IMPACT OF TEXAS HIGH SCHOOL SCIENCE TEACHER CREDENTIALS ON STUDENT PERFORMANCE IN HIGH SCHOOL SCIENCE

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A study was conducted to determine the relationship between the credentials held by science teachers who taught at a school that administered the Science Texas Assessment on Knowledge and Skills (Science TAKS), the state standardized exam in science, at grade 11 and student performance on a state standardized exam in science administered in grade 11. Years of teaching experience, teacher certification type(s), highest degree level held, teacher and school demographic information, and the percentage of students who met the passing standard on the Science TAKS were obtained through a public records request to the Texas Education Agency (TEA) and the State Board for Educator Certification (SBEC). Analysis was performed through the use of canonical correlation analysis and multiple linear regression analysis. The results of the multiple linear regression analysis indicate that a larger percentage of students met the passing standard on the Science TAKS state attended schools in which a large portion of the high school science teachers held post baccalaureate degrees, elementary and physical science certifications, and had 11-20 years of teaching experience.

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INTRODUCTION

Nations become competitive internationally when they are able to generate innovative ideas and products that appeal to a broader populace. We are now in a time in which science, technology, engineering, and mathematics (also known as STEM fields) are at the forefront of international concern. As a nation, we are still reeling from the Russians being able to get the *Sputnik* satellite launched into space well before we were prepared to be competitive in what is now commonly known as the space race. Almost every president since the launch of *Sputnik* has made some sort of reference to being outperformed by the Russians. Presidents continually encourage Congress and STEM field leaders to support innovative ideas necessary for the United States (U.S.) to have a successful future. This desire to be internationally competitive has been a source of motivation behind an avalanche of educational reforms since the 1950s. Many of the current foci of reform are on the improvement of institutions, teacher quality, and student-learning expectations. In this study, the focus is on how credentialing of high school science teachers impact students' performance on a standardized exit examination required by the state of Texas.

Statement of the Problem

Several initiatives and laws have been put in place both at the state and national levels with the intention of improving the quality of education provided to our children. These initiatives employed several approaches to improve the present condition of the educational system. The bottom line is that which students enter the classroom cannot be chosen, but the requirements and training of the teachers chosen to support the classroom can be regulated. Therefore, there is a need for an evaluation of the impact of teacher quality on student performance in science in the state of Texas such that state and national legislators can make informed decisions about teacher requirements for those who desire to teach science.

Purpose of this Study

This study discusses the history of how Texas teachers acquire certification, research that has been performed in similar areas to this study, the results of an analysis of state of Texas teacher credentials, targeting credentials of chemistry teachers when possible, and Texas high school student performance on the Exit Level Science Texas Assessment of Knowledge and Skills (TAKS) test during the 2009-2010 school year.

Research Questions

Every teacher is an individual who brings something different to the classroom. Much of the reported information is interpretive since teaching is a personal passion for many of the individuals who choose to make a career out of mentoring and shaping young minds. However, in this study, efforts have been made to quantify available objective data collected by the state of Texas in order to describe the relationship between teacher credentialing and high school student performance measured by the high stakes exit examination required for graduation from a Texas public high school. This study is designed to investigate the impact of teacher quality as defined by education level, certification type, and experience on student performance in science, which encompasses life and physical sciences. One way to measure student performance in science is to evaluate the percentage of students who met standard on the Exit Level Science TAKS test. In this study, “met standard” is intended to describe successful passing performance on the TAKS test.

A predictive model was not available for this research study. Consequently, it was necessary to develop a predictive model relevant to the Texas high school science teacher population and their students. The advantages of using this statistical predictive model based on the entire population of available high school science teachers whose students are required to be assessed by the Exit Level Science TAKS test are:

- removal of opinion and other biases possibly held by the researcher prior to evaluation of data,
- ability to apply the statistical model to smaller samples while maintaining any deviations from the normal distribution seen in the total population,
- reduce the level of Type I and Type II errors,
- maximize the variance in student performance explained by the predictor variables, and
- maximize the probability of reproducing similar results using a smaller sample of high school science teachers within the state of Texas.

Ultimately, this project is designed to address the following research questions at the campus level:

1. What is the correlation between the degree level held by high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?
    a. What is the correlation between high school science teachers not having a baccalaureate degree or higher with the percentage of students on the Exit Level Science TAKS test who met standard?
    b. What is the correlation between high school science teachers having a baccalaureate degree with the percentage of students on the Exit Level Science TAKS test who met standard?

c. What is the correlation between high school science teachers having master degrees with the percentage of students on the Exit Level Science TAKS test who met standard?

d. What is the correlation between high school science teachers having doctoral degrees with the percentage of students on the Exit Level Science TAKS test who met standard?

2. What is the correlation between the certification type(s) held by high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

    a. What is the correlation between high school science teachers with non-science certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

    b. What is the correlation between non-certified high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

    c. What is the correlation between composite science/science certified high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

    d. What is the correlation between high school science teachers with life science certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

e. What is the correlation between high school science teachers with physical science certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

f. What is the correlation between high school science teachers with subject specific certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

g. What is the difference in the type of certification held by high school science teachers measured by the percent of students on the Exit Level Science TAKS test who met standard?

3. What is the correlation between categories of the number of years of teaching experience of high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

    a. What is the correlation between novice high school science teachers with 0-4 years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

    b. What is the correlation between early-career high school science teachers with 5-10 years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

    c. What is the correlation between middle-career high school science teachers with 11-20 years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

   d. What is the correlation between full-career high school science teachers with 21 or more years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

4. What combination of high school science teacher's degree level (no baccalaureate or higher, baccalaureate, master, or doctoral), certification type (composite science, life science, physical science, science subject specific, gifted and talented (GT), non-science, or not certified), and years of teaching experience (novice, early-career, middle-career, or full-career) show a significant relationship with student achievement as measured by scores on the Exit Level Science TAKS test?

Significance of the Study

The intention of this study is to provide readers and educational personnel with a guide that will be useful in making decisions on how to build and advise a staff that can function as a team in order to provide their students with the best opportunities to be successful in science. Every campus has a unique set of variables, including population demographics and background of available teachers. Staffing a school, in this researcher's opinion, is about balancing the qualities that each teacher has to offer in order to maximize the potential of the whole team. The goal of staffing a school is to create a learning environment in which every child is provided the opportunity to be successful.

The type of data used in this study can also be used to inform state and national decision makers about the requirements necessary to make successful science teachers. The results and policies that could potentially precipitate from this investigation will be valuable in designing or refining teacher preparation programs, such that the next generation of teachers is able to participate in preparation programs that are most beneficial for students studying science. Results from this research has the potential to influence the requirements to complete a teacher preparation program as well as influence the recommendations provided to future teachers by these programs as they begin to choose their type of certifications and content area.

Definition of Terms and Acronyms

This study focuses on the background of Texas high school science teachers and student performance. The following is a list of terms and acronyms will be utilized throughout this discussion.

4×4 Curriculum – The 4×4 curriculum is the newly approved high school graduation plan mandated by the State Board of Education. This curriculum requires four credits of each English, math, social studies, and science.

AP Program – The Advanced Placement Program was developed by the College Board to provide students with the opportunity to complete advanced level coursework in high school and to be eligible to earn college credit hours prior to graduation from high school.

CCA – A canonical correlation analysis is an analysis within the general linear model in which the relationship between two groups of variables, made of two or more variables in each group, can be evaluated. Each function derived from a canonical correlation analysis describes a portion of the residual that was not described by the previously derived function and are designed to maximize the Pearson *r* for the portion of the variance explained.

CCRS – The College and Career Readiness Standards are a set of standards agreed upon by the Texas Higher Education Coordinating Board (THECB) and the Texas Education Agency (TEA) that will prepare students to be successful in entry level college courses.

Certification types – The following certification types will be used in the following discussion. The subjects taught under the certifications and their names were changed and are included in Table 1.

Table 1

Relevant Certification Types Offered by the Texas Education Agency

	Phased Out Date	First Administered Date
Biology	Spring 2001	
Life Science (Replaced Biology)		Fall 2002
Composite Science	Spring 2001	
Science (Replaced Composite Science)		Fall 2002
Physics/ Mathematics		Fall 2004
Chemistry		Fall 2005
Physical Science	Spring 2001	Fall 2002

Cook's D – Cook's D is a function of the multiplicative relationship between leverage and discrepancy values for each observation. Leverage is a function of the relationship between the independent variables. The discrepancy value is a function of the difference between the predicted and observed value for each observation (Allen, 1997).

DFITS – The standardized design, fabrication, and integration and test values are standardized measures of the effect of a change to the statistical model when individual cases are removed. This measure can also be used to identify cases as potential outliers.

EE – The Essential Elements was the set of state curricular guidelines used in Texas from 1984 until 1998.

ELA – English language arts courses include instruction in literature, grammar, and reading.

EOCs – End-of-course exams are standardized exams given to measure student competency in a subject.

ESC – Education Service Centers provide training and curriculum, planning opportunities to teachers in Texas, divided into 20 regions.

ESL – English as a second language programs and courses are sheltered courses designed for students whose first language is not English and who have demonstrated difficulty using English to communicate in an academic setting. Students are monitored for a minimum of two years after placement into non-sheltered classes in order to monitor progress.

ExCET – Examination for the Certification for Educators in Texas is an examination program for certification of teachers in Texas public school system.

Exit Level Science TAKS test – The science Texas Assessment of Knowledge and Skills is the high stakes exit level examination used to evaluate a student's content knowledge and understanding of science based on the Science Texas Essential Knowledge and Skills (TEKS) given at Grade 11 and of which a passing score is required for graduation from an accredited Texas public high school.

FERPA – The Family Educational Rights and Privacy Act of 1974 determines appropriate access to student's educational information. This act allows for the parents and guardians of minor students to obtain access to their children's academic records. Each state has a different set of protocol for researchers to obtain educational data. The type and amount of data that can be obtained varies by state.

GT – Gifted and talented describes programs or students enrolled in programs that are designed for students whose educational needs exceed the age- or grade-level objectives of mainstream courses.

High school – A high school describes any school in which the Exit Level Science Texas Assessment of Knowledge and Skills test is administered at Grade 11, typically these schools include Grades 9 – 12, but not in all cases.

High school science teacher – A high school science teacher refers to an individual who is assigned to teach at least one section of a science class at a campus that administers the Exit Level Science TAKS test.

High stakes exit level examination – This examination is a non-negotiable graduation requirement for students to be eligible to complete their high school careers.

Highly qualified teacher – A teacher who holds a state certification in the content area taught, has earned a minimum of a baccalaureate degree, and has demonstrated a reasonable level of competency in the subject area is classified as highly qualified according to the No Child Left Behind Act (NCLB).

LEP – Individuals whose primary language is not English and have difficulty reading, writing, speaking, or understanding English are classified as having a limited English proficiency. These individuals are eligible to receive services in order to overcome this language barrier.

Met standard – Met standard describes successful passing performance on the TAKS test, determined every year by the Texas Education Agency (TEA).

NCATE – The National Council for Accreditation for Teachers was organized to evaluate the quality of teacher preparatory programs nationally.

NCLB – The No Child Left Behind Act of 2001 was a reauthorization of the Elementary and Secondary Education Act of 1965 and was revised in 2004. This act set minimum credential requirements to describe teachers as highly qualified.

NSF – The National Science Foundation was created in 1950 to oversee scientific growth in the United States (U. S) and receives funding from the U.S. Congress.

PCAST – The President's Council of Advisors on Science and Technology is part of the Office of Science and Technology Policy that is comprised of scientists, engineers, and health care professionals who advise the President of the United States.

PEIMS – The Public Education Information Management System is used by the Texas Education Agency (TEA) to manage information regarding public education. This information includes data specific to student demographics and academic performance as well as personnel, organizational and financial information for public schools.

SBEC – The State Board for Educator Certification was established in 1995 by legislation in the Texas Education Code to govern the standards regarding preparation, certification, and conduct of teachers in the state of Texas.

SBOE – The State Board of Education is the administrative body responsible for making educational policy regarding curriculum guidelines, extracurricular rules, school district accreditation, high school graduation requirements, textbook adoptions, standards for minimum performance on standardized tests, and management of the Permanent School Fund. Representatives are elected to the State Board of Education and are not paid for their service.

SCOPE – The Select Committee on Public Education was appointed by Governor Mark White in 1984 to make recommendations to the Texas Legislature in order to implement the adjustments that needed to be made to address the concerns and recommendations presented in "A Nation at Risk" by the National Commission on Excellence in Education.

This committee provided recommendations that dramatically changed the education system in Texas.

Science TEKS – The set of required Texas Essential Knowledge and Skills in science for the state of Texas is divided into five objectives (i.e., The Nature of Science; The Organization of Living Systems; The Interdependence of Living Organisms and the Environment; The Structures and Properties of Matter; and Motion, Forces, and Energy).

STAAR – The State of Texas Assessment of Academic Readiness is the assessment tool implemented in Texas after these data were collected for this study. Successful completion of three end-of-course exams (EOCs) in each of the four subject areas in the 4×4 curriculum is required at the high school level.

STEM – Science, technology, engineering, and/or mathematics

STEM innovator – A STEM innovator is a person who has developed an expertise in a science, technology, engineering, or mathematics profession or who has developed breakthroughs or advances in understandings contributing to science, technology, engineering, or mathematics field.

