of the family, which produces a positive influence on mathematics achievement" (p. 1568).

Another study conducted by Jacobs and Harvey (2005) analyzed the differences between parents of high and low achieving students in Australia. They concluded that the educational achievements obtained by the parents led to more expectations of the school to be effective at educating their children. Using multiple regression analyses the study revealed that parent expectations of their students' educational level was the strongest prediction of high achievement. If education was not a high priority for the parent, than the students were not pushed by their parents to reach high academic achievement.

Using the Walberg productivity model as a basis for their study, Koutsoulis and Campbell (2001) studied the influence of the home environment on male and female school motivation and achievement. The model had the components of aptitude, instruction, and environment and determined how they contribute to student achievement. The study was conducted in high schools in Cyprus. They found that the SES of the family had a positive effect on students' educational motivation. High SES parents encouraged their children to attend college, did not put additional pressure on them to achieve, and provided more psychological support. The opposite was found for low SES families where additional pressure and less psychological support was found which impacted student academic self-concept. This in turn will impact a students' self-concept in mathematics and science affecting achievement.

The relationship between income level and mathematics achievement has been documented by Chiu (2010); Opdenakker, *et al*. (2002); and Yang (2003). While the findings reported suggest that particular ethnic/racial and socio-economic groups outscore others, it is important to keep in mind that such findings do not apply to every individual within these groups. Moreover, the majority of the studies report quantitative results and do not explore the contextual, socio-historical, or cultural factors that might have influenced the reported findings.

Summary

The purpose of the study was to determine the relationship between teacher training and student performance on end of course exam in Algebra 1. The results of previous studies regarding whether traditional or alternative certification programs produce more effective and qualified teachers have been inconclusive (Darling-Hammond, 2005; Dee & Cohodes, 2008; Monk, 1994). Other factors influence student

achievement in mathematics such as gender, race/ethnicity, and socioeconomic status. There is a need to examine the impact of all of these factors on students' success; however this is not the focus of this study. End of course exams (EOC) are beginning to replace competency based testing programs such as the FCAT mathematics test. As a result, teachers need to be knowledgeable in their subject area, able to convey this knowledge to their students, and capable of teaching a diverse population. Certification in mathematics is required for all teachers in the state of Florida in order for them to be qualified to teach all levels of mathematics in grades 6 through 12. They can become certified by passing subject area exams or by meeting certain course qualifications. (See Appendix A)

Table 2–1. Algebra 1 standards

Standard	Objective
LA.910.1.6.1:	The student will use new vocabulary that is introduced and taught directly;
LA.910.1.6.2:	The student will listen to, read, and discuss familiar and conceptually challenging text;
LA.910.1.6.5:	The student will relate new vocabulary to familiar words;
LA.910.3.1.3:	The student will prewrite by using organizational strategies and tools (e.g., technology, spreadsheet, outline, chart, table, graph, Venn Diagram, web, story map, plot pyramid) to develop a personal organizational style.
MA.912.A.1.8:	Use the zero product property of real numbers in a variety of contexts to identify solutions to equations.
MA.912.A.10.1:	Use a variety of problem-solving strategies, such as drawing a diagram, making a chart, guessing- and-checking, solving a simpler problem, writing an equation, working backwards, and creating a table.
MA.912.A.10.2:	Decide whether a solution is reasonable in the context of the original situation.
MA.912.A.10.3:	Decide whether a given statement is always, sometimes, or never true (statements involving linear or quadratic expressions, equations, or inequalities, rational or radical expressions, or logarithmic or exponential functions).
MA.912.A.2.3:	Describe the concept of a function, use function notation, determine whether a given relation is a function, and link equations to functions.
MA.912.A.2.4:	Determine the domain and range of a relation.
MA.912.A.2.13:	Solve real-world problems involving relations and functions.
MA.912.A.3.1:	Solve linear equations in one variable that include simplifying algebraic expressions.
MA.912.A.3.2:	Identify and apply the distributive, associative, and commutative properties of real numbers and the properties of equality.
MA.912.A.3.3:	Solve literal equations for a specified variable.
MA.912.A.3.4:	Solve and graph simple and compound inequalities in one variable and be able to justify each step in a solution.
MA.912.A.3.5:	Symbolically represent and solve multi-step and real-world applications that involve linear equations and inequalities.

Table 2–1. Continued.

Standard	Objective
MA.912.A.3.7:	Rewrite equations of a line into slope-intercept form and standard form.
MA.912.A.3.8:	Graph a line given any of the following information: a table of values, the x- and y-intercepts, two points, the slope and a point, the equation of the line in slope-intercept form, standard form, or point-slope form.
MA.912.A.3.9:	Determine the slope, x-intercept, and y-intercept of a line given its graph, its equation, or two points on the line.
MA.912.A.3.10:	Write an equation of a line given any of the following information: two points on the line, its slope and one point on the line, or its graph. Also, find an equation of a new line parallel to a given line, or perpendicular to a given line, through a given point on the new line.
MA.912.A.3.11:	Write an equation of a line that models a data set, and use the equation or the graph to make predictions. Describe the slope of the line in terms of the data, recognizing that the slope is the rate of change.
MA.912.A.3.12:	Graph a linear equation or inequality in two variables with and without graphing technology. Write an equation or inequality represented by a given graph.
MA.912.A.3.13:	Use a graph to approximate the solution of a system of linear equations or inequalities in two variables with and without technology.
MA.912.A.3.14:	Solve systems of linear equations and inequalities in two and three variables using graphical, substitution, and elimination methods.
MA.912.A.3.15:	Solve real-world problems involving systems of linear equations and inequalities in two and three variables.
MA.912.A.4.1:	Simplify monomials and monomial expressions using the laws of integral exponents.
MA.912.A.4.2:	Add, subtract, and multiply polynomials.
MA.912.A.4.3:	Factor polynomial expressions.
MA.912.A.4.4:	Divide polynomials by monomials and polynomials with various techniques, including synthetic division.
MA.912.A.5.1:	Simplify algebraic ratios.
MA.912.A.5.4:	Solve algebraic proportions.
MA.912.A.6.1:	Simplify radical expressions.
MA.912.A.6.2:	Add, subtract, multiply, and divide radical expressions (square roots and higher).
MA.912.A.7.1:	Graph quadratic equations with and without graphing technology.

Table 2–1. Continued.

Standard	Objective
MA.912.A.7.2:	Solve quadratic equations over the real numbers by factoring and by using the quadratic formula.
MA.912.A.7.8:	Use quadratic equations to solve real-world problems.
MA.912.A.7.10:	Use graphing technology to find approximate solutions of quadratic equations.
MA.912.D.7.1:	Perform set operations such as union and intersection, complement, and cross product.
MA.912.D.7.2:	Use Venn diagrams to explore relationships and patterns and to make arguments about relationships between sets.
MA.912.G.1.4:	Use coordinate geometry to find slopes, parallel lines, perpendicular lines, and equations of lines.

(FLDOE, 2012)

CHAPTER 3
METHODOLOGY

An overview of the quantitative method used in this study will be presented in Chapter 3 and is divided into the following subsections: (a) research design; (b) participants; (c) data collection; and (d) statistical analysis.

Research Design

After receiving permission from the University of Florida Institutional Review Board and the school district where the study took place, principals and teachers of Algebra 1 in the 2011 school year were contacted to request their participation in this survey design study.

Participants

The study was conducted in one Southwest Florida school district comprised of 11 middle schools and nine high schools. All teachers with a teaching assignment that included Algebra 1 or Algebra 1 honors and their eighth or ninth grade students enrolled in these courses were potential participants. Approximately 40 teachers and 2500 students were potential participants in this study. Due to lack of participation by middle school teachers, they were not included in the study. All but one high school had at least one teacher responding and taking part in the study. Fifteen teachers and 790 students were the actual participants in the study.