STEM literate – An individual who may not have specific training in a science, technology, engineering, or mathematics (STEM) field, but is able to make informed decisions involving science, technology, engineering, and mathematics concepts.

TAAS – The Texas Assessment of Academic Skills was the state mandated test in Texas beginning in 1990; replaced by the Texas Assessment of Knowledge and Skills (TAKS) in 2003.

TABS – The Texas Assessment of Basic Skills was the first standardized test in Texas; used from 1979 to 1985.

TAC – The Texas Administrative Code includes the laws passed by the Texas Legislature that govern public education in Texas.

TAKS test – The Texas Assessment of Knowledge and Skills was the state mandated standardized test in Texas beginning in 2003 and is now in the process of being phased out and replaced by the State of Texas Assessment of Academic Readiness (STAAR) exams as a graduation requirement for the freshman class of the 2011-2012 school year.

TASP – Texas Academic Skills Program was used to determine eligibility for entry into a teacher preparatory program from 1989 until 1993.

TEA – The Texas Education Agency is the administrative component of the State Board of Education (SBOE) and is responsible for implementing SBOE policies.

TEAMS – The Texas Educational Assessment of Minimum Skills replaced the Texas Assessment of Basic Skills in 1985 and was used until 1990. This was the first standardized test in Texas in which satisfactory performance was included as a requirement for graduation from high school.

TEKS – The Texas Essential Knowledge and Skills are the current curricular standards used in Texas.

TExES – The Texas Examination for Educator Standards is the current testing program used in the teacher certification process in Texas; implemented in 2001.

THECB – The Texas Higher Education Coordinating Board provides guidelines and regulations for post-secondary education in Texas.

TIMSS – The Trends in International Mathematics and Science Study provided data which compared academic performance in mathematics and science of American students to students in other countries.

Limitations of the Study

This study has several limitations outside of data entry errors made at the campus level. The first limitation is in the nature of the data gathered by the state for this study. While the certification information was continually updated throughout the 2009-2010 school year, degree and employment information were gathered on one snapshot date determined by the responsible state agencies in the fall. As a result, some high school science teachers may have been inaccurately reported as not holding a baccalaureate degree or higher due to delayed entry of documentation, despite state minimum legal requirement of a baccalaureate degree for all public school teachers. The Texas Education Code 21.044 allows for educators in STEM fields to be employed to teach an applied STEM course, if the individual has obtained a national certification in their field, a minimum of an associate’s degree, and a minimum of three years of work experience in the field. The definition of an applied STEM course is discussed in section 28.027 of the Texas Education Code. These courses can be used to fulfill the fourth year of science required in the current 4×4 curriculum, but cannot replace courses in biology, chemistry, or physics. These applied STEM courses can count towards a professional certification, such as an Emergency Medical Technician certification. While these courses are not traditional science courses, the teachers assigned to these courses may still be reported as members of the science department. Additionally, Texas Education Code 21.055 allows for school districts to issue local teaching certifications for an individual to be able to legally teach. Under this statute, the school district is required to notify the state commissioner when this situation arises, but these certifications are not reflected in the data provided by the State Board for Educator Certification (SBEC) (TEA, 2012).

Texas Education Agency (TEA) and the Texas Higher Education Coordinating Board (THECB) are the two agencies that have written the regulations regarding the release of educational data for purposes of research. These regulations are designed to comply with The Family Educational Rights and Privacy Act of 1974 (FERPA) and only allow the release of deidentified student data to anyone other than the parent or legal guardian of a child (O'Brien, 2008). Data obtained through public information requests to TEA, THECB, or obtained from one of the three education research centers in Texas are deidentified prior to being made available for research, preventing direct student-teacher links and are therefore can only be analyzed at the campus level.

Individual student-teacher links and the subject areas of the degrees held by teachers are on file at each school within their PEIMS files. However, schools are not required to provide all of the information that they input into PEIMS to TEA. The major area of study for each degree is among the information that is typically not reported. It is possible to gain access to the information collected at the school level but not shared with TEA through cooperation with individual school districts. Obtaining access to the records of all 1,102 school districts would be a lengthy process that would exceed the scope of this project. Additionally, this approach would introduce the possibility of excluding data on the basis of availability resulting in exclusion of data from a whole school district. The public records requests limited this study to clustering at the campus level, but allowed for all teachers in the target population of high school science teachers in the state of Texas to be included in this analysis.

CHAPTER 2

LITERATURE REVIEW

National Science Education

Education of students in chemistry began as a separate subject in America at medical colleges. The first professorship of chemistry in America was in 1767 at King's (Columbia) College. Two years later, the study of chemistry in universities expanded and the first chemistry department was developed in 1769 at the medical school of the College of Philadelphia (University of Pennsylvania). The training of science teachers to instruct the children of farmers and mechanics in chemistry, philosophy, and natural history was a goal for the Rensselaer Polytechnic School when it opened in 1824. Chemistry courses began to grow in popularity and became well established in the college curriculum by the mid-1800s (Fay, 1931).

The popularity of chemistry courses stemmed from interest in colleges. However, chemistry was taught the first year at Worcester Female High School in Massachusetts in 1924. The North Eastern Ohio Teachers' Association held an institute in 1870 to provide instruction on chemistry teaching methods to prepare teachers to meet the growing interest in offering chemistry in high school. The method and depth of chemistry instruction were areas of discussion, but it was agreed upon by the 1920s that chemistry was a necessary high school course for students who desired to continue into post-secondary education (Fay, 1931).

President Franklin D. Roosevelt (FDR) wrote a letter to Vannevar Bush, Director of the Office of Scientific Research and Development, on November 17, 1944 requesting his recommendations on the future of the work to be done during peace time. Among other areas of concern, one regarded the identification and growth of scientific talent among America's youth. FDR's concern was centered on planning the growth and future of this Nation (qtd in Bush, V., 1945). V. Bush responded to FDR's request with a report titled "Science: The Endless Frontier". In this report, V. Bush stated that more jobs, higher wages, and an overall better quality of life would result when science is "put to practical use" (Bush, V., 1945, p. 232). He also asserted that men and women trained in science are needed for the public's welfare and to continue the growth of scientific knowledge that was occurring at this time. His suggestions to support this growth included advice regarding regulation and support of scientific research, request for funding to be set aside to provide undergraduate scholarships and graduate fellowships for men and women to continue studies and research in the sciences, and the recommendation that an organization such as the National Science Foundation (NSF) be created to oversee scientific growth in the United States (U.S.) (Bush, V., 1945).

In the post atomic bomb era, the idea to create a national foundation for science was well received by Congress, but it took five years of debate before Congress and the executive administration were finally able to agree on how to respond to the report by V. Bush. The project was even vetoed by President Truman in 1947, the same year that the Atomic Energy Commission assumed control of the Manhattan project focusing on research regarding nuclear energy. The concern regarding the formation of the NSF was not so much whether or not to support scientific growth in the U.S., but more as to how this foundation would be managed and what its responsibilities would encompass (Mazuza, 1994).

The NSF was finally authorized as Public Law 507 and signed May 10, 1950, during the Truman administration. Although the NSF was authorized, the guidelines that were agreed upon for this program were not completely in the image that V. Bush had envisioned. The disparity between American science and Russian science was brought to the forefront of this discussion when the Russians launched *Sputnik* on October 5, 1957, causing an immediate negative selfappraisal of American science, technology, and education. As a result, funding for the program grew through the late 1950s (Mazuza, 1994).

Future presidents were given the charge of addressing the state of American science and management of scientific resources and talent. President Eisenhower established The Presidents' Science Committee in 1957, composed of eminent scientists, who advised the president, and authorized the National Defense Education Act of 1958. This legislation established a student loan program, graduate student fellowships, and important to this study, financial support to elementary and secondary programs in science, foreign language, and mathematics (Mazuza, 1994). After Eisenhower, President John F. Kennedy illustrated the need for growth of our knowledge in the fields of mathematics and science, when he declared on September 12, 1962, that the U.S. would use undiscovered alloys to develop a spacecraft that would allow for our nation to put a man on the moon within the decade (Kennedy, 1962). Shortly before his assassination, Kennedy warned the National Academy of Sciences against a sense of elitism in the relationship between science and government (Mazuzan, 1994).

President Lyndon B. Johnson, a graduate of Southwest State Teachers College in Texas, carried out a presidential term known as the "Golden Age" of science (Mazuzan, 1994). The Great Society philosophy that was utilized in Johnson's term provided funding for science and research. This philosophy provided the basis for several programs that developed during this time, including the Higher Education Facilities Act in 1963. This act resulted in several institutions of higher education being able to build facilities appropriate for research and development of new ideas and technologies. This "Golden Age" quickly came to an end with the beginning of the military conflict in Vietnam.

The financial resources that were once available for science and inquiry were then diverted to support the U.S. military effort (Mazuzan, 1994). The economic struggles seen by the Nixon, Ford, and Carter administrations, combined with a large influx of students soon overshadowed the benefits of the boom of construction experienced in Johnson's "Golden Age". The Reagan administration attempted to balance the depleted national budget by greatly reducing funding to the NSF in 1982 (Mazuzan, 1994).

About the same time, the National Commission on Excellence in Education published a report in 1983 titled "A Nation at Risk: The Imperative for Educational Reform" (aka, "A Nation at Risk") that included conclusions and suggestions to address the condition of education in the U.S. based on the results of an 18-month study. The findings of this study included the conclusion that content curricula had been diluted since students were provided with many opportunities to avoid challenging courses, reduced homework, and lower graduation requirement. These lowered expectations and the inability of the teaching profession to attract "enough of the academically able students" reduced the international competiveness of American students (National Commission on Excellence in Education, 1983, p. 122). This report was followed by a wave of educational reforms across several states (Funkhouser, 2000). Texas contributed by enacting Senate Bill 994 which required teachers to obtain an academic degree other than major in education (Warner, 1990). The repercussions of the choices to reduce NSF funding had become evident, and in 1988 the Reagan administration proposed that the NSF budget should be doubled over the course of five years as part of the National Science Foundation Act of 1988 (100th Congress, 1988).

In addition to financial appropriations, the national government has also passed a large amount of legislation that provided guidelines and expectations for public education. These guidelines and expectations define the criteria for states to follow in order to be eligible to receive the funding that has been set aside for public education. In the past10 years, education standards were regulated by the No Child Left Behind Act (NCLB) that was originally passed in 2001 as a reauthorization of the Elementary and Secondary Education Act of 1965. NCLB addressed teacher quality and included the condition that classroom teachers be "highly qualified." The highly qualified clause according to this legislation required that teachers have a state certification in the content area taught, a minimum of a baccalaureate degree, and demonstrate a reasonable level of competency in the subject area (107th Congress, 2002).

National and local concern regarding public education continued to be at the forefront of policy making. The requirements to become and remain a science teacher and the quality of science education provided in public schools were highlighted in the discussion of public education as a result of the current definition of a highly qualified teacher and the increased demand for individuals trained in science, technology, engineering, or mathematics (STEM). The need for increased focus on STEM fields was reiterated by President George W. Bush when The American Competitiveness Initiative was announced in the State of the Union Address on January 31, 2006. This initiative was designed to address the national shortcomings in STEM fields (Bush, G., 2006). This particular initiative drew attention to the quality of education in STEM fields, a driving force behind this study.

On May 5, 2010, the National Science Board published a report titled "Preparing the Next Generation of STEM Innovators: Identifying and Developing our Nation's Human Capital" in response to the growing need of quality STEM innovators in our nation. This report defines STEM innovators "as those individuals who have developed the expertise to become leading STEM professionals and perhaps the creators of significant breakthroughs or advances in scientific and technological understanding" (National Science Board, 2010, p. vii). The dominant recommendations from this report were to "provide opportunities for excellence", "cast a wide net", and "foster a supportive ecosystem" (National Science Board, 2010, p. 3). These recommendations have brought student performance and teacher effectiveness to the attention of both policy makers and researchers and have resulted in several laws and programs designed to provide incentives that will allow for teachers and students to have opportunities to excel.

The President's Council of Advisors on Science and Technology (PCAST) published a report in September 2010, which stated that American Students in Grades K-12 are not performing at a satisfactory level in mathematics and science based on the results from the Trends in International Mathematics and Science Study (TIMSS) (PCAST, 2010). The TIMSS assessment included concepts and cognitive skills that were expected to be mastered in mathematics and science at Grades 4 and 8. The results showed fewer students performing at higher levels as students progressed into more advanced grade levels (Gonzales et al., 2008). These performances are areas of concern because technology and science are making greater contributions to all aspects of society than ever before.

An average citizen makes decisions in a variety of areas that utilize information from STEM fields through the process of performing simple daily tasks. These decisions can range from those involving personal health and casual purchases to jury duty, voting, and holding public office. All citizens benefit and utilize information from STEM fields regardless of an individual's contribution to society. As a result, the PCAST report states that all citizens need to be STEM capable so that they can make educated decisions regarding issues that impact our nation and our planet. In addition to being STEM literate in the case of making decisions, it also impacts the number of job opportunities available to an individual, since the number of positions utilizing this type of information has grown in accordance. An increase in proficient STEM professionals is needed to continue our growth in industry as a means for improved economic competition and continuance of educating future generations (PCAST, 2010).

The plan of action suggested by the PCAST report to achieve a greater number of STEM capable citizens focused on the issue of the quality of STEM education offered in the U.S. According to this report, students will develop into STEM capable citizens when science education focuses beyond presentation of knowledge-level information such that students are able to develop the skills to analyze and interpret information as well as collaborate together to apply these skills. The approach suggested in the report is to improve the resources available to STEM teachers. The idea is that teachers would have the proper tools to inspire and motivate students to go beyond learning what they need in order to pass the class and continue their own scientific inquiries beyond high school as they progress into undergraduate studies, if teachers were provided with proper professional development (PCAST, 2010).

President Obama referenced the impact that *Sputnik* had and continues to have on our nation as it applies to the American economy in his State of the Union Address on January 25, 2010. In this address he declared that we were in our generation's "*Sputnik* moment" as a result of the investments and advances that have been achieved in biomedical research, information technology, and clean energy (Obama, 2010). The Race to the Top Competition was announced as a challenge to encourage American innovation. This competition challenged the states to come up with innovative plans for educational reform in exchange for the funding to implement their plans. The current reauthorization of the Elementary and Secondary Education Act included the initiation of the Race to the Top Competition and was designed to allow educators to be more flexible in meeting the needs of their students (Obama, 2010). Texas and Alaska were the only states that declined the opportunity to participate in this program (Dillon, 2010).

History of Texas Education

The qualifications of teachers in the classroom and quality of the education provided in the classroom have long been important to Texans. As early as 1802, legislative proclamation efforts, even though not successful, were issued compelling parents to send their children to school. The Bexar schools were slated as some of the best in Coahuila and Texas, even though the wealthiest settlers would still send their children to the U.S. for a more established education. If settlements or military post had large enough populations, the Mexican government deemed it necessary for the salaries of teachers to be provided, and sometime after 1812 a public school was established at San Antonio. Public funds were used to support the school, but the school had a precarious existence and did not last (Berger & Wilborn, n.d.). As early as 1823, competitive examination of teachers for public schools was proposed by the Mexican government (Garrett, n.d).

The lack of public education provided by the Mexican government was one of the points brought up by Texians in the Declaration of Independence from Mexico (Sayles, 1888). The second president of the Republic of Texas, Mirabeau B. Lamar, proposed that public lands be set aside for public schools and universities on January 26, 1839. Lamar became most well-known for saying that a "Cultivated mind is the guardian genius of democracy" in an address that he delivered to the Republic of Congress and for being the “Father of Texas Education” (Gambrell, n.d.).

The Republic of Texas approved an act on February 5, 1840, which appointed the chief justice and two associate justices to be the county school board. One of the responsibilities of the county school board was to administer examinations to individuals applying to teach in academic or common schools. A candidate needed to have evidence of good moral character and be a graduate of a college or university prior to being eligible to take the examination for a teaching certification, according to this act (4th Congress, 1840).

Several colleges and universities were established prior to Texas joining the U.S. Rutersville College was established in 1840 as the first institution of higher learning in Texas and is still operative in its original location, now known as Southwestern University (Whisenhunt, 1984). What is now known as the University of Mary Hardin-Baylor was originally established as a co-educational college by Baptist missionaries from New York who appreciated the value of a post-secondary education in 1845 and is the oldest continuously operating university in Texas (Lane, 1903; Whisenhunt, 1984). University of San Augustine, University of Nacogdoches, and Galveston University were also founded prior to Texas becoming a state (Whisenhunt, 1984).

When Texas was annexed by treaty into the U.S., the new state constitution of 1845 article X, section 2, made provisions for public schools funded through taxes. School Law of 1854 enacted by the legislature set up the Permanent School Fund (Preuss, 2009). A large expansion of common schools was seen after Texas became a state in 1845 (Whisenhunt, 1984). The State of Texas received ten million dollars from the U.S. Federal Government as a result of the Compromise of 1850 and set aside two million dollars to establish the Permanent School Fund (Wharton, 1930). All schools that met specific requirements were declared public schools in 1856 and funds raised by taxation were to be used for the education of indigent children. The law was amended in 1858 so that only children of the poor could benefit from state money and all others were required to pay tuition. Teachers eventually began reporting all students whose accounts were delinquent as indigent because it was easier to collect money from the government than from parents or guardians (Wharton, 1930). The state public education system, among other public constructs, suffered greatly during the U.S. Civil War (1861-1865) and officially fell apart by 1862 (Whisenhunt, 1984).

After the War Between the States (aka, the U.S. Civil War) ended, the Texas Constitution of 1867 laid the foundation for the compulsory education laws (Sayles, 1880). The specifics of the compulsory education laws for children between the ages of 5 and 16 were included in The Texas Constitution of 1869, which called for a new highly centralized school system that was overseen by a state superintendent of public instruction (Wharton, 1930; Whisenhunt, 1984). A representative of the Peabody Fund (set up to provide funding to promote education in the South) toured Texas in 1870. This representative determined that the condition of educational laws and sentiment of Texas residents at that time were not acceptable, resulting in the decision to withhold funds from the state of Texas at that time (Pruess, 2009).

The state school system of public free schools opened in September 1871 (Whisenhunt, 1984). School law of 1871 ordered the State Board of Education (SBOE) to oversee certification and placement of teachers, determine teachers' salaries, determine the appropriate course of study and their accompanying textbooks, and define the responsibilities of school districts' board of directors (Pruess, 2009). The SBOE consisted of the governor, attorney general, and superintendent of education (Wharton, 1930). These changes that were made at this time were not well received and were considered radical. In 1873 the "radical" Republicans were overthrown and authority over schools was transferred to the county level, decentralizing the school system. By 1875, management of public schools was shifted completely from the state to the county, giving parents local control (Whisenhunt, 1984).

All remnants of the Republican school system were abolished in the Constitution of 1876. This constitution abolished compulsory education, the state superintendent, and local taxation. The range of ages for school aged children was limited to ages 8 to 14. School Law of 1876 dramatically limited the responsibilities of the SBOE. The Peabody Fund began providing funding to Texas in 1876. Burleson, President of Baylor University, became the state's Peabody agent. In this role, Burleson advocated free public education, permanent school districts, improvement of teacher education, permanent schools, and reform of supervision provided by the SBOE across the state (Pruess, 2009).

The 1879 revision of the Texas Constitution required teachers to obtain a teaching certificate from the county judge after passing an examination given by the county examination board, which consisted of educated individuals appointed by the county judge. Certification Law of 1879 established three levels of certification, with the highest level requiring examinations in both the content area and teaching methods. In response to the need for educator preparation, the first state funded normal school was Sam Houston Normal Institute, which opened in 1879 (16th legislature, 1879). Prairie View Institute for the education of African American leaders also opened in 1879 (Whisenhunt, 1984). Amendments made to the 1883 Constitution authorized the formation of independent school districts and permitted them to levy taxes (Wharton, 1930). School Law of 1884 reinstated the state superintendent (Pruess, 2009). Educators and politicians soon became concerned with the concept of school accountability and accreditation. The initial accreditation evaluations of schools began in 1885 on a voluntary basis through The University of Texas (Preuss, 2008).

A number of private institutions were established to train teachers, including the establishment of Texas Normal College and Teachers' Training Institute in 1890 (UNT, 2012).

In 1893 the Texas Constitution provided several options for a teacher to obtain a teaching certification. Certifications could be approved by the county board of examiners at the city, county, or state levels. County certificates could be one of four classes: third grade, second grade, first grade, or permanent. Larger cities and towns that had become independent school districts were given permission to issue permanent and temporary certificates. The classes of these certificates were primary, intermediate, and high school. Diplomas from Texas State Normal School, Peabody Normal School at Nashville, TN, North Texas Normal College of Denton, TX, and Coronal Institute at San Marcos, TX were to rank equally with permanent state teaching certificates. Diplomas and certificates issued by the University of Texas School of Pedagogy were also considered state level certificates that did not require further examination. Regardless of certificate level, teachers were required to have some level of certification that was honored by their school and any teacher working in a public school must be certified in order to be paid out of the free school funds (23rd Legislature, 1893). North Texas State Normal School in Denton and Southwest Texas State Normal School in San Marcos officially became state institutions in 1899 (Pruess, 2008).

The general laws of Texas in 1903 made provisions for state funded textbooks and other materials, subject to the approval of the SBOE (23rd Legislature, 1903). By 1907, several schools had begun to consolidate in order to share resources (Whisenhunt, 1984). By 1911, the SBOE had the responsibility of approving all teaching certifications. Graduates of approved programs, whose coursework included four courses in the arts and one course in the education department, were qualified for a first-class teaching certificate that was valid for four years (32nd Legislature, 1911). A state tax to support free textbooks was approved through a constitutional amendment in 1918 (Whisenhunt, 1984). The county superintendent had the responsibility of teacher certification as a result of legislative provisions in 1912 (Warner, 1990). Certification Law of 1921 granted permanent teaching certificates to individuals who had completed either a bachelor of arts or a bachelor of science degree without the requirement of a certification examination (Blanton & Marrs, 1922). All normal schools became teachers' colleges in 1923 (Whisenhunt, 1984).

By 1926, 257 (43%) of the 595 accredited schools in Texas offered chemistry as a junior level course as part of the regular coursework. This was a large percentage of schools offering chemistry in public high schools in southwestern states. The concern with offering chemistry was that laboratory experiments required resources that were not reusable, which made it more expensive to offer chemistry as opposed to other sciences, such as physics. The State Department of Education of Texas also issued a statement that voiced concern about the over emphasis of the practical uses of chemistry. The position of the State Department of Education of Texas was that without a solid understanding of basic concepts, the use of practical applications in the chemistry classroom was meaningless (Otto, 1926).

Texas schools faced economic struggles during World War II as a result of the hardships endured during the Great Depression. Many public schools were in the position where they had to consolidate with nearby schools in order to provide appropriate resources for the growing population, despite the desire for local control of education (Preuss, 2009). During this time, graduates of Texas schools were not competitive in the work place, especially when compared to graduates of programs from other states. In response, many public schools in Texas expanded by 1941 to include 12 years of instruction in order to prepare their graduates to be competitive nationally (Whisenhunt, 1984).

An avalanche of educational reform occurred in the late 1940s and 50s including reform in public education as it applied to rural schools (Preuss, 2009). The Gilmer-Aiken Laws of 1949 brought much needed regulation to Texas education system. These laws completely reorganized the state education system, formed an elected SBOE, which appointed the Commissioner of Education (Preuss, 2008), created the Texas Education Agency (TEA), resumed state responsibility of schools, and regulated the quality of the educational environment for children (Whisenhunt, 1984). These laws, including the Minimum Foundation Program designed to provide financial assistance to schools in low economic areas, dramatically changed the type and level of education provided in Texas schools, and also began to address the issue of the teacher shortage (Preuss, 2008). Changes in teacher certification were seen in 1955 when the Standards for Teacher Education allowed for lifetime certification upon completion of an approved course of study at a college or university. These teaching certifications were honored in neighboring states as well (Smith, 1986).

The standards for educator preparatory programs were revised again in 1972 to be competency based (TEA, 1974). Despite the standards that were in place, the SBOE did not have any consequences for programs that were deemed unacceptable until Senate Bill 909 was enacted in 1979 with the establishment of the Commission on Standards for the Teaching Profession (Warner, 1990). A law also passed in 1979 repealed the provision for all certificates to be provisional without expiration (Smith, 1986). Standardized testing of student learning began for Texas in 1979, with the Texas Assessment of Basic Skills (TABS), which tested students in Grades 3, 5, and 9 (Funkhouser, 2000). The TABS was used to assess the level of student mastery in reading, mathematics, and writing. Students who did not pass the assessment in Grade 9 were required to take the assessment in subsequent years until either the student passed or graduated. A successful score on TABS was not required for graduation (Ott, n.d.).

Dramatic changes were seen in Texas education in 1984 after “A Nation at Risk” came out highlighting the weaknesses in American education (Funkhouser, 2000). The Select Committee on Public Education (SCOPE), led by H. Ross Perot recommended minimum standards in all subjects under what became known as “no pass, no play”, reorganization of TEA, developed standards to assess and accredit schools based on performance, and standardization of teacher evaluation and training (Preuss, 2008). The Texas Assessment of Minimum Skills (TEAMS) replaced the TABS in 1985 and added Grades 1, 7 and 11 to the list of grades evaluated. Evaluation of Grade 1 was soon discontinued and satisfactory performance of the assessment in Grade 11 was required to receive a high school diploma. The Essential Elements (EE) curriculum, which was created as a result of the report produced by SCOPE, provided the framework for the TEAMS (Funkhouser, 2000). House Bill 72 was subsequently passed and mandated that all teachers and administrators take and pass the Texas Examination of Current Administrators and Teachers (TECAT), a certification exam, before June 30, 1986, in order to keep their certifications. The imposition of the certification requirement was not well received by teachers and several law suits ensued because teachers who were previously issued lifetime certification were now having to prove themselves again to retain their “lifetime” certifications (Smith, 1986).