Data Collection

Teachers were given a questionnaire adapted from the 2009 NAEP Mathematics Teacher Background Questionnaire and asked to self-report: (a) gender; (b) race/ethnicity; (c) college major; (d) highest degree obtained; (e) method of teacher certification for mathematics; (f) undergraduate or graduate mathematics courses taken;

(g) education methods courses taken; (h) years of experience teaching mathematics; and (i) years of experience teaching Algebra 1. (See Appendix B) Participants were given the choice of completing the survey online through surveymonkey.com or by downloading the survey which was attached to their request for participation email and returning the completed survey to the researcher. Each teacher was also required to sign the informed consent form (see Appendix C) and return to the researcher. Teacher certification information was verified through the Florida Department of Education Teacher Certification website.

Teacher data was coded by the school (M01 – M11) for middle and (H01 – H09) for high school. Each teacher was also assigned a number (MT01 – MT19 or HT01 – HT22). Teachers' name, school, and any other identifying data were anonymous and known only to the researcher.

Teacher data was coded as follows: gender: 0 = male, 1 = female; race/ethnicity: 1 = White, 2 = Black, 3 = Hispanic, 4 = Asian, 5 = American Indian or Alaskan Native, 6 = other; college major: 1 = mathematics, 2 = mathematics education, 3 = education, 4 = other mathematics related field, 5 = other majors; highest degree obtained: 1 = B.S. or B.A., 2 = M.A., M.S., or M. Ed, 3 = Ed.S, 4 = Ph.D or Ed.D; mathematics courses taken: 0 = did not take, 1 = did take; education courses taken: 0 = did not take, 1 = did take; teacher training program or method used for certification in mathematics: 1 = traditional program, 2 = Troops to Teachers, 3 = Teach for America; 4 = other accelerated program, 5 = Florida subject area test only, 6 = other; and type of Florida certificate: 1 = professional, 2 = temporary, 3 = emergency.

Student data was collected and coded based on middle or high school status (M001 – M100 or H001 – H2400) and remained anonymous except to the researcher. Other independent variables of the students included: (a) gender; (b) race/ethnicity; and (c) socioeconomic status. This information was collected from existing data available from the district data warehouse program.

Student data was coded by the following: gender: 0 = Male, 1 = Female; race/ethnicity: 1 = White, 2 = Black, 3 = Hispanic, 4 = Asian, 5 = Other; and SES by free/reduced lunch status: 1 = does not qualify, 2 = free, and 3 = reduced.

Algebra 1 end of course exam test scores (dependent variable) were collected from the 2011 data provided by the Florida State Department of Education and retrieved from the district data warehouse program. The FLDOE reported the scores as a T-score. Students without test scores were removed from the study.

Description of Teacher Data

Fifteen teachers participated in the study, 11 (73.3%) were White and four teachers (26.67%) were Hispanic, 11 (73.3%) were male teachers and four (26.67%). were female. Three teachers (20.00%) majored in mathematics, three teachers (20.00%).majored in education with an emphasis in mathematics, and nine teachers (60.00%) majored in other areas including biology, aeronautical science, aerospace engineering, business, accounting and finance, and liberal arts. Two teachers (13.33%) held a doctoral degree, one teacher (6.67%) had a specialist degree, four teachers (26.67%) had master's degrees, and eight teachers (53.33%) had bachelors' degrees. Subject certification in mathematics included: one teacher (6.67%) with 5 – 12 math, three teachers (20.00%) with 5 – 9 math, nine teachers (60.00%) with 6 – 12 math, one teacher (6.67%) with 9 – 12 math, and one teacher (6.67%) with 5 – 9 math and 6 – 12

math. Eight teachers (53.33%) with alternative certification were certified by subject area testing, two teachers (13.33%) certified by alternative programs, and five teachers (33.33%) were traditionally trained.

The mean for years teaching mathematics was 10.20 with a standard deviation (*SD*) of 9.50. Experience ranged from one year to 37 years. The mean for years teaching Algebra was 5.47 with a *SD* of 5.19 while the range was one to 20 years (See Table 3–1 for Demographics of teacher participants).

Description of Student Data

Data from 429 males (54.3%) and 361 (45.7%) females were analyzed. The race/ethnicity of the sample was: White (n = 295) or 37.34%, Black (n = 84) or 10.63%, Hispanic (n = 374) or 47.34%, and other (n = 37) or 4.68%. SES was determined by lunch status. The number of students that did not qualify for free/reduced lunch was 317 (40.2%), while 413 (52.3%) qualified for free lunch, and 59 (7.48%) qualified for reduced lunch.

Statistical Analysis

Using the type of training program as the control variable, teacher characteristics were compared to students' test scores on the EOC exam in Algebra 1. Additional teacher variables of gender, major type, number of years teaching Algebra 1, subject certification, number of education courses, and number of mathematics courses were compared to student variables of gender, race/ethnicity, and SES to determine what effect they have on student performance on the EOC in Algebra 1.

Frequency distributions were used to describe teacher and student data. Mean and standard deviation (*SD*) were used to compare teacher and student data in relationship to test scores. Spearman Correlation Coefficients were used to analyze

teacher variables of years teaching Algebra 1 to number of math courses taken and number of education courses taken to analyze the strength of their associations such as if one variable increases, does the other variable increase or decrease? Wilcoxon scores for teacher variables on number of mathematics courses taken and number of education courses taken were compared with teacher training methods, race/ethnicity, and gender. Hierarchical Linear Modeling (HLM) is a procedure that analyzes group correlations and was used in this study to determine the relationship between teacher training and student gender, race/ethnicity, and SES.

Limitations

There was limited participation by schools and teachers. The results of the study may not accurately reflect the true effect of teacher training on student achievement. There was also an imbalance in the number of traditionally certified teachers compared to the alternatively certified. Many of the alternatively certified teachers obtained their certification to teach mathematics by taking the subject area exam offered by the Florida Department of Education.

Table 3–1. Demographics of teacher participants

Participant number	Ethnicity	Gender	College major	Highest degree	Training program	Florida certificate type	Subject/ grade levels certification	Years teaching math	Years teaching Algebra 1
HT06	White	Male	Business	Master’s	Subject area testing	Temporary	6 - 12 Math	2	1
HT09	White	Male	Accounting finance	Specialist	Subject area testing	Professional	6 - 12 Math	6	6
HT10	White	Female	Liberal arts	Bachelor's	Subject area testing	Professional	6 - 12 Math 5 - 9 Math	7	5
HT13	White	Female	Mathematics	Bachelor's	Subject area testing	Professional	6 - 12 Math	12	5
HT07	Hispanic	Male	Education	Doctorate	Subject area testing	Professional	5 - 9 Math	10	1
HT16	White	Male	Education	Master’s	Subject area testing	Professional	5 - 9 Math	1	1
HT17	White	Male	Aeronautical science	Master’s	Subject area testing	Professional	5 - 9 Math	5	3
HT18	White	Male	Aerospace engineering	Bachelor's	Subject area testing	Temporary	9 - 12 Math	1	1
HT02	White	Male	Biology	Bachelor's	Alternative	Professional	5 - 12 Math	8	3
HT03	Hispanic	Male	Education	Bachelor's	Traditional	Professional	6 - 12 Math	11	10
HT01	Hispanic	Male	Applied math	Doctorate	Alternative (Educator Preparation Institute Edison State College)	Professional	6 - 12 Math	37	7
HT04	White	Female	Education	Master’s	Traditional	Professional	6 - 12 Math	24	20

Table 3–1. Continued

Participant number	Ethnicity	Gender	College major	Highest degree	Teacher training program	Florida certificate type	Subject/ grade levels certification	Years teaching math	Years teaching Algebra 1
HT05	White	Female	Mathematics education	Bachelor's	Traditional	Professional	6 - 12 Math	14	12
HT11	White	Male	Mathematics education	Bachelor's	Traditional	Professional	6 - 12 Math	11	4
HT12	Hispanic	Male	Mathematics education	Bachelor's	Traditional	Professional	6 - 12 Math	4	3

CHAPTER 4
RESULTS AND ANALYSIS

The purpose of Chapter 4 is to present the findings related to each of the research questions.

Research Question 1: Is there a relationship between teachers who completed a traditional preparation program and those who received alternative certification on student performance on the end of course exam in Algebra 1?

Descriptive statistics were used to compare teacher training methods with Algebra 1 T-scores of the students in each category. The mean T-score for students of teachers who completed a traditional training program was 45.71, *SD* = 10.05, minimum T-score = 20, and maximum T-score = 78. Students of alternatively trained teachers had a T-score mean = 40.65, *SD* = 7.99, minimum T-score of 27 and a maximum T-score of 56. Subject area testing teachers had student mean T-score = 43.91, *SD* = 10.98, minimum T-score of 20, and maximum T-score of 67. The results support the hypothesis for research question one of no significant difference in the relationship between teachers who completed a traditional preparation program and those who received alternative certification on student performance on the end of course exam in Algebra 1.

After adjusting for student gender, race/ethnicity, and socioeconomic status is there a relationship between teacher preparation method and student performance on the end of course exam in Algebra 1?

The GLIMMIX Procedure is a hierarchical modeling procedure used when data have hierarchical or clustered structures such as students nested within schools. In this study it was used to determine the relationship between teacher training, student performance on the Algebra 1 EOC, and the effect on student variables of gender, race/ethnicity, and socioeconomic status. Hierarchical linear modeling (HLM) used covariance parameter estimation, Type III Tests of Fixed Effects to determine the

significance of teacher training and student performance on the Algebra 1 EOC on each of the variables. Student gender produced *F* value = 0.19, and Pr > *F* = 0.67 a statistically non-significant finding meaning that there was no significant difference between teacher preparation method and student performance on the end of course exam in Algebra 1 after adjusting for gender. Student race/ethnicity produced *F* value = 1.48, and Pr > *F* = 0.24 and was also not statistically significant meaning that there was no significant difference between teacher preparation method and student performance on the end of course exam in Algebra 1 after adjusting for race/ethnicity. However, student socioeconomic status produced *F* value = 3.91, and Pr > *F* = 0.04 which was statistically significant demonstrating there was a significant difference due to socioeconomic status. When comparing all variables, SES superseded all other variables (*F* value = 3.76, Pr > *F* = 0.04) thus it was impossible to see the effects of teacher major type (*F* value = 0.08, Pr > *F* = 0.79), type of teacher training (*F* value = 0.14, Pr > *F* = 0.72), years teaching mathematics (*F* value = 2.05, Pr > *F* = 0.20), and years teaching Algebra (*F* value = 0.77, Pr > *F* = 0.41) on student performance results.

To determine if the concept “frog pond effect” (a social context where individuals judge their abilities by comparing themselves to others in their group and is influenced by if they see themselves as a “big fish in a small pond” or “little fish in a big pond”) was a factor in the differences in student test scores, descriptive statistics were collected at a low SES school and a high SES school. The results were as follows: Students on free/reduced lunch (n= 50) at a high SES school had a mean test score = 45.34, *SD* = 9.02 compared to the students that did not qualify for free/reduced lunch (n=116) with a mean test score = 50.29, *SD* = 7.76. All students were taught by teachers with subject

area testing. The SES level of the school did not seem to impact test scores. An analysis of a low SES school showed the following results. Students on free/reduced lunch (n = 136) had a mean test score = 44.43, *SD* = 9.57 and students that did not qualify for free/reduced lunch (n = 7) had a mean test score of 40.14, *SD* = 13.52. These students had a traditionally certified teacher. Again, there seems to be no impact when evaluating by the “frog pond effect”.

The results indicated that the effect of the type of teacher training program on student performance on the Algebra 1 EOC is only statistically significant when compared to the students’ socioeconomic status.

Research Question 2: Is there a relationship between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics on student performance on the end of course exam in Algebra 1?

Descriptive statistics were used to compare Algebra 1 EOC test scores of students with teachers who majored in mathematics and with teachers who majored in education with an emphasis in mathematics. Three teachers were identified in each category. The mean T-score for the 226 students of the teachers with mathematics major was 46.68, *SD* of 10.14, and with a minimum T-score of 20.0 and maximum T-score of 78.0. The mean T-score for the 144 students of education majors with an emphasis in mathematics was 44.16, *SD* of 9.79, and with a minimum T-score of 20.0 and a maximum T-score of 64.0. There was no statistic significance in student performance on the end of course exam when compared to mathematics majors and education majors with an emphasis in mathematics. The findings showed there was no significant difference between teachers’ major area of study and student performance on the end of course exam in Algebra 1.

There were 420 students of teachers (n = 9) without either a teacher with a mathematics major or education major with an emphasis in mathematics with a mean test score of 43.73, *SD* = 10.86, and a minimum T-score of 20.0 and a maximum T-score of 67.0. Again, no statistical significance was noted demonstrating that there was no significant difference in the relationship between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics by student performance on the end of course exam in Algebra 1.

After adjusting for student gender, race/ethnicity, and socioeconomic status is there a relationship between teacher preparation method and student performance on the end of course exam in Algebra 1?

Student gender and performance on the Algebra 1 EOC produced the following results: males (n = 429) mean T-score of 44.38, *SD* = 10.33, minimum T-score of 20.0 and a maximum T-score of 67.0; females (n = 361): mean T-score of 44.97, *SD* = 10.78, minimum T-score of 20.0 and maximum T-score of 78.0. There was no significant difference in performance due to gender. Race/ethnicity and performance on the Algebra 1 EOC results were: White (n = 295) mean T-score of 47.42, *SD* = 9.52, minimum T-score of 20.0 and maximum T-score of 67.0; Black (n = 84) mean test of 41.58, *SD* = 11.06, minimum T-score of 20.0 and maximum T-score of 64.0; Hispanic (n = 374) mean T-score of 43.24, *SD* = 10.75, minimum T-score of 20.0 and maximum T-score of 78.0; and other (n = 37 - includes all individuals not classified as White, Black, Hispanic, or Asian) mean T-score of 43.81, *SD* = 10.44, minimum T-score of 20.0 and maximum T-score of 58.0. No significant difference in performance was noted for race/ethnicity. Socioeconomic status (SES) was determined by participation in free/reduced lunch program. Students that did not qualify (n = 317) had a mean T-score

of 47.18, *SD* = 10.10, and a minimum T-score of 20.0 and a maximum T-score of 67.0. Students on free lunch (n = 413) had a mean T-score of 42.67, *SD* = 10.23, minimum T-score of 20.0 and a maximum T-score of 64.0. Students on reduced lunch (n = 59) had a mean T-score of 45.07, *SD* = 12.10, minimum T-score of 20.0 and a maximum T-score of 78.0. There was no significant difference in student performance for SES when comparing with teacher major.

The findings showed that there was no significant differences between teacher training program and student performance on the Algebra 1 EOC when comparing teacher training (mathematics major or education major with an emphasis in mathematics) by gender, race/ethnicity, and socioeconomic status and there was no significant difference between teachers who majored in mathematics and those who were education majors with an emphasis in mathematics on student performance on the end of course exam in Algebra 1 after adjusting for gender, race/ethnicity, and socioeconomic status.