The 1987 legislature approved Senate Bill 994, which required an academic degree for certification after September 1, 1991 (Warner, 1990). Influence from the National Council for Accreditation for Teachers (NCATE) resulted in additional revisions to teacher certification requirements, which became the foundation for the Examination for the Certification of

Educators in Texas (ExCET) in 1987. Students applying for a teacher certification program were required to pass the Texas Academic Skills Program (TASP) from 1989 until 1993. The Texas Assessment on Academic Skills (TAAS) replaced the TEAMS in 1990 with the intention of broadening the scope of expectations for students and was administered to Grades 3-8 and 10 (Funkhouser, 2000).

Senate Bill 1 established the SBEC in 1995 (Kerere & Walsh, 2000). The Texas Essential Knowledge and Skills (TEKS) were legislated in 1997 to effectively replace the EE Curriculum on September 1, 1998 (Funkhouser, 2000). Included in the TEKS was the requirement that all science courses were to have 40% of the class time set aside for students to have the opportunity of hands-on experiences. The 40% laboratory requirement is documented in Section 19, Chapter 74, Subchapter A of the Texas Administrative Code. In light of the revisions to NCLB, Senate Bill 1108 (78R) was written. Senate Bill 1108 resulted in the initiation of the Texas Assessment of Knowledge and Skills (TAKS) in 2003 (TEA, 2010). The SBOE began offering the Texas Examination for Educator Standards (TExES) in 2001 and began to of phase out the ExCET test system by 2004 (Harrell, Harris, & Jackson, 2009). The new requirements included in Senate Bill 1031 and House Bill 3 resulted in a reevaluation of the new college readiness standards and the current academic standards in Texas. This reassessment inspired revisions in the TEKS that aligned them with the College and Career Readiness Standards (CCRS) (TEA, 2010).

The alignment of the TEKS with the CCRS lead to the TAKS being phased out and replaced by the Student Assessment of Academic Readiness (STAAR) that began in the 2011-2012 school year based on the current revision of the TEKS (TEA, 2010). Manrique and Mason (2010) described two symposia that occurred, called the College and Career Readiness Symposia on Chemistry. These symposia provided opportunities for high school science teachers to meet with representatives from community and technical colleges to address any content knowledge gaps that may exist between the high school chemistry courses and the college level courses in chemistry. The high school science teachers were encouraged to invite mathematics teachers to the second symposium to share any insights about what has worked for them in the past when they had taught topics that are generally considered to be difficult in the chemistry curriculum. These symposia provided post-secondary educators and high school mathematics and science teachers with the opportunity to begin a dialogue regarding the importance of mathematics in chemistry coursework and the educational needs of students as they transition from high school to post-secondary education and to assure that the standards published in the revised TEKS (2008) and CCRS (THECB & TEA, 2009) are vertically aligned. This opportunity has aided in the current process in the attempt to minimize the discrepancies between expectations for high school and post-secondary education. Additionally, Texas educators had the opportunity to develop effective methods to implement the new TEKS and CCRS (Manrique & Mason, 2010).

The University of Texas at Austin developed a program in the mid-1990s, called UTeach, designed to prepare STEM teachers. This program integrated teaching curriculum with academic majors in science, mathematics, and engineering. The results of this program have attracted national attention and the UTeach program has been recognized by Congress and the National Academy of Sciences as being a viable model to address the teacher shortage in STEM fields. The National Math and Science Initiative is a non-profit organization that has offered schools the opportunity to apply for a grant to implement programs similar to the UTeach program underwritten by ExxonMobil. This grant was designed to provide schools with $2.4-million over five years to assist schools in the development of programs similar to the UTeach program. Several institutions took this opportunity to implement models in the image of the UTeach program, including Florida State University, Louisiana State University at Baton Rouge, Northern Arizona University, Temple University, University of California at Berkeley, University of California at Irvine, University of Colorado at Boulder, University of Florida, University of Houston, University of Kansas, University of North Texas, The University of Texas at Dallas, and Western Kentucky University (Brainard, 2007). Currently, a total of 29 schools in 14 states have now implemented this nationwide program (UTeach Institute, 2012).

Rigorous Courses

The intention of the reforms that have been made over the years has been to improve the quality and level of instruction provided to students in public schools. The quality of the teacher affects the quality of the courses offered to students. Students need to be taking courses that are in line with the standards that are used to measure content mastery. Mason and Griffin (2003) investigated the relationship between the difficulty of courses and student performance on the TAAS. In this study, students who took more challenging course loads were more likely to pass the TAAS than students in remedial classes who performed at lower levels. Each student was given a course load score, based on the level of the English, mathematics, and science courses taken. The TAAS was administered at the end of the sophomore year, and therefore sophomore level classes were considered to be on-level in this study. On-level courses were given a value of 2, and other courses were assigned values based on its level above or below this point of reference. A student who was enrolled in all sophomore level classes, the level at which the TAAS was administered, would have a course load score of 6 for the three chosen courses. On the average, none of the students with a course load score of a 6 or higher failed the TAAS test in this study. Mason and Griffin (2003) concluded that students were more likely to be successful when assessed on a standardized test if the on-level coursework was completed. This study highlights the need for students to be tested at the level where the preparatory work is completed. The most predictive course for success on the TAAS was the science class that the student was enrolled in (Mason & Griffin, 2003). As of 2010, the revised TEKS and CCRS were vertically aligned and the gaps in expectations between high school and post –secondary education were still evident. Mason and Manrique suggested in 2010 that if all high school chemistry courses were modeled after dual-credit courses or the Advanced Placement (AP) program students would be better prepared for post-secondary coursework.

Teacher Certification

The specific content area of certification is what is usually used to determine the teaching assignments of a teacher. The importance of teachers being certified in the field that they are assigned to teach was addressed in North Carolina when a group of researchers evaluated student performance on the end-of-course exams (EOCs) for five subject areas (algebra; English I; geometry; economic, legal, and political systems; and biology) and directly compared the individual student data clustered by classroom. Data on a particular student were only included if data were available for any three of the five EOCs. The information on each teacher was provided by school administration (Clotfelter, Ladd, & Vidgor, 2010).

A basic linear regression model was used to analyze classroom characteristics and teacher characteristics as predictors for student success on the standardized subject-specific EOCs. Characteristics that represented small portions of the population tended to show larger effect sizes, were reported as a source of measurement error, and a conclusion was made that these characteristics were not representative of the population. This article concluded that subject specific certification has a positive influence on student achievement, particularly in mathematics and English, but that determination of the value of a teacher based solely on credentials alone would be a mistake. The researchers in this study indicated that student performance was influenced by teacher qualities as well as demographic aspects of the school and classroom settings. There are also other aspects of teacher effectiveness that can only be gauged by observation of interactions between the teacher and students (Clotfelter, Ladd, & Vidgor, 2010).

Teacher Training

In 2009 Andreasen investigated the relationship between various education and training methods available to teachers and the statewide standardized test results of their students in Arizona. Teacher training was broken down into formal education, certification, outside subject-specific workshops, and campus-level development through collaboration including mentor programs. The data from the state exam were evaluated at the state level and the teacher data were collected through teacher surveys. Similar to this study, individual teacher data could not be compared to individual student data. Analysis of the available data included multiple linear regression analysis, which was used to determine the aspects of teacher quality that were considered to be significant. Degree level and the type of certification preparation program did not provide a significant effect in this study. Participation in teacher mentor programs and subject-specific workshops, however, were the most valuable aspects of teacher development in improving student performance on the state standardized test based on the findings from the multiple linear regression analysis (Andreasen, 2009).

Teaching Experience

A recent study in the public schools of North Carolina investigated the effectiveness and attrition of novice science and mathematics teachers over a four-year period. The target population for this study included all teachers in North Carolina who taught subjects with EOCs and had less than five years of teaching experience (Henry, Fortner, & Bastian, 2012). The effectiveness of these teachers was measured using a value-added model based on the scores that their students earned on the standardized EOCs, adjusted for prior achievement of the individual students and the covariates from the school, other students, and classroom. These data were obtained from the North Carolina Department of Public Instruction. Teacher development and attrition were evaluated individually in separate models. A third model was developed that combined the first two models. This third model combined all courses and measured years of experience as a continuous variable and resulted in a comparison of the returns seen from mathematics and science teachers in comparison to teachers from non-STEM subjects (Henry, et al., 2012).

Henry et al. (2012) described the greatest increase in teacher effectiveness is between Years 1 and 2, with the returns diminishing returns until Year 5. The trajectories of teachers who continued teaching after the fifth year continued to increase, while teachers who left before they completed their first five years of teaching plateaued or fell after their fourth year in the classroom. Teachers who remained in the classroom tended to score above their novice peers who left the classroom earlier, with the exception of geometry, chemistry, and physics teachers where a significant difference between those who stayed and those who left was not observed. The effects of replacing an experienced teacher with a first-year teacher are largest for physics and chemistry classes. Geometry, algebra 1, algebra 2, and physical science show moderate effects, with biology and non-STEM courses indicating the least consequences (Henry et al., 2012).

Theoretical Constructs

The theoretical basis of this study is rooted three theories: experiential learning theory, constructivist theory, and social learning theory. This study focuses on the experiences of the teacher through training, both formal and informal, and years of experience in the classroom. Teacher training can include a variety of “practical” opportunities to learn about becoming an effective teacher ranging from classroom observations and student teacher programs to mentoring relationships that are set up once the teachers enter their own classrooms. The common thread between these theories is that learning occurs through some level of experience.

Based on the theory of experiential learning, there are two types of learning: cognitive and experiential. Cognitive learning is the knowledge level information in Bloom’s Taxonomy. Experiential learning involves the application of the knowledge attained in cognitive learning. In this theory learning is facilitated when the learner participates in the learning process, confronts a variety of problems, and self-evaluates progress or success. It is also important for the learner to be open to change in his or her beliefs (Kearsley, 2009). When teachers have taken the opportunity to experience and learn science, they will be able to continue to construct new knowledge of science and science teaching, consistent with the constructivist theory. Researchers who studied the development of teachers of science recognized that elementary teachers’ conceptions of teaching science were generally based on the teachers’ own experiences as learners of science and science pedagogy in schools, at the university, and in classroom experiences as teachers (Dana, Campbell, & Lunetta, 1997).

Teaching is also an ongoing process of learning. A central point in the constructivist theory is that the learner plays an active role in the learning process. This learning process involves the learner constructing his or her knowledge based on current and past experiences. This happens every time a teacher is able to sit down and evaluate what worked and what did not work in a particular lesson with the intention of improving the lesson the next time and is also consistent with social learning theory. Social learning theory is based on the idea that learners acquire new skills and behaviors through observing and modeling them. This is the theoretical foundation for practical training programs, such as student teaching (Kearsley, 2009).

Teachers need to learn accepted practices used in science so that they can, in turn, model these skills and behaviors for their own students. The implications of a study by Dana, Campbell, and Lunetta (1997) in which the constructivist theory was applied to science teaching were that science teachers should focus on developing new methods to facilitate learning in science, share these ideas with colleagues, and continue to maintain their own knowledge and skills on a continual basis in order to provide the best instruction possible for their students.

Summary

Education in the U.S. and Texas has gone through many legislative changes over the past 200 years and will continue to undergo reform as research continues to contribute to the overall body of knowledge. We have gone from one-room school houses with students bringing whatever textbook they had or could afford to national and state educational standards with legislation regulating student and teacher performance expectations and state funded resources. It is important to remember that the needs of our students and teachers will continue to change as new technology is developed and as social issues continue to change.

The teacher is a perpetual student of practices and methods intended to optimize student learning and understanding as the body of knowledge of how children learn and scientific and technological advances continue to expand the realm of what is known. Education and teaching go hand-in-hand in the quest for perpetual expansion of knowledge into the unknown. One of the responsibilities of the science teacher is to maintain the sense of curiosity and imagination themselves in order to be able to effectively demonstrate these practices for their students. The scientists of tomorrow are among the students that are in the classrooms today; they deserve the opportunity to learn from their own experiences in science and share them with others in ways that we have not yet even imagined.

CHAPTER 3

RESEARCH METHOD

Overview

This project was designed as a correlational study using a snapshot of information in order to better understand the current status of science education in the state of Texas. Teacher education level, teacher certification, teacher employment, and student performance data have been collected from all of the high schools administering the Exit Level Science Texas Assessment of Knowledge and Skills (TAKS) test during the 2009-2010 school year and combined into one file used for analysis. Teacher salary is based on years of teaching experience and the highest degree earned by the teacher. The purpose of this analysis was to determine if the relationship between student performance and teacher credentials was similar to the relationship between total pay and teacher credentials. A canonical correlation analysis (CCA) was performed with degree level, any science certification, not certified at all, and years of experience as predictor variables of the average salary and the percentage of students who met standard, or achieved a. successful passing score on the TAKS test. This analysis was performed to determine if teacher credentials showed similar relationships with teacher total pay and student performance or if other variables, such as demographics (e.g. teacher home region, school type, teacher gender, student demographics, and student enrollment in specialized programs), needed to be addressed in this study by being included a predictor variables.