Research Question 3: Is there a relationship between the number of mathematics courses taken by the teacher and preparation type, teacher gender, and race/ ethnicity?

The state of Florida uses a Statewide Course Numbering System (SCNS) to allow smooth articulation between universities and colleges. To better facilitate a way to obtain an accurate list of mathematics courses a teacher may have taken in their undergraduate or graduate study, a list of mathematics courses from the University of Florida course catalog for mathematics majors and education majors with an emphasis in mathematics were provided to each teacher. A link to the university course descriptions was provided for teachers to examine the content of the course for clarification. The original intent of the study was to look for a relationship between the

content of mathematics courses taken and teacher variables. However, it became evident there was no pattern to the types of courses taken by the teachers. (See Table 4–1 for teacher training programs and mathematics courses taken.) Therefore, it was the number of mathematics courses taken by the teachers in the different preparation types used in the analysis.

Using descriptive statistics traditionally trained teachers were compared with alternatively certified teachers, and those teachers whom received certification by subject area testing in mathematics. Traditionally trained teachers (n = 5) had a mean score for mathematics courses taken of 13.40, *SD* = 3.51, and a range of nine courses to 18 courses. Alternatively trained teachers (n = 2) had a mean score for mathematics courses taken of 9.00, *SD* = 2.83, and a range of seven courses to 11 courses. Teachers taking the mathematics subject area test (n = 8) had a mean score for mathematics courses taken of 7.75, *SD* = 4.95, and a range one course to 15 courses.

The NPAR1WAY procedure was used for an analysis of variables of teacher training and number of mathematics courses. Wilcoxon scores (rank sums) provided the expected sum of scores under the null hypothesis if no differences among programs and number of mathematics courses were found. Traditionally trained teachers (n = 5) had a sum of scores of 56.50, with an expected value under the null hypothesis (Ho) of 40.0, *SD* = 8.11, and a mean score of 11.30. Teachers trained by alternative methods (n = 2) had a sum of scores of 14.50, with an expected value under the Ho of 16.0, *SD* of 5.85, and mean score of 7.25. The subject area testing teachers (n = 8) had a sum of scores of 49.00, with an expected value under the Ho of 64.0, *SD* of 8.57, and mean score of 6.13.

The Kruskal–Wallis Test (a non-parametric version of ANOVA) was used to test the null hypothesis since there was no difference between variables. Results of the Chi-square = 4.25, degrees of freedom (*df*) = 2, and Pr > Chi-Square = 0.12 showed no significance between number of mathematics courses taken and type of teacher training. The findings showed that there was no significant difference between the number of mathematics courses taken by the teacher and preparation type (See Table 4–3 for results).

Teacher gender and number of mathematics courses were also compared using descriptive statistics, Wilcoxon Scores Test, Wilcoxon Two-Sample Test, and Kruskal-Willis Test. The mean score for males (n = 11) was 8.45, *SD* = 4.61, minimum number of mathematics courses = 1.0 and a maximum number of mathematics courses = 15.0. Females (n = 4) had a mean score of 13.50, *SD* = 3.70, minimum number of mathematics courses =10.0 and a maximum number of mathematics courses of 18.0.

Wilcoxon scores (rank sums) for males had a sum of scores = 74.0, an expected value under the null hypothesis (Ho) = 88.0, *SD* under Ho =7.60, and a mean score of 6.73. Females results were: sum of scores = 46.0, an expected value under the Ho = 32.0, *SD* under the Ho = 7.60, and a mean score = 11.50.

Wilcoxon Two-Sample Test is a test of the null hypothesis to determine that there is no difference between two variables. In this analysis, the variables are the number of mathematics courses taken and teacher gender. The Wilcoxon statistic equals 46.0 which was greater than 32.0, the expected value under the null hypothesis. As a result the NPAR1WAY procedure produces right-sided *p*-values. The *t* approximation yielded one-sided Pr > Z = 0.05 which was statistically significant. The two-sided *t*

approximation yielded Pr > $|Z|$ = 0.09 which was also statistically significant at a trend level. The normal approximation (Z = 1.78) yielded a one-sided Pr > Z of 0.04 which was statistically significant. The two-sided normal approximation yielded Pr > $|Z|$ = 0.08 which was also statistically significant at a trend level. The *t* and normal approximation showed that there was a significant difference between the number of mathematics courses taken by the teacher and teacher gender.

The Kruskal-Wallis test yielded a chi-square of 3.39, *df* = 1, and Pr > chi-square = 0.07 which was also statistically significant at a trend level, rejecting the null hypothesis of no significant difference between the number of mathematics courses taken by the teacher and teacher gender (See Table 4–4 for results).

Teacher race/ethnicity and the relationship to number of mathematics courses taken were analyzed using the same methods described above. Descriptive statistics were: the mean score for Whites (n = 11) of 8.91, *SD* = 5.22, minimum number of mathematics courses = one and maximum number of mathematics courses = 18.0. Hispanics (n = 4) had a mean score of 12.25, *SD* = 2.75, minimum number of mathematics courses of 9.0 and maximum number of mathematics courses of 15.0. No other race/ethnic groups were identified.

Wilcoxon scores (rank sums) for Whites had a sum of scores = 78.50, an expected value under the null hypothesis (Ho) = 88.0, *SD* under Ho =7.60, and a mean score of 7.14. Hispanic results were: sum of scores = 41.50, an expected value under the Ho = 32.0, *SD* under the Ho = 7.60, and mean score = 10.38.

Wilcoxon Two-Sample Test measured the number of mathematics courses taken with the race/ethnicity. The Wilcoxon statistic equaled 41.5 which was greater than 32.0,

the expected value under the null hypothesis. As a result the NPAR1WAY procedure produced right-sided *p*-values. The *t* approximation produced one-sided Pr > Z = 0.13 and two-sided Pr > $|Z|$ = 0.26 which were not significant. The normal approximation (Z = 1.18) yielded a one-sided Pr > Z = 0.12 and two-sided Pr > 0.24 which were not significant. The *t* and normal approximation showed that there was no significant difference in the relationship between the number of mathematics courses taken by the teacher and teacher race/ethnicity.

The Kruskal-Wallis test yields a chi-square of 1.56, *df* = 1, and Pr > chi-square = 0.02 which was not significant, supporting the hypothesis on the relationship between the number of mathematics courses taken and teacher race/ethnicity (See Table 4–5 for results).

The findings for research question three varied. There was no significant difference between the number of mathematics courses taken by the teacher and preparation type and race/ethnicity of the teacher. However, there was a significant difference in the number of mathematics courses taken by the teacher and teacher gender.

Research Question 4: Is there a relationship between the number of educational methods courses taken by the teacher and preparation type, teacher gender, and race/ethnicity?

The same statistical procedures used in research question three were also used for research question four. Teachers were given a list of educational methods courses and a link to the University of Florida course descriptions for clarification of the content of the courses. As with the mathematics courses, there was no set pattern of course taking by the different teacher groups so instead of examining the content of the

educational methods courses taken by the teachers (See Table 4–2 for number of educational methods courses taken by teacher groups), the number of educational methods courses were analyzed.

Descriptive statistics compared the traditionally trained teachers, alternative certification teachers, and teachers certified with the mathematics subject area exam on the number of educational methods courses that were taken in undergraduate or graduate study. The following results were revealed: traditionally trained teachers (n = 5), had a mean score of 11.40, *SD* = 6.23, and a minimum of four and maximum of 20.00 for the number of educational methods courses taken; alternatively certified teachers (n = 2), mean score of 7.50, *SD* = 0.71, and a minimum of seven to a maximum of eight for the number of educational methods courses taken; and teachers taking the mathematics subject area exam (n = 8), mean score of 5.63, *SD* = 4.37, and a minimum of zero to a maximum of 13.00 for the number of educational methods courses taken.