Multiple linear regression analysis was used to evaluate the contributions and interactions of demographic and teacher quality variables in the prediction of the percentage of students who met standard on the Exit Level Science TAKS test. An initial demographic model was developed to identify the school and teacher demographic variables to be included in the regression model in order to address the concerns that were identified in the CCA, followed by a base model that included all teacher credential variables. The base model was used to identify the non-science teaching certifications that provided statically significant contributions. The non-science teaching certification predictor variables with p values greater than .10 in the base model were removed in order to create a third model that was used to calculate the standardized design, fabrication, and integration and test (DFITS) values and Cook's distances (Cook's D) for each case to determine potential outliers. The final multiple linear regression model was designed using significant demographic and non-science teaching certification information determined from the demographic and base models to identify the statistically significant degree levels, science certification types, and experience categories at the .05 level after the removal of outliers. The final multiple linear regression model was evaluated at the .05 level to further reduce the probability of Type I errors prior to being used to answer the research questions of this study.

Sampling Procedures

The target population was high school science teachers (N = 13,469 teachers) in Texas who taught science in a school that administered the Exit Level Science TAKS test, grouped by school (N = 1,300 schools in 856 districts in 20 ESCs). Not all high schools that administer the Exit Level Science TAKS test include Grades 9 and 10 and therefore were excluded from analysis. The data obtained from state agencies, including the Texas Education Agency (TEA), the State Board for Educator Certification (SBEC), and the Public Education Information System (PEIMS), were clustered by school. Although errors may exist in the data provided through public information requests, resulting in data being appropriately excluded, this process provided a reasonable representation of the whole target population.

The state of Texas is divided into 20 Regional Education Service Centers (ESCs) to provide educational planning for the public school system (Texas System of Education Service Centers, n.d.). The ESCs are assigned to serve schools in a defined surrounding area, or region. The regions are further organized around school districts. The 856 school districts are classified as the following: other central city, other central city suburban, major urban, non-metro stable, major suburban, non-metro fast growing, independent town, rural, or charter school. Districts are also described as one of three types: independent school district, open enrollment charter school district, or common school district. There are 1,300 high schools in the state of Texas that administer the Exit Level Science TAKS test. Schools are classified as being an instructional campus, detention alternative education program only, alternative instructional unit, or juvenile justice alternative education program.

The total population of the state of Texas from the 2010 United States (U.S.) Census Report is 25.1 million people according to Texas Department of State Health Services (2010). Table 2 indicates that there were 338,630 teachers (1.3%) employed in Texas public schools and 13,469 (0.054%) of the Texas population was science teachers during the 2009-2010 school year. The average years of teaching experience for Texas high school science teachers is slightly lower than the average years of teaching experience for the total population and is reflected in the lower average base pay. The higher average in total pay for high school science teachers may be a result of a stipend offered to science teachers and/or for additional duties. While a large majority of Texas teachers are female (77.0%), the gender distribution of Texas science teachers is more evenly distributed (59.6% female). Many teachers in Texas have certifications in different subjects and can be certified to teach multiple levels. This study only counted teachers once per subject area. Changes made to certification law in 1999 resulted in SBEC discontinuing to offer lifetime teaching certificates. The ratio of lifetime certifications to renewable certifications is similar in the high school science teacher population to the population of all Texas teachers, supporting the similarity in the average years of experience for both groups.

Table 2

Demographics of all Teachers in Texas and Texas High School Science Teachers

	Number of All Texas Teachers	Number of High School Science Teachers	High School Science Teachers Included in Sample
Total Texas Teachers	338,630	13,469	13,206
Average Years of Experience	11.3	10.9	10.9
Salary			
Base	$47,900	$47,600	$47,600
Total	$49,200	$49,700	$48,800
Gender			
Male	78,053 (33.0%)	5,578 (41.4%)	5,453 (41.3%)
Female	260,577 (77.0%)	7,891 (58.6%)	7,753 (58.7%)
Total Teaching Certifications *	606,540	11,933	11,706
Lifetime	309,821 (51.1%)	5,881 (49.3%)	5,763 (49.2%)
Renewable	296,719 (48.9%)	6,052 (50.7%)	5,943 (50.8%)
Level of Certification*			
Elementary	277,420 (45.7%)	329 (2.8%)	320 (2.7%)
Middle School	9 (< 0.01%)	14 (0.1%)	0 (0%)
Secondary	156,107 (25.7%)	11,590 (97.1%)	11,386 (97.3%)
All Level	42,752 (7.0%)	0 (0%)	0 (0%)
Special Education	20,265 (3.3%)	0 (0%)	0 (0%)
Other	109,987 (18.1%)	0 (0%)	0 (0%)
Degree Level			
No baccalaureate or higher	2,872 (0.85)	53 (0.4%)	42 (0.3%)
Baccalaureate	260,804 (77.0%)	9,577 (71.1%	9,447 (71.3%)
Master	73,092 (21.6%)	3,565 (26.5%)	3,482 (26.4%)
Doctoral	1,862 (< 0.01%)	274 (2.0%)	265 (2.0%)

(table continues)

Table 2 *(continued)*

	Number of All Texas Teachers	Number of High School Science Teachers	High School Science Teachers Included in Sample
ESC			
1	26,649	1,000 (3.8%)	971 (3.6%)
2	7,242	330 (4.6%)	314 (4.3%)
3	4,166	240 (5.8%)	238 (5.7%)
4	71,028	3,153(4.4%)	3,121 (4.4%)
5	6,023	256 (4.3%)	253 (4.2%)
6	12,066	492 (4.1%)	486 (4.0%)
7	12,900	572 (4.4%)	566 (4.4%)
8	4,797	208 (4.3%)	205 (4.3%)
9	3,251	211 (6.5%)	199 (6.1%)
10	51,260	1,642 (3.2%)	1,611 (3.1%)
11	36,283	1,298 (3.6%)	1,266 (3.5%)
12	11,386	444 (3.9%)	436 (3.85)
13	26,347	939 (3.6%)	919 (3.5%)
14	4,057	190 (4.7%)	187 (4.6%)
15	3,836	201 (5.2%)	197 (5.1%)
16	6,651	336 (5.1%)	324 (4.9%)
17	6,566	227 (3.5%)	225 (3.4%)
18	5,568	231 (4.1%)	225 (4.0%)
19	11,999	505 (4.2%)	498 (4.2%)
20	26,579	993 (3.7%)	965 (3.6%)

* Some teachers hold multiple certifications and some teachers do not hold a state teaching certificate. The values for the certifications of the total population accounts for all certificates held by teachers. The values for the science certifications do not account for multiple certificates for the same subject held by high school science teachers.

Protection of Human Subjects

The University of North Texas (UNT) Institutional Review Board (IRB) Website defines a human subject as "a living individual about whom an Investigator (whether professional or student) conducting research obtains: (1) data through intervention or interaction with the individual or (2) identifiable private information” (University of North Texas, n.d.). The data used did not require intervention or interaction with the individuals and were made available as a matter of public record requests. Sample clustering at the school level prevents the identification of data at the personal level. IRB approval has been granted by UNT for this project. (A copy of UNT IRB approval is available in Appendix A.)

Data Collection and Variables

The dependent variable for this study is student performance on the Exit Level Science TAKS test, measured by the percentage of students who met standard by campus. The independent variable is teacher quality defined by: degree level, certification type(s), and years of teaching experience. These data are collected by TEA and SBEC and these data, in addition to student performance and enrollment, are stored in PEIMS. These data were made available through public information requests of the Texas Open Records Act (see Appendices B-E for the request forms and the correspondences from TEA). These requests resulted in files containing information on all of the teachers employed in Texas in the fall 2009 data snapshot. The snapshot date is an official Texas designation and is a floating date that occurs in the fall semester, but the specific date is not made public due to policy considerations. The combination of these files provided years of experience, teaching certification(s), highest degree attained, content area assignment(s), and additional information used in PEIMS to describe each teacher. The files provided all data except teacher certifications, which were collected only once on the snapshot date in the fall of 2009, and that certification files were updated continually by SBEC. These data were converted into frequency values and then converted to percentages at the campus level in order to create a predictive model for student performance at the campus level.

Dependent Variable: Student Performance

Student performance on the Exit Level Science TAKS test was part of the data held by TEA, and enrollment information and performance were kept in the PEIMS database. The student data for performance on the Exit Level Science TAKS test is only available when grouped by school to protect the identities of students and teachers alike. Data collected reflect the performance and conditions from the 2009-2010 school year. The demographics of the students are broken down by percentage of the campus enrollment in the following categories: Asian, African American, Hispanic, Native American, and White (non-Hispanic). Students were also classified based on economic status (economically disadvantaged) and by participation in state approved programs for special education (SPED), gifted and talented (GT), English as a second language (ESL), or limited English proficient (LEP). The percentages passing for each of these subpopulations were reported. However, this study was only concerned with the passing rates for all students in the state of Texas; therefore the passing rates of each subpopulation were not used in the analysis. Some students were members of multiple subpopulations, providing the opportunity for the results to be confounded.

Independent Variables: Teacher Credentials

Research Question 1: *What is the correlation between the degree level held by high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?*

The base pay for teachers was determined by the number of years of teaching experience and highest degree attained. The highest degree attained by high school science teachers is maintained in the PEIMS database by the individual schools and is included in the data reported to TEA. The degree levels are recorded in four categories: no baccalaureate degree or higher, baccalaureate degree, master degree, and doctoral degree. Figure 1 is a graph depicting the percentage breakdown of all teachers by degree type. Data kept in PEIMS are reported to TEA on a snapshot date in the fall semester.

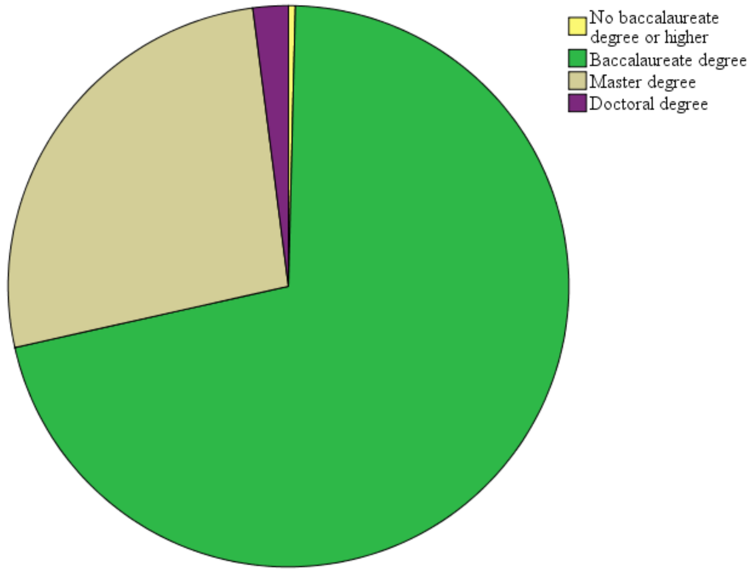

Figure 1. Distribution of science teachers in Texas by degree type. A large majority of teachers in Texas have met the minimum degree requirement, with diminishing amounts of teachers holding graduate-level degrees; 'no baccalaureate degree or higher' category is the smallest.

Any records updated after the state's snapshot date are not reflected in the data provided from TEA. Therefore, it is possible for a teacher to complete a degree during the school year, or transfer to a new school district without having all of the records updated in the PEIMS files prior to the snapshot and therefore not have these changes reported to TEA. The presence of the category 'no baccalaureate degree or higher' is an area of concern although the actual number of teachers without a degree cannot be disentangled from those who have a degree but it has not posted. The areas shown in red on Figure 2 indicate the regions in Texas where teachers were employed without a baccalaureate degree or higher as recorded in the PEIMS database as of the fall 2009 snapshot date. Texas Education Code 21.044 allows for educators in the fields of science, technology, engineering or mathematics (STEM) to be employed to teach an applied STEM course, if the individual holds a national certification in their field, a minimum of an associate's degree, and a minimum of three years of work experience in the field.

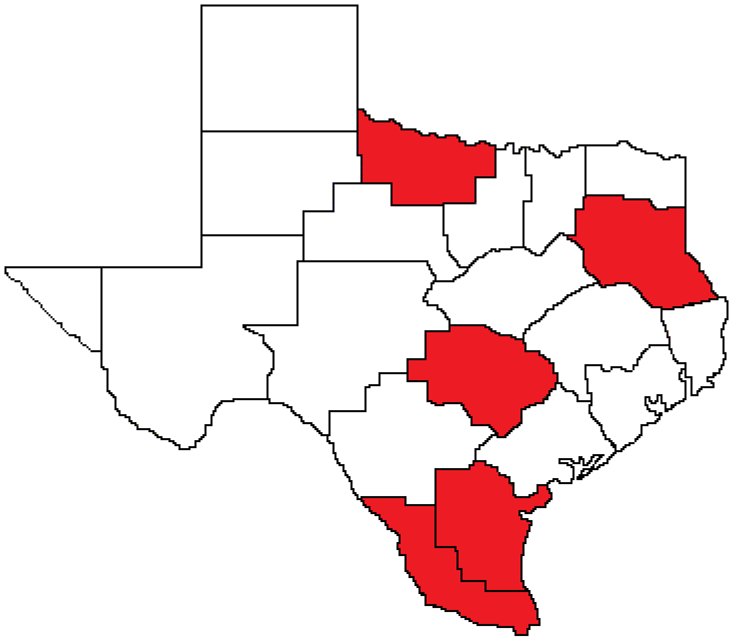

Figure 2. Regions of Texas where teachers without a baccalaureate degree or higher were employed. The regions in red reported 1-3% of the teachers employed as not having a baccalaureate degree or higher. The white regions of the map indicate areas in which all teachers employed were reported as having at least a baccalaureate degree. Adapted from the Texas Education Agency (TEA, 2011).