The Wilcoxon test was also performed for the variables of teacher training and number of educational methods courses. Traditionally trained teachers (n = 5) had a sum of scores of 54.0, an expected value under the null hypothesis (Ho) of 40.0, *SD* = 8.12, and a mean score of 10.80. Teachers trained by alternative methods (n = 2) had a sum of scores of 16.0, an expected value under the Ho of 16.0, *SD* = 5.86, and mean score of 8.00. Teachers using subject area testing (n = 8) had a sum of scores of 50.00, an expected value under the Ho of 64.0, *SD* = 8.59, and mean score of 6.25.

The Kruskal-Wallis test was also performed with the following results: Chi-Square of 3.22, degrees of freedom = 2, and Pr > Chi-Square = 0.20 which revealed no

statistical significance between the number of educational methods courses taken and the type of teacher training (See Table 4–3 for results).

Teacher gender and race/ethnicity were also compared to the number of educational methods courses taken by the teachers. The Wilcoxon Scores (rank sums) for variable (number of educational methods courses) classified by variable (teacher gender) results were males (n = 11): sum of scores = 84.0, an expected value under the Ho = 88.0, *SD* under the Ho = 7.62, and a mean score of 7.64; females (n = 4): sum of scores = 36.0, expected value under Ho = 32.0, *SD* under Ho = 7.62, and a mean score of 9.00.

The Wilcoxon Two-Sample test used the variables of the number of educational methods courses taken and teacher gender. The Wilcoxon statistic equals 36.00 which was greater than 32.0, the expected value under the null hypothesis. As a result the NPAR1WAY procedure produces right-sided *p*-values. The *t* approximation yielded one-sided Pr > Z = 0.33 and a two-sided Pr > $|Z|$ = 0.65 which were not statistically significant. The normal approximation (Z = 0.46) yielded a one-sided Pr > Z of 0.32 which was not statistically significant. The two-sided normal approximation yielded Pr > $|Z|$ = 0.65 which was also not statistically significant.

The Kruskal-Wallis Test yielded a chi-square of 0.28, *df* = 1, and Pr > chi-square of 0.60 which reveals no statistically significance between teacher gender and the number of educational methods courses taken (See Table 4–4 for results).

Teacher race/ethnicity and the relationship to number of educational methods courses taken were also analyzed using the same methods described above. The descriptive statistics were: the mean score for Whites (n = 11) of 7.36, *SD* = 5.64,

minimum number of educational methods courses of zero and a maximum number of mathematics courses of 20. Hispanics (n = 4) had a mean score of 9.00, *SD* = 4.69, minimum number of educational methods courses of four and a maximum number of mathematics courses of 15.0. No other race/ethnic groups were identified in the study.

Wilcoxon scores (rank sums) for Whites had a sum of scores = 83.0, an expected value under the null hypothesis (Ho) = 88.0, *SD* under Ho =7.62, and a mean score of 7.55. Hispanic results were: sum of scores = 37.0, an expected value under the Ho = 32.0, *SD* under Ho = 7.62, and a mean score = 9.25.

The Wilcoxon Two-Sample Test compared the number of educational methods courses taken with teacher race/ethnicity. The Wilcoxon statistic equals 37.0 which was greater than 32.0, the expected value under the null hypothesis. As a result the NPAR1WAY procedure produced right-sided *p*-values. The *t* approximation produced one-sided Pr > Z = 0.28 and two-sided Pr > $|Z|$ = 0.56 which were not statistically significant. The normal approximation (Z = 0.59) yielded a one-sided Pr > Z = 0.28 and two-sided Pr > $|Z|$ = 0.55 which were not statistically significant.

The Kruskal-Wallis test yields a chi-square of 0.43, *df* = 1, and Pr > chi-square = 0.51 which was not statistically significant (See Table 4–5 for results).

Additional Research Findings

The CORR procedure was used to determine the relationship between three variables: number of years teaching Algebra, number of mathematics courses taken, and number of educational methods courses taken. The mean, standard deviation median, minimum and maximum were analyzed for each variable for the 15 teachers involved in the study. For years teaching Algebra: mean = 5.47, *SD* = 5.19, median = 4.00, minimum = 1.00, and maximum = 20.00; number of mathematics courses: mean =

9.80, *SD* = 4.84, median = 10.00, minimum = 1.00, and maximum = 18.00; number of educational methods courses: mean = 7.80, *SD* = 5.29, median = 8.00, minimum = 0, and maximum = 20.00.

Spearman's Correlation Coefficients (n= 15; Prob > │r │under Ho: Rho = 0) were used to determine the relationship between two of the variables. Comparing years teaching Algebra to the number of mathematics courses yields rho = 0.64, and $p = 0.01$ was statistically significant. Years teaching Algebra to the number of educational methods courses yields rho = 0.38, and $p = 0.16$ and was not statistically significant. Comparing number of mathematics courses to the number of educational methods courses yields rho = 0.34 and $p = 0.21$ was not statistically significant.

Summary

The purpose of Chapter 4 was to describe the quantitative results of the data analysis of this study. The findings revealed:

1. No significant differences were found on student performance on the Algebra 1 EOC and the type of training of their teacher. Comparison of student variables of gender and race/ethnicity revealed no significant differences in Algebra 1 test scores. However, student variable of socioeconomic status was statistically significant. Results revealed that the lower the economic status of the student (free lunch), the lower the mean score of the Algebra 1 EOC.

2. No significant differences were found between student performance on the Algebra 1 EOC and teachers that majored in mathematics, education with an emphasis in mathematics, or the variety of other majors the teachers demonstrated. No significant difference was found when comparing teacher variable of mathematics major or education major with an emphasis in mathematics on student variables of gender, race/ethnicity, and socioeconomic status.

3. There was no significant difference in the number of mathematics courses taken and type of teacher training. There was also no significant difference in race/ethnicity of the teacher and the number of mathematics courses taken. However, there was a significant difference in the number of mathematics courses taken and teacher gender. Female teachers mean scores for number of mathematics courses taken was significantly higher than the mean scores for

males. There was also a significant difference in the number of mathematics courses taken and number of years teaching Algebra.

4. There was no significant difference in the number of educational methods courses taken by teachers and type of teacher training program, teacher gender, or race/ethnicity of teacher. There also was no significant difference in the number of years teaching Algebra to the number of educational methods courses taken by the teacher.

5. There was no significant difference in the number of mathematics courses taken to the number of educational methods courses.

Table 4–1. Mathematics courses taken by teachers

Course number	Course title	Number of teachers taking course		
		Traditional (n = 5)	Alternative (n = 2)	Subject area testing (n = 8)
MGF1106	Mathematics for liberal arts majors	0	0	2
MAC1105	College algebra	3	2	2
MAC1114	Trigonometry	1	2	3
MAC1140	Precalculus	0	0	3
MAC1147	Precalculus: algebra and trigonometry	1	1	0
MAC2311	Analytic geometry and calculus 1	5	1	6
MAC2312	Calculus 2	5	2	3
MAC2313	Calculus 3	5	1	3
MHF3404	History of mathematics	4	0	2
MHF3202	Sets and logic	3	0	1
MTG3212	Geometry	2	2	2
MAP2302	Differential equations	5	1	3
MAP4102	Probability theory	3	0	3
MAD3107	Discrete mathematics	5	0	3
MAD4203	Combinatorics	2	0	0
MAD4401	Numerical analysis	3	1	2
MAS4105	Linear algebra	4	2	3
MAS4301	Abstract algebra	4	0	3
MAS4203	Number theory	3	0	1
MAA4226	Real analysis	1	0	2
MAA4227	Complex analysis	1	0	3
STA4321	Mathematical statistics 1	4	2	7
STA4322	Mathematical statistics 2	3	1	5

Table 4–2. Educational methods courses taken by teachers

Course number	Course title	Number of teachers taking course		
		Traditional (n = 5)	Alternative (n = 2)	Subject area testing (n = 8)
EDF1001	Introduction to the teaching profession	3	2	3
EDF2085	Introduction to diversity for educators	4	2	3
EDF3110	Human growth and development	5	1	3
EDF3210	Educational psychology	4	2	4
EDF3214	Learning and cognition in education	3	1	3
EDF4430	Measurement and evaluation in education	3	1	3
SDS3430	Family and community involvement in education	1	0	0
SDS4410	Interpersonal communication skills	1	0	2
EDG3377	Mathematics and science	3	0	2
EDG4203	Elementary and secondary curriculum	1	0	2
EDG4204	Curriculum and instruction for secondary learners	5	1	4
EDM4403	Middle school education	0	0	1
ESE4340C	Effective teaching and classroom management in secondary education	2	1	4
MAE2364	Explorations teaching secondary mathematics and science	2	0	0
MAE4331	Secondary school mathematics methods and assessment	3	1	1
MAE4941	Practicum in teaching secondary mathematics and science	1	0	0
MAE4947	Secondary mathematics practicum	2	0	0
MAE5327	Middle school mathematics methods	1	0	1
MAE5395	Multicultural math methods	1	0	0
MAE6313	Problem solving in school mathematics	1	0	1
TSL4324	ESOL strategies for content area teachers	4	2	3
EEX4394	Differentiated instruction	2	0	2
EEX3257	Core teaching strategies	2	0	1
EEX3616	Core classroom management strategies	2	1	2

Table 4–3. Training methods and number of mathematics and education coursework

Teacher training	Number of observations	Variable - number of courses	Mean	Standard deviation
Traditional	5	Math[(a)]	13.4	3.5
		education[(b)]	11.4	6.2
Alternative	2	Math[(a)]	9.0	2.8
		education[(b)]	7.5	0.7
Subject area testing	8	Math[(a)]	7.8	4.9
		education[(b)]	5.6	4.4

[(a)] *p*-value for this test equals 0.12.
[(b)] *p*-value for this test equals 0.20.

Table 4–4. Teacher gender and number of mathematics and education coursework

Teacher gender	Number of observations	Variable - number of courses	Mean	Standard deviation
Male	11	Math[(a)]	8.5	4.6
		education[(b)]	7.1	4.6
Female	4	Math[(a)]	13.5	3.7
		education[(b)]	9.8	7.2

[(a)] *p*-value for this test equals 0.09.
[(b)] *p*-value for this test equals 0.65.

Table 4–5. Teacher race/ethnicity and number of mathematics and education coursework

Teacher Race	Number of observations	Variable - number of courses	Mean	Standard deviation
White	11	Math[(a)]	8.9	5.2
		education[(b)]	7.4	5.6
Hispanic	4	Math[(a)]	12.3	2.8
		education[(b)]	9.0	4.7

[(a)] *p*-value for this test equals 0.3.
[(b)] *p*-value for this test equals 0.6.

CHAPTER 5
DISCUSSION

The purpose of this study was to determine if there was a relationship between teacher training programs and student performance on the Algebra 1 EOC exam. The findings of this study are presented in Chapter 5. The implications of these findings on the future of teacher training programs and recommendations are discussed.

Summary of Results

Teacher training methods of traditional/conventional program, alternative certification, and subject area testing were compared to student test scores. No statistically significant differences were found when comparing teacher training programs to student performance on the Algebra I EOC. However, when student socioeconomic status (SES) was compared to teacher training programs, students with low SES (free or reduced lunch status) test scores were statistically lower compared to the students who provided their own lunch.

There was no statistically significant difference in student performance of teachers with a degree in mathematics compared to those with a degree in education with an emphasis in mathematics or other majors reported by the teachers in the study. Student variables of gender, race/ethnicity, or socioeconomic status showed no statistically significant difference to teacher major areas of study.

An analysis of the number of mathematics courses and the number of educational methods courses taken by the teachers showed no significant difference when compared to the teacher training method. Teacher variables of gender and race/ethnicity were studied and showed mixed results. Female teachers mean score for number of mathematics courses was significantly higher than for males. There was no

statistically significant difference when comparing teacher gender to number of educational methods courses taken. Race/ethnicity of teachers showed no statistically significant difference in either the number of mathematics courses taken or educational methods courses taken.

Comparing number of years teaching Algebra showed a significant difference in the number of mathematics courses taken. The longer a teacher taught Algebra, the more mathematics courses taken. However, overall, teacher training programs do have some effect on student performance. This effect was found in the socioeconomic status of the student where the qualifications of teachers do make a difference.

Discussion

Previous studies that looked at teacher training and student achievement were inconclusive (Cohen, *et al*. 2007; Darling-Hammond, 2000; Tournaki, *et al*. 2009; Wayman, *et al*. 2003). This study demonstrated that there was no significant difference on student performance based on test results on the Algebra 1 EOC by the type of training program a teacher completed. This may be the first study to look at the impact of teacher training on student performance on end of course exams in Florida. As the state moves to the implementation of these exams as a graduation requirement instead of FCAT Math, more studies will be needed. This becomes more relevant as teacher pay and continued employment are becoming partly based on student performance on EOC exams and FCAT 2.0 Reading in Florida (Florida Statute 1012.34).

This study required teachers to self-report their teacher training program. Notably, there was no way to analyze each program to determine if they were equivalent in program requirements. Researchers have noted that this is one the major concerns with alternative programs. All programs are not equal in requirements and vigor and as such,

it is impossible to lump them all into the same category without depleting the strength of some and overinflating the weaknesses of others (Darling-Hammond, *et al*. 2005; Humphrey & Wechsler, 2005; Selko & Fero, 2005). One interesting finding in this study was that many of the teachers (n = 8) became certified to teach mathematics by taking the subject area exam, which demonstrated competency in subject content knowledge. A review of the educational methods courses taken by these teachers indicates that they may have followed some type of traditional program but in another discipline. As a result, this was treated as another category and provided an additional look at how teachers become certified to teach mathematics.

Researchers have observed that student's socioeconomic status impacts their achievement (Crosnoe, 2009; Koutsoulis & Campbell, 2001; Opdenakker & Van Damme, 2001). Many studies have shown that student's SES can be a determining factor in whether or not that student is successful. Factors such as limited access to educational experiences, less parental involvement among those who are working multiple jobs to maintain the household, and having less qualified teachers in the classroom as a result of school location may contribute to lower levels of student achievement. Crosnoe (2009) studied the effects of low income students that are placed in a high SES school and found that they were also at a disadvantage. Interestingly, they did not progress as well as the high SES students even though they have had access to better educational resources. However, simply placing low SES students in a high SES school does not eradicate other psychosocial effects that they may face. Also, students may gain a sense of affinity and thus might remain an outsider in their school.

This study revealed that socioeconomic status had an impact on student performance. Low SES (free/reduced lunch) students scored lower than those students that did not qualify for free/reduced lunch. Students taught by teachers with subject area testing or alternative certification had lower mean test scores than the students of traditionally trained teachers. Descriptive statistics did not indicate that the “frog pond effect” (a social context where individuals judge their abilities by comparing themselves to others in their group and is influenced by if they see themselves as a “big fish in a small pond” or “little fish in a big pond”) was a factor in determining how low SES students performed when placed in a high SES school. Traditionally, low SES schools will have the least qualified teachers; however, the school with the highest number of low SES students in the district studied had traditionally trained teachers in the classroom. This provided an advantage to these students based on the results of the study.