Research Question 2: *What is the correlation between the certification type(s) held by high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?*

Certification types are kept in SBEC files. Any administrative type certification held by science teachers were excluded from analysis because these data are not a focus of this study. Figure 3 shows the distribution of certifications held by teachers assigned to teach science. Non-science certifications that were not statistically significant at $\alpha = .10$ in the base multiple linear regression model were removed prior to creating the final model. The .10 significance level was used in the generation of the base model in order to allow a greater number of predictor variables to be used in the final model.

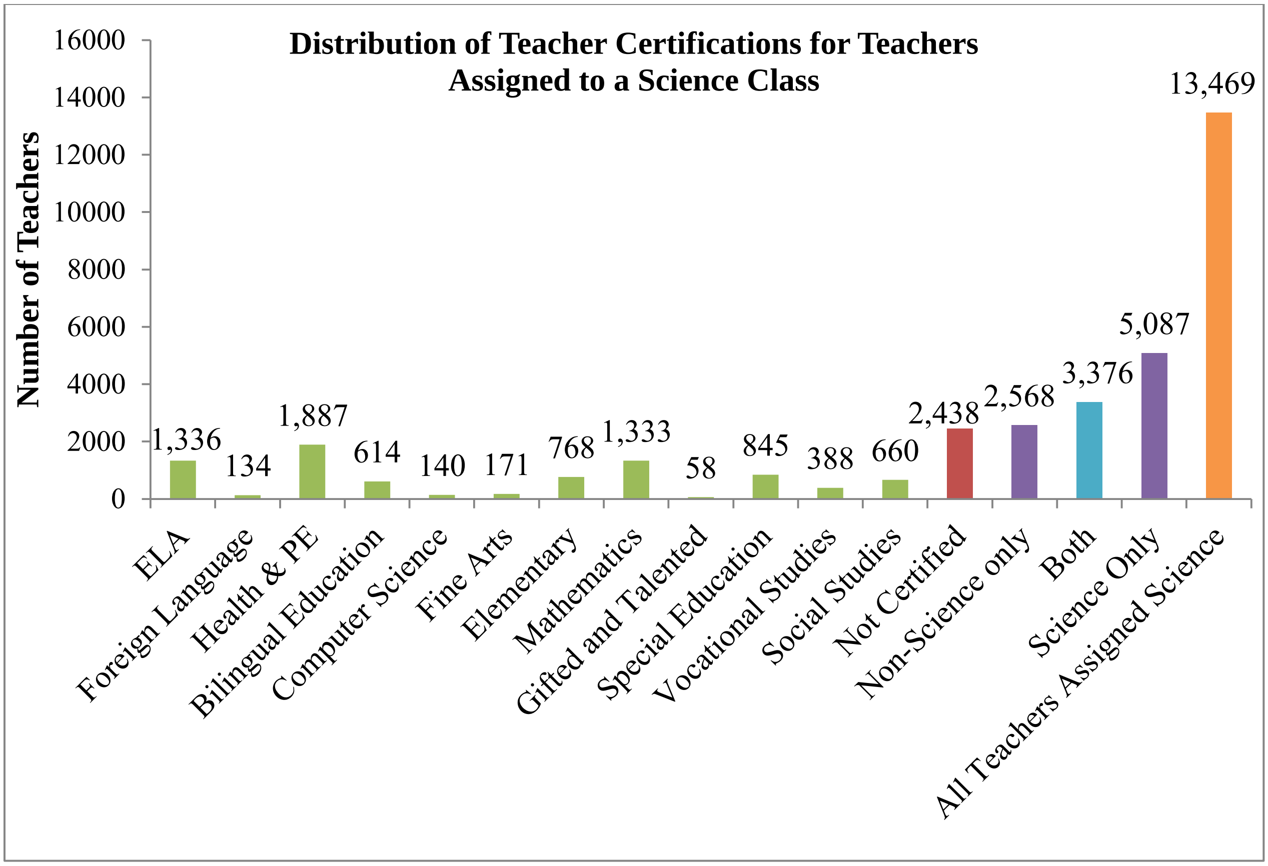

Figure 3. Distribution of teaching certificates of teachers assigned to science classes. The non-science subject area certifications are indicated in greeen. The category "both" represents teachers who have a science certification and a non-science certification that could be either another subject or an administrative certification. The non-science only category includes those who are not certified to teach science, but are certified in at least one of the non-science subjects shown in the graph or administrative categories (not shown).

There were 2,568 teachers who were certified to teach, but not certified to teach science. There were 2,438 teachers assigned to science classes that did not have any teaching certification on file with SBEC at any time during the 2009-2010 school year. Texas Education Code 21.055 allows for school districts to issue local teaching certifications for an individual to be able to legally teach (TEA, 2012). Under this statute, the school district is required to notify the state commissioner when this situation arises, although the data did not reflect local teaching certificates. Figure 4 is a map indicating where the concentrations of science teachers without state teaching certifications were reported.

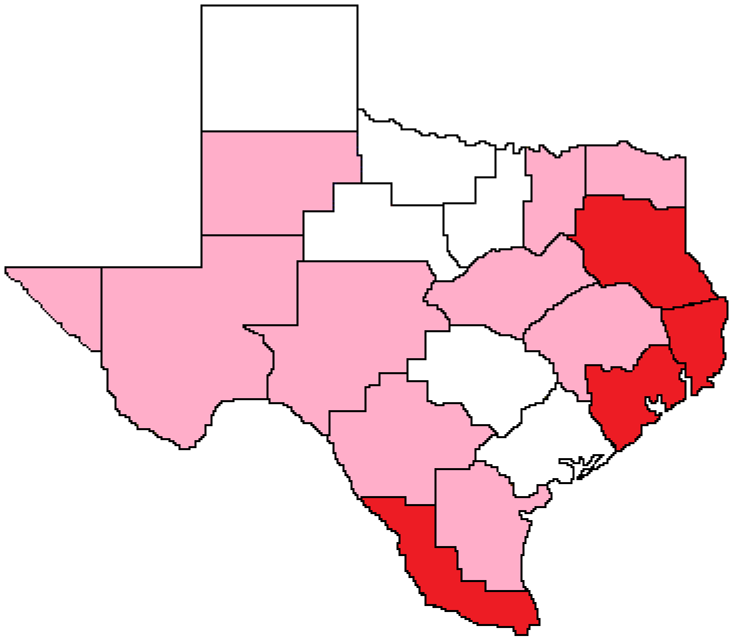

Figure 4. Concentration of science teachers without a state teaching certificate. The red areas represent 21-25% of the science teachers employed in a region who do not hold a valid teaching certificate in Texas. The pink areas represent 16-20% of the science teachers employed in a region who do not hold a valid teaching certificate in Texas. The white areas represent 11-15% of the science teachers employed in a region who do not a valid teaching certificate in Texas. None of the regions in Texas reported more than 90% of the employed science teachers as holding valid state-level teaching certificates. Adapted from the Texas Education Agency (TEA, 2011).

The distribution of science certifications are divided into certifications issued prior to the changes made to certification law in 1999, which made specific regulations for entry into teacher preparatory programs. This distribution is shown in Figure 5 with the blue portion reflecting the certification types that were discontinued in 1999 and red portion reflecting the certification types that were created in 1999. The SBEC files are updated continuously and should reflect any certification held prior to the beginning of or issued during the 2009-2010 school year. All influential certifications were evaluated in the final model with $\alpha = .05$ for interpretation in order to reduce the probability of Type I errors in the conclusions from the final model.

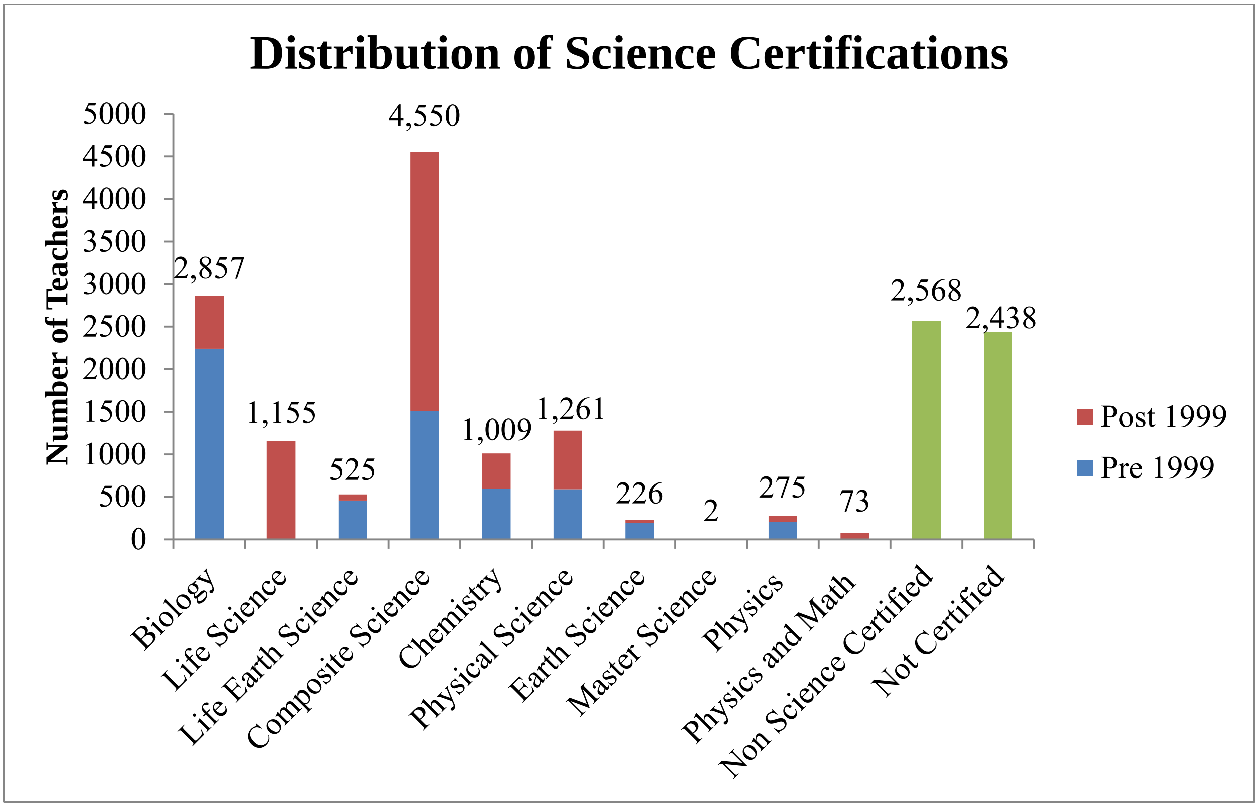

Figure 5. Distribution of science certifications held by science teachers. The type of teaching certificate available to teachers changed in 1999. Certifications issued prior to 1999 were lifetime certificates without course and grade point average (GPA) entrance requirements for admission to a teacher preparatory program. Certifications issued after 1999 must be renewed periodically and require continued professional education credits (CPE) of 150 clock-hours over five years for renewal.

Research Question 3: *What is the correlation between categories of the number of years of teaching experience with the percentage of students on the Exit Level Science TAKS test who met standard?*

Years of teaching experience were divided into four categories: novice teachers with 0-4 years of experience, early-career teachers with 5-10 years of experience, middle-career teachers with 11-20 years of experience, and full-career teachers with 21 or more years of teaching experience and is shown in Figure 6. These data are maintained in PEIMS and therefore teachers transferring from other states may not have received credit for years of teaching prior to the fall snapshot date.