Another concern related to student achievement is teachers’ content knowledge of mathematics which teachers should be required to possess. Previous studies have shown mixed results regarding whether a teacher needs to be a mathematics major or an education major with an emphasis in mathematics. The argument seems to be that mathematics majors do not have strong pedagogical content knowledge, therefore do not know how to instruct students and that education majors do not have sufficient subject content knowledge to adequately teach mathematics (Ferrini-Mundy & Findell, 2010; Proulx, 2008; Wagner, Speer, & Rossa, 2007). The results of this study indicated that there was no statistical difference in whether a teacher was a mathematics major or education major with an emphasis in mathematics.

The array of mathematics courses taken by teachers within the different training programs indicated that there was no obvious pattern or set of required courses. While comparing the different programs it became evident that both the traditionally trained teachers and the subject area testing teachers took the most courses. The fact that the subject area testing teachers took as many or more than the alternative certified teachers indicates that mathematics was a subject area that they were required to take in their major area of study or an interest they pursued.

Another interesting findings concerning mathematics coursework was the significance of the number of courses taken by female teachers. This negates previous research that indicated females were spending less time in mathematics classrooms due to lower self-concept of their ability to be successful (Nagy, *et al.* 2006; Van de gaer, *et al.* 2008). These findings suggest females may be more confident in their mathematical abilities and are pursuing careers that involve mathematical knowledge

When comparing the number of educational methods coursework completed by teachers in the different training programs, it also became apparent that alternatively certified teachers did not take as many courses, however it did not prove to be significant. However these findings raise the question of how important pedagogy really is and whether or not methods courses are needed to make an effective teacher as originally proposed by Shulman (1987).

Teacher race/ethnicity was not a significant factor in either the number of mathematics courses or educational methods courses. Research has shown that students may perform better when their teacher is of their race/ethnicity, but it also shows that many times in schools where one race/ethnic group is more dominant than

others, that minority students suffer because they do not have the role models of their race/ethnic group available. In these same schools, there is the tendency to attract more qualified teachers of the dominant race/ethnic group and less qualified teachers of the lesser race (Dee, 2004).

Implications

The study's findings contribute to previous research that continues to demonstrate varied results regarding whether or not the type of teacher training program has an effect on student achievement. Perhaps, alternative programs in general have improved because of the demand for teachers or because the No Child Left Behind Act of 2001 has mandated revamping alternative programs to ensure that there are highly qualified teachers in every classroom. The findings also point that administrators need to be cognizant of their student population and ensure that teachers are meeting students' educational needs.

Further studies will be needed whether mathematicians or education majors should be placed in the classroom or whether additional collaboration between mathematics departments and education departments of colleges is needed to determine the best way to prepare mathematics teachers.

As Florida moves to implementing EOC exams and requiring a passing grade of level 3 (equivalent to a letter grade of C) to meet graduation requirements, teachers will be held increasingly more accountable for their students' success. Learning does not stop when a teacher becomes certified. Thus, wise district and school administrators will find ways to provide ongoing staff development that is geared toward the individual needs of the teacher and/or school.

University teaching requirements does not ensure that all individuals will become effective teachers. This process takes practice, mentorship by an effective teacher, recognizing and meeting all students' learning needs, using technology to enhance instruction, and communicating effectively with students, parents, colleagues, and administrators. These skills are essential to those who wish to become teachers. Unfortunately, not all teacher training programs provide this.

Recommendations for Future Research

Researchers continue to study and debate about the most effective way to provide quality teachers in changing school environments. In the haste to fill positions, administrators may be overlooking the traits necessary to enhance student performance. Future research should look at the following areas:

1. Replicate this study in other states and compare those results to the findings in this study.
2. Locate alternative certification and teacher preparation programs with standardized mathematics requirements and compare students of those teachers to determine which program results in better student achievement.
3. Analyze the impact EOC exams have on graduation rates longitudinally and determine how EOC exams impact graduation rates.
4. Analyze the scores on each standard of the end of course exams and use the finding to suggest that whether remediation of standards can best be met by current teachers or whether instruction geared toward those standards will need to be provided by colleges and universities with expanded subject content during teacher preparation.
5. Future studies should explore how alternatively and traditionally trained teachers present mathematical concepts during instruction and compare students' EOC results.
6. Replicate the study and collect teacher data earlier in the school year, and/or obtain letter of support for study from someone in the district office.
7. Assess teacher skill level relative to skills they are teaching.

8. Determine what pedagogy is necessary in the teaching of mathematics and provide ongoing professional development in the use of instructional strategies (ie, breaking instruction down into smaller parts and then bringing it together as a whole, providing culturally responsive approached, and use of repetition or practice of skills.

Summary

The purpose of this study was to determine the relationship between teacher training programs and student performance on the end of course exam in Algebra 1. Chapter 5 provided a review of the findings, discussion of the findings and implications of these results, and recommendations for future research.

When considering the results, it is important to point out that the sample size was limited due to the voluntary nature of the participants. However, the findings demonstrated that there was no significant relationship between the type of teacher training program and student performance on the Algebra 1 EOC. The findings showed that low SES (free/reduced lunch) students scored lower than those students that did not qualify for free/reduced lunch. Students taught by teachers with subject area testing or alternative certification had lower mean test scores than the students of traditionally trained teachers.

As the state of Florida moves to implement end of course exams to meet graduation requirements in the academic areas of mathematics, science, and social studies, it is imperative that “highly qualified” teachers are present in all classrooms. However, given rising student enrollment, teacher attrition, state mandated class size requirements, and teacher retirement there is a concomitant need to fill teacher vacancies rapidly. As a result, some individuals are entering alternative teacher training programs to attain certification and fill these positions.

For many years, researchers have disagreed as to whether or not alternative programs produce teachers of the same caliber as the traditionally trained program (Cohen-Vogel & Smith, 2007; Darling-Hammond, 2000; Dee & Cohodes, 2008; Glazerman, *et al.* 2006, Kane, *et al.* 2006; Nunnery, *et al.* 2009). Studies have shown that student achievement is related to the teacher effectiveness in how subject matter is presented students (Moyer-Packenham, *et al.* 2008, Wilson, *et al.* 2002). While this was not the focus of this study, the present results indicated that there was no statistical difference in whether a teacher was a mathematics major or education major with an emphasis in mathematics.

APPENDIX A
ADMINISTRATIVE RULE 6A-4.0262

Specialization Requirements for Certification in Mathematics (Grades 6-12)--Academic Class.

(1) Plan One. A bachelor's or higher degree with an undergraduate or graduate major in mathematics, or

(2) Plan Two. A bachelor's or higher degree with thirty (30) semester hours in mathematics to include the areas specified below:

(a) Six (6) semester hours in calculus,

(b) Credit in geometry,

(c) Credit in probability or statistics, and

(d) Credit in abstract or linear algebra,

(3) Plan Three. A bachelor's or higher degree with specialization requirements completed for physics and twenty-one (21) semester hours in mathematics to include the areas specified below:

(a) Six (6) semester hours in calculus,

(b) Credit in geometry,

(c) Credit in probability or statistics, and

(d) Credit in abstract or linear algebra.

Specific Authority 1001.02, 1012.55, 1012.56 FS. Law Implemented 1001.02, 1012.54, 1012.55, 1012.56 FS. History–New 7-1-90, Amended 7-17-00.
(FLDOE, 2011)

APPENDIX B
TEACHER BACKGROUND SURVEY

General Directions: The survey will take approximately fifteen minutes to complete. All responses will be kept confidential. The information obtained will be used for research purposes in determining the relationship between teacher training and student achievement on the end of course exam in Algebra 1. Your participation may benefit educational leader's to better meet students' learning needs and provide professional development opportunities for teachers.