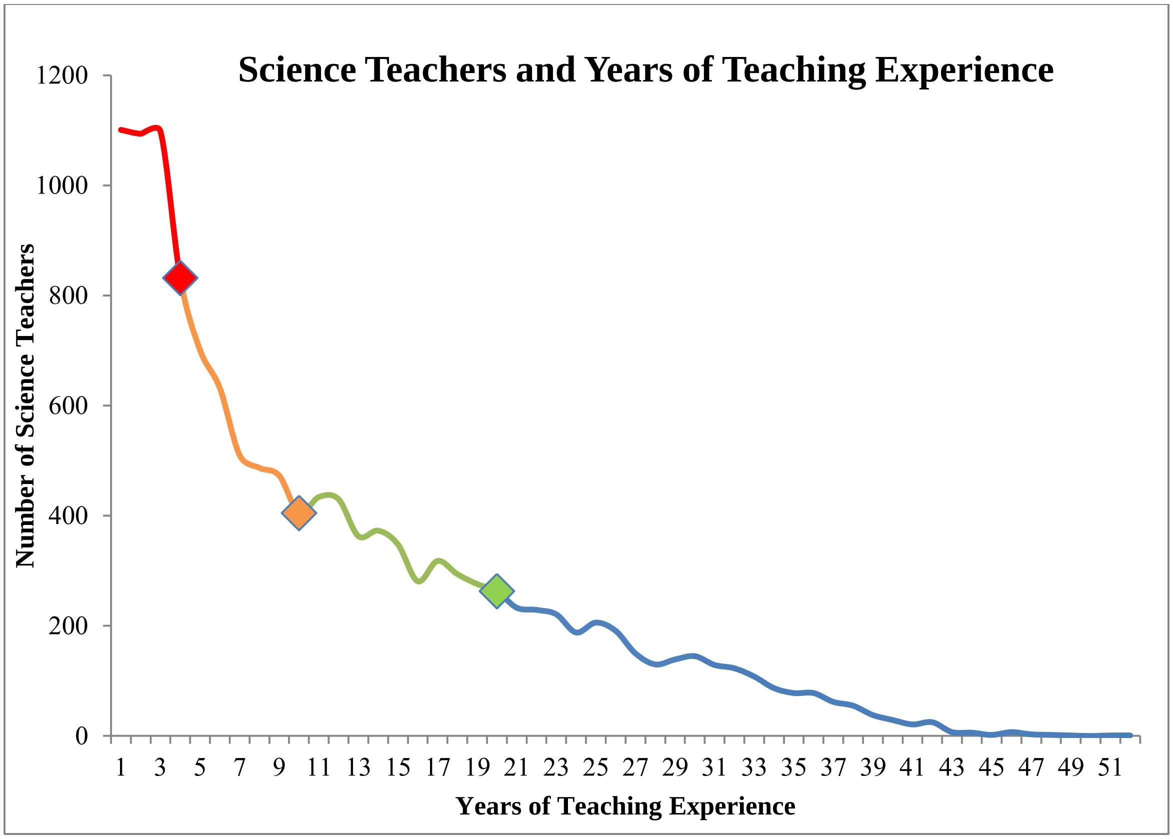

Figure 6. Science teachers and years of teaching experience. The red portion of the graph represents novice teachers with 0-4 years of teaching experience (*n* = 4,835). The orange portion represents early-career teachers with 5-10 of teaching experience (*n* = 2,959). Middle-career teachers with 11-20 years of teaching experience are represented in green (*n* = 4,044). The blue section represents full-career teachers with 21 or more years of teaching experience (*n* = 1,738).

Research Question 4: *What combination of degree level (no baccalaureate or higher, baccalaureate, master, or doctoral), certification type (GT, non-science, not certified composite science/science, life science, physical science, or science subject specific), and years of teaching experience (novice, early-career, middle-career, or full-career) show a significant relationship with student achievement as measured by scores on the Exit Level Science TAKS test?*

Of the 13,469 science teachers at the high school level assigned to a campus that administers the Exit Level Science TAKS test (Grade 11), 2,438 (18.1%) teachers were uncertified, 53 (0.4%) teachers did not have a degree on file with the state of Texas at the time of the snapshot date, and 7,891 (58.6%) teachers assigned to at least one science class were female.

Table 3 breaks down categories of teachers without a baccalaureate degree or higher into those holding a state teaching certification or not being state certified. The question regarding the concentration of the high school science teachers who do not have either a certification or minimum of a baccalaureate degree or higher is addressed in Table 4, which indicates the percentage of these 20 teachers employed in each of these selected regions. Figure 7 is a graph of the average years of experience by degree type. Figure 8 is a chart showing the number of teachers by years of experience with a separate graph for each degree type. What is interesting about Figure 8 is that the remarkable drop off at year 4 for teachers holding a baccalaureate degree is not accompanied by an increase of teachers holding graduate-level degrees.

Table 3

Distribution of Teachers Based on Minimum Requirements

	State Certified (%)	Not State Certified (%)
Baccalaureate or higher	10,997 (81.6 %)	2,418 (18.0%)
No baccalaureate or higher	34 (0.3%)	20 (0.1%)

Table 4

Distribution of High School Science Teachers without State Certification or Baccalaureate Degree

Region Number	Number of teachers without a degree or a baccalaureate or higher
1	6 (30%)
2	1 (5%)
4	3 (15%)
7	1 (5%)
9	1 (5%)
10	1 (5%)
11	3 (15%)
13	2 (10%)
20	2 (10%)

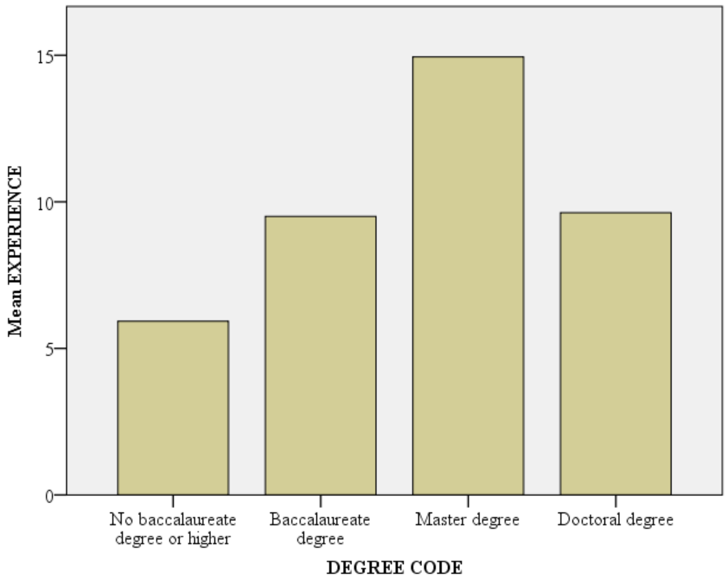

Figure 7. Average years of experience by degree type. On average, teachers with master degrees tend to have the most experience, followed by baccalaureate and doctoral degrees.

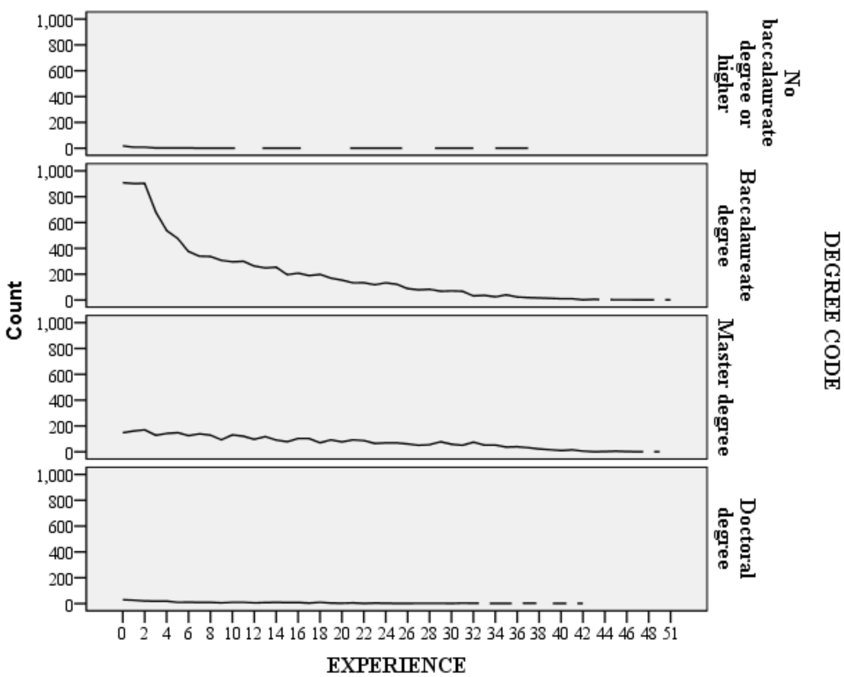

Figure 8. Distribution of teachers versus years of experience divided by degree level. A large number of beginning teachers with baccalaureate degrees do not continue teaching after five years. A possible interpretation is that many teachers are lost from this profession as seen by the dramatic drop, which is not accompanied by an increase in the graduate degrees after 4 years.

Data Preparation Method for Analysis

The data set requested by the Texas Open Records Act was received in various forms. The first set of files included two separate Microsoft (MS) Excel® spreadsheets from TEA. One of the files listed the district, campus, degree level, total years of experience, tenure (years of experience at that campus), and a scrambled identification code. The second file included teaching assignments, base pay, other pay (stipend pay), total pay, full-time equivalent status, and campus information for teachers based on the same scrambled identification code as the first file. These files were merged together based on the scrambled identification codes.

The second set of files included the teacher rolls for all teachers in the state of Texas from the PEIMS database. These files were received in separate text files, broken down by region. These files were imported into one MS Excel® file. This combined file contained all of the information provided in the previous files with the exception of the specific course assignment. In addition, this file also contained district and campus demographic information, teacher demographic information (see Table 2), teacher roll, and all departmental assignments for all teachers in Texas of which only the high school science teachers were selected.

The data from SBEC included information regarding certification such as: certification validity dates, credentialed subject, and type of certification. This file used the same scrambled identification codes as the second set of data. The value lookup function MS Excel® allows for items with unique identification codes in separate files to be merged into one file. However, the codes provided by SBEC included asterisks (*) causing the value lookup function in MS Excel® to not function reliably because the program read the asterisk as allowing any value in that place, therefore a third identification code was assigned to these individuals. A separate spreadsheet was created for each subject area certification. The value lookup function was used on the combined sheet to identify if a teacher had a specific certification.

The Exit Level Science TAKS scores for each campus were then added to the master file, in which all of the other files were combined, linked by the campus number assigned to each teacher. Teachers assigned to campuses without Exit Level Science TAKS scores were removed from the file. Next all teachers who were not assigned at least one section of science were also removed. Binary coding was used for gender, the experience-level divisions, and the degree types prior to the file being imported into IBM® SPSS® Statistics Version 20 (SPSS®). A new randomized identification value was assigned to each teacher. The teacher credentials, including experience division, gender distribution, and certification types were averaged at the campus level to give a ratio for each campus on each trait. This ratio was then converted to a percentage, allowing for these values to be treated as continuous variables.

Removal of Outliers

Two criteria were used to exclude teachers from analysis. The first level of exclusion was for 61 teachers whose school's TAKS data were incomplete for various reasons. The second level of exclusion of data was based on the evaluation of the DFITS values and the Cook's D. Since the data were aggregated at the campus level, all teachers at the same campus will have identical values for both DFITS and Cook's D.

The DFITS values and Cook's D values are calculated in the SPSS® program using the base linear regression model. The change in model fit that results when an observation is removed from the model can be evaluated using the standardized DFITS statistic (Belsley, Kuh, & Welsch, 1980). Cook's D is a function of the multiplicative relationship between leverage and discrepancy values for each observation. Leverage is a function of the relationship between the independent variables. The discrepancy value is a function of the difference between the predicted and observed value for each observation (Allen, 1997). The general guideline to identify possible outliers are cases with DFITS values greater than $2\sqrt{(K+1)/n}$, where K is the number of parameters and n is the number of cases. The Cook's D values are compared to the $F(\propto; K+1, n-K-1)$ value in the determination of potential outliers (Dielman, 2005).

Upon analysis of the potential outliers identified through both Cook's D and DFITS, 213 teachers were removed, leaving a usable population of 13,206 teachers and population retention of 98%, making this a population study, not a sample study. This means that these results are only generalizable to the high school science teachers and their students. The purpose of the assumptions used in regression is to ensure that the sample adequately reflects the population. Since the sample used in this study is 98% of the population, the conclusions of this analysis are applicable to the population without testing the assumptions (Allen, 1997).

Data Validity

Data obtained directly from TEA, SBEC, and PEIMS should be the most representative of the target population, being all Texas high school science teachers and their students. A cluster sampling method was used for both the teacher and student data by grouping the information by school. The desired information about the members of the target population was tracked by the state and the data from the state agencies should provide a reasonable representation of the target population.

CHAPTER 4

RESULTS

Overview of Statistical Procedures

Teacher information measured by degree level, certification, and years of teaching experience aggregated by school were compared to student performance by school on the Exit Level Science Texas Assessment of Knowledge and Skills (TAKS) test distributed by school using IBM® SPSS® Statistics Version 20 (SPSS®) software. A canonical correlation analysis (CCA) was performed to determine if variance in teacher credentials explained differences in teacher total pay and student performance to equal extents. Due to the results from the CCA, it was discovered that additional variables, such as demographic information of the individual schools, may be required to better understand the impact of teacher information measured by degree level, certification, and years of teaching experience upon the Exit Level Science TAKS test. Multiple linear regression analysis was used to identify statistically significant demographic variables that could potentially influence the Exit Level Science TAKS scores in the demographic model. Upon the creation of the demographic model, all teacher credential values were included along with the predictor variables from the demographic multiple linear regression model to determine statistically significant non-science teaching certifications, determine potential outliers, and form the base model. The base model was used to identify potential outliers before the final analysis to determine the values of the teacher credential predictor variables and their coefficients. The standardized coefficients were used in the comparison of the predictor variables and the unstandardized coefficients were used in the development of the predictive multiple linear regression equation.

Canonical Correlation Analysis

A CCA was conducted using four descriptive teacher criteria (degree code, any science certification, not certified at all, and years of experience) as predictors of the two outcome variables (products), total pay and percent met standard, or percentage of students who demonstrated successful passing performance on the TAKS test, to evaluate the multivariate shared relationship between the two variable sets (i.e., teacher criteria and products). Total pay is the combination of base pay and stipend pay. The analysis yielded two functions with squared canonical correlations (R_c^2) of 0.426 and 0.005. Collectively, the full model across both functions was statistically significant using the Wilks's λ = 0.57148 criterion, $F(8, 26804) = 1{,}081.58913$, $p < .001$. The full model effect size is calculated using 1 – λ in an r^2 metric because Wilks's λ represents the variance unexplained by the model. Thus, the r^2 type effect size for the two canonical functions is 0.43, which indicates that the full model explained about 43% of the variance shared between the two variable sets.