Please fill in the blanks or circle only one answer for each question except where noted.

Personal Information

1. Name: _____

2. Current School: _____

3. Grade level of students in your class: _____

4. Which of the following best describes you?
   a. White
   b. Black or African American
   c. Hispanic
   d. Asian
   e. American Indian or Alaskan Native
   f. Other _____

5. What is your gender?
   a. Male
   b. Female

Educational Background

6. In your undergraduate or graduate coursework, which of the following was your major?
   a. Mathematics
   b. Mathematics education
   c. Education
   d. Other mathematics related field: List here_____
   e. Other majors: List here _____

7. What is the highest degree obtained?
   a. B.S. or B. A.
   b. M.A., M.S., or M. Ed.
   c. Ed. S
   d. Ph. D or Ed. D

8. Place a check in the blank for each mathematics course you have taken in your undergraduate or graduate studies. Course names and numbers are from the state university system in Florida. Course descriptions may be accessed at http://www.registrar.ufl.edu/catalog/programs/courses/math.html Note: Exact course names/number may differ from state to state. Check all that are similar to the courses you have taken.

____ Mathematics for Liberal Arts Majors 1 (MGF 1106)
____ College Algebra (MAC 1105)
____ Trigonometry (MAC 1114)
____ Precalculus (MAC 1140)
____ Precalculus: Algebra and Trigonometry (MAC 1147)
____ Analytic Geometry and Calculus 1 (MAC 2311)
____ Calculus 2 (MAC 2312 or 2512 or 3473)
____ Calculus 3 (MAC 2313 or 3574)
____ History of Mathematics (MHF 3404)
____ Sets and Logic (MHF 3202)
____ Geometry (MTG 3212)
____ Differential Equations (MAP 2302)
____ Probability Theory (MAP 4102)
____ Discrete Mathematics (MAD 3107)
____ Combinatorics (MAD 4203)
____ Numerical Analysis (MAD 4401)
____ Linear Algebra (MAS 4105)
____ Abstract Algebra (MAS 4301)
____ Number Theory (MAS 4203)
____ Real Analysis (MAA 4226)
____ Complex Analysis (MAA 4227)
____ Mathematical Statistics 1(STA 4321)
____ Mathematical Statistics 2 (STA 4322)

List other courses taken: _____

_____

9. Place a check in the blank for each education course you have taken in your undergraduate or graduate studies. Course names and numbers are from the state university system in Florida. Course descriptions may be accessed at http://www.registrar.ufl.edu/catalog/programs/courses/edstl.html Note: Exact course names/number may differ from state to state. Check all that are similar to the courses you have taken.

____ Introduction to the Teaching Profession (EDF 1005)
____ Introduction to Diversity for Educators (EDF 2085)
____ Human Growth and Development (EDF 3110)
____ Educational Psychology (EDF 3210)
____ Learning and Cognition in Education (EDF 3214)
____ Measurement and Evaluation in Education (EDF 4430)
____ Family and Community Involvement in Education (SDS 3430)
____ Interpersonal Communication Skills (SDS 4410)

____ Mathematics and Science (EDG 3377)
____ Elementary and Secondary Curriculum (EDG 4203)
____ Curriculum and Instruction for Secondary Learners (EDG 4204)
____ Middle School Education (EDM 4403)
____ Effective Teaching and Classroom Management in Secondary Education (ESE 4340C)
____ Explorations Teaching Secondary Mathematics and Science (MAE 2364)
____ Secondary School Mathematics Methods and Assessment (MAE 4331/5332)
____ Practicum in Teaching Secondary Mathematics and Science (MAE 4941)
____ Secondary Mathematics Practicum (MAE 4947)
____ Middle School Mathematics Methods (MAE 5327)
____ Multicultural Math Methods (MAE 5395)
____ Problem Solving in School Mathematics (MAE 6313)
____ ESOL Strategies for Content Area Teachers (TSL 4324)
____ Differentiated Instruction (EEX 4394)
____ Core Teaching Strategies (EEX 3257)
____ Core Classroom Management Strategies (EEX 3616)
List other courses taken: _____
_____

10. Which teacher training program or method did you use for certification in mathematics?
    a. Traditional method (college degree program with educational methods coursework)
    b. Troops to Teachers
    c. Teach for America
    d. Other accelerated program: List program _____
    e. Florida subject area test only
    f. Other _____

11. What kind of Florida Certificate do you currently hold?
    a. Professional
    b. Temporary

12. List the subject/grade levels on your Florida Certificate:
    _____
    _____
    _____

Teaching Experience

13. How many years (including this year) have you taught mathematics? _____

14. How many years (including this year) have you taught algebra 1? _____

(adapted from NAEP Mathematics Teacher Background Questionnaire, 2009)

APPENDIX C
INFORMED CONSENT OFFICIAL DOCUMENT

Informed Consent

Protocol Title: Relationship between teacher training and student achievement on the end of course (EOC) exam in algebra 1.

Purpose of the research study:
The purpose of the study is to determine the relationship between teacher training and student achievement in algebra 1 as determined by the results of the EOC exam.

What you will be asked to do in the study:
You will be asked to complete a survey asking questions about your background and academic preparation.

Time Required:
The teacher survey will take approximately 15 minutes to complete.

Risks and Benefits:
There are no risks involved in participation. The study findings may help teachers, principals, and district personnel by identifying teacher characteristics that predict higher student achievement in algebra 1 EOC exams.

Compensation:
There is no compensation for participation.

Confidentiality:
Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number and your name will never be identified when data are presented. Your responses will be collected by the survey administrator. Information collected through your participation will be used as data for a dissertation, may be presented at a professional meeting, or published in a professional journal.

Voluntary participation:
Your participation in this study is completely voluntary. There is no penalty for not participating.

Right to withdraw from the study:
You may withdraw from the study at any time without consequence.

Whom to contact if you have questions about the study:
Cathy Hargis, Graduate Student, College of Education, University of Florida, phone 239-455-4981.
Dr. Linda Behar-Horenstein, Dissertation Chair, University of Florida, Gainesville, FL; phone 352-273-4330.

Whom to contact about your rights as a research participant in this study:
IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250, phone 352-392-0433.

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

Participant: _____ Date: _____
Principal Investigator: _____ Date: _____

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2011-U-0344
For Use Through 05-16-2012

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BIOGRAPHICAL SKETCH

Cathy Griffin Hargis was born in Henderson, KY in 1954. She went to Webster County High School in Dixon, KY. After graduating from high school in 1972, she attended Henderson Community College in Henderson, KY. Mrs. Hargis married and was a “stay at home mom” to her three children. Once her children were old enough to attend school or day care she returned to school at Indiana State University Evansville (which later became the University of Southern Indiana), and graduated in 1983 with a Bachelor of Science in science teaching: primary emphasis in biology; supporting area in general science; and a minor in physical education. While attending the Indiana State University Evansville, she received the academic award in Physical Education for two consecutive years. After relocating to Naples, FL in 1984 she began her educational career in Collier County as a high school biology, physical science, and health teacher at Barron Collier High School. In 1993, she earned her master’s degree in counselor education from the University of South Florida - Ft. Myers campus. After teaching for 14 years, Mrs. Hargis became a school counselor at Barron Collier High. Mrs. Hargis has had the opportunity to open two new high schools (Gulf Coast High as a school counselor and Palmetto Ridge High as the Director of Guidance). She currently serves as a school counselor at Beacon High School, an alternative school for students not meeting academic success in the traditional school setting. In 2009, she graduated from University of Florida with a Specialist degree in educational leadership. In 2010, Mrs. Hargis was selected by the Florida School Counselor Association as the High School Counselor of the Year for the state of Florida.