The dimension reduction analysis allows the researcher to test the hierarchal arrangement of functions for statistical significance. As noted, the full model (Functions 1 to 2) was statistically significant. Function 2, the only function tested in isolation and therefore the only function that can be discussed individually, did not explain a significant amount of the variance between the two variable sets, $F(3,13403) = 22.50950$, $p < .001$. Given the R_c^2 effects for both functions, the first function was the only one that was considered noteworthy in the context of this discussion (42.6%). Table 5 represents the standardized canonical function coefficients and structure coefficients for Functions 1 and 2. The squared structure coefficients are also given with the communalities across the two functions for each variable. Looking at the Function 1 coefficient, one sees that the relevant criterion variable was primarily total pay. This conclusion was supported by the squared structure coefficients.

Total pay also tended to have the larger function coefficient. All of the structure coefficients for the product variable group had a positive sign, indicating that they were positively related. Regarding the predictor variable set for Function 1, the amount of experience a teacher had was the primary contributor. There was a negative relationship associated with a teacher not having any type of certification. Therefore, it was determined that an additional analysis should be performed that used demographic information to form a demographic multiple linear regression model prior to the evaluation of the research questions in order to increase the amount of variance explained in the percentage of students who met standard.

Table 5

Canonical Solution for Teacher Credentials Predicting Outcomes for Functions 1 and 2

	Function 1			Function 2			
Variable	function coefficient	structure coefficient	squared structure	function coefficient	structure coefficient	squared structure	communality coefficient
Percent Passing	0.05938	0.12649	1.6	1.0053	0.99197	98.4	100
Total Pay	0.99424	0.99824	99.6	-0.12678	-0.05924	0.4	100
R_c^2			42.6			0.5	43.1
Degree Code	0.15609	0.34859	12.2	0.00896	0.00211	0.0	12.2
Any Science Certification	0.1008	0.28084	7.9	0.2483	0.71387	51.0	58.8
Not Certified At All	-0.04055	-0.37736	14.2	-0.86256	-0.89827	80.7	94.9
Experience	0.92217	0.98014	96.1	-0.40642	-0.11787	1.4	97.5

Description of Demographic Regression Model

Determination of significant demographic information was evaluated through the use of forward stepwise multiple linear regression with demographic variables as the predictors for percentage of students who met standard on the Exit Level Science TAKS test. The following independent variables and the order of entry: percentage of students enrolled at each campus who were reported as economically disadvantaged, campus type (instructional campus and alternative instruction unit), percentage of students participating in a state-approved special education (SPED) instructional program or a regular education program using special education support services, supplementary aids, or other special arrangements, percentage of students participating in a state-approved career and technology education course, or participating in a state-approved programs English as a second language (ESL) program, percentage of students reported as African American, percentage of students reported as Hispanic, percentage of high school science teachers who are female, average base pay, percentage of students participating in a state-approved career and technology education course, percentage of students reported as Asian, percentage of students participating in a state-approved gifted and talented (GT) program, and average stipend pay. The predictor variables describing the percentages of students classified as Native American and students enrolled in state approved bilingual education programs were excluded from the model by the statistical software, SPSS®, and therefore were not included in the subsequent models. This regression model served as the demographic model that was used to evaluate the teacher credential variables. The standardized coefficients were used for comparison between the variables and the unstandardized coefficients were used in the predictive multiple linear regression equation.

Description of Base Model

The influential out-of-field certifications were next to be identified by adding all teacher credential variables, including degree level, certification teaching fields (science, out-of-field teaching certification, and not certified at all), and experience categories (novice, early-career, middle-career, and full-career) to the demographic model along with a collinearity diagnostic to determine the base model. The baccalaureate degrees and novice teacher categories were removed by SPSS® and are to be treated as the baseline for comparison. The out-of-field variables were evaluated with the significance level of $\alpha = .10$ in the creation of the base model, instead of the standard $\alpha = .05$ to allow for more predictor variables to be available for incorporation into the final model. Table 6 includes the values for the non-science teaching certifications and the *p* values greater than .10 have been bolded. The certification predictor variables for teaching certifications in computer science, fine arts, foreign language, mathematics, and social studies were removed from the base model prior to creating the third regression model, which was used to identify cases as potential outliers. The variance inflation factor (VIF) is a measure the amount of correlation between predictor variables, called collinearity. Hare et al. (2010) recommends designing a model where the VIF values are below 10. The VIF values were all under 3 in this model indicating that the assumption of non-multicollinearity required for regression analysis has been met.

Table 6

Evaluation of Non-Science Certifications Using the Demographic Model to Determine Significant Contributions

Demographic Model with Credential Variables	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.	Collinearity Statistics	
	β	Std. Error	*β*			Tolerance	VIF
Bilingual Ed.	-0.025	0.006	-0.024	-4.019	0.000	0.802	1.247
Computer Science	0.021	0.013	0.009	1.615	**0.106**	0.925	1.081
ELA	-0.049	0.005	-0.084	-9.941	0.000	0.415	2.412
Fine Arts	0.016	0.013	0.007	1.262	**0.207**	0.845	1.184
Foreign Language	-0.020	0.015	-0.008	-1.358	**0.175**	0.879	1.138
Elementary	0.013	0.005	0.015	2.398	0.017	0.786	1.272
Health and PE	-0.015	0.004	-0.025	-3.620	0.000	0.602	1.660
Mathematics	-0.001	0.005	-0.001	-0.107	**0.915**	0.557	1.795
GT	-0.056	0.020	-0.015	-2.768	0.006	0.937	1.068
SPED	-0.010	0.005	-0.011	-1.821	0.069	0.796	1.256
Vocational Studies	0.017	0.007	0.015	2.579	0.010	0.843	1.186
Social Studies	0.008	0.006	0.008	1.256	**0.209**	0.815	1.226
None	-0.022	0.005	-0.040	-4.838	0.000	0.428	2.338

Assessment of Outliers

A third multiple linear regression analysis was performed to determine the influence statistics from the standardized design, fabrication, and integration and test (DFITS) values and Cook's distances (Cook's D) for each case with the following certification predictor variables removed: computer science, fine arts, foreign language, mathematics and social studies. Inspection of the coefficients was made to determine that the *p* values of the non-science certification variables still met the criteria of being significant with α = .10. Additionally, the VIF values were evaluated to confirm that they remained below 10 to ensure that multicollinearity did not appear between the predictor variables prior to the assessment of potential outliers. The DFITS reference value used for this population is |0.10218| and the Cook's D for this population is 0.0002991. The DFITS criterion could potentially exclude 202 teachers, which represented approximately 1.5% of the population and 99 (7.6%) of the campuses. The Cook's D criterion could potentially exclude 787 teachers (5.8%), representing 241 (18.5%) campuses. Potential outliers were then identified using the DFITS criterion due to the higher population retention.

Regression Analysis of Research Questions

A final regression model was determined after the removal of outliers from the analysis. The predictor variables in the final multiple linear regression model included the statistically significant demographic variables determined from the demographic model, the statistically significant non-science teaching certifications determined from the base model, degree categories, science teaching certifications, and experience categories for the campus percentages, weighted by the number of teachers at each campus to predict the percentage of students who met standard on the Exit Level Science TAKS test. The sample multiple correlation coefficient, commonly referred to as R^2, was 0.607, indicating that approximately 60.7% of the variance of the percentage of students who met standard can be accounted for by the linear combination of these variables within the final model. The sample in this case, represents 98% of the population. Therefore the sample multiple correlation coefficients are useful for almost all of this population. Table 7 provides the statistics from the final multiple linear regression model for the predictor variables that were retained from the demographic model and Table 8 provides the confidence intervals and collinearity values.

Table 7

Demographic Variables Beta Weights and Significance

Final Model	Unstandardized Coefficients β	Unstandardized Coefficients Std. Error	Standardized Coefficients B	t	Sig.
(Constant)	120.557	0.751		160.608	0.000
Students reported as Asian	0.033	0.008	0.028	4.093	0.000
Students reported as African American	-0.091	0.003	-0.219	-26.964	0.000
Students reported as Hispanic	-0.052	0.003	-0.232	-17.783	0.000
Students reported as economically disadvantaged	-0.065	0.004	-0.237	-17.529	0.000
Students in an ESL program	-0.183	0.009	-0.165	-20.994	0.000
Students in a career and technology course	0.027	0.003	0.069	10.391	0.000
Students in a GT program	0.026	0.005	0.030	4.786	0.000
Students in a SPED program	-0.220	0.012	-0.127	-17.710	0.000
Campus Type	-22.083	0.326	-0.392	-67.838	0.000
Average Base Pay	0.000	0.000	0.053	6.592	0.000
Average Stipend Pay	0.000	0.000	-0.026	-4.430	0.000
Percentage of teachers female	-0.024	0.003	-0.059	-9.754	0.000

Table 8

Demographic Variables Confidence Intervals and Collinearity

Final Model	95.0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	119.086	122.028		
Students reported as Asian	0.017	0.049	0.620	1.613
Students reported as African American	-0.098	-0.085	0.451	2.217
Students reported as Hispanic	-0.057	-0.046	0.175	5.699
Students reported as economically disadvantaged	-0.072	-0.058	0.163	6.135
Students in an ESL program	-0.200	-0.166	0.483	2.070
Students in a career and technology course	0.022	0.032	0.681	1.469
Students in a GT program	0.015	0.037	0.761	1.313
Students in a SPED program	-0.245	-0.196	0.582	1.719
Campus Type	-22.721	-21.445	0.892	1.121
Average Base Pay	0.000	0.000	0.460	2.174
Average Stipend Pay	0.000	0.000	0.852	1.174
Percentage of teachers female	-0.029	-0.020	0.809	1.236

Research Question 1

What is the correlation between the degree level held by high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

The contribution of the degree type was statistically significant for both of the graduate degrees with α = .05 within the final model. The coefficients and significance are reported in Table 9 for the individual components within the final model. There is not a statistically significant difference between the two types of graduate degrees. The percentages of teachers with graduate degrees are statistically significant in this regression model at the .05 level. The beta weight for a doctoral degree is greater than the beta weight for a master degree. This is most likely a compensation for the disparity between the numbers of teachers who have one of these two degrees listed as the highest degree attained. The percentage of teachers who had attained a baccalaureate degree was excluded from the model by SPSS® and is the point reference in this model. The VIF values for the degree levels that were included in the analysis were low, which is an indication that there are low interactions between these predictor variables and all of the predictor variables in this model. These beta weights are indicated in Table 9 and the VIF values are shown in Table 10.

Table 9

Degree Level Beta Weights and Significance

Final Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	β	Std. Error	*β*		
No baccalaureate degree	0.020	0.018	0.006	1.095	0.273
Baccalaureate degree	.a		*.b*		
Master degree	0.009	0.003	0.021	3.438	0.001
Doctoral degree	0.046	0.009	**0.030**	5.240	0.000

[.a] Excluded from model

[.b] Not included in the model, but point used in discussion

Table 10

Education Level Confidence Intervals and Collinearity Statistics

Final Model	95.0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
No baccalaureate degree	-0.016	0.055	0.964	1.037
Baccalaureate degree			0.000	
Master degree	0.004	0.015	0.819	1.222
Doctoral degree	0.029	0.063	0.903	1.107

[.a] Excluded from model

Research Question 1a. What is the correlation between high school science teachers not having a baccalaureate degree or higher with the percentage of students on the Exit Level Science TAKS test who met standard?

Teachers without baccalaureate degrees or higher were not statistically significant in the final multiple linear regression analysis used to predict the percentage of students who met standard on the Exit Level Science TAKS test; therefore, there in not a statistically significant relationship between these two variables. The low percentage of teachers in this category did not impact the overall model enough to influence student performance on the Exit Level Science TAKS test.

Research Question 1b. What is the correlation between high school science teachers having a baccalaureate degree with the percentage of students on the Exit Level Science TAKS test who met standard?

Teachers with baccalaureate degrees were removed from the multiple linear regression model by SPSS® and therefore are not statistically significant in the multiple linear regression analysis used to predict the percentage of students who met standard on the Exit Level Science TAKS test. This variable is considered the point of reference in the evaluation of the total model.

Research Question 1c. What is the correlation between high school science teachers having master degrees with the percentage of students on the Exit Level Science TAKS test who met standard?

There is a statistically significant relationship between teachers with master degrees and the percentage of students who met standard on the Exit Level Science TAKS test. This relationship is positive, indicating that students benefit from teachers holding master degrees.

Research Question 1d. What is the correlation between high school science teachers having doctoral degrees with the percentage of students on the Exit Level Science TAKS test who met standard?

There is a statistically significant relationship between teachers with doctoral degrees and the percentage of students who met standard on the Exit Level Science TAKS test. This relationship is positive with the largest beta weight, indicating that students benefit most from teachers holding doctoral degrees. Although small in number, this group of teachers is making a significant positive difference.

Research Question 2

What is the correlation between the certification type(s) held by teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

Many teachers assigned to teach high school science are also certified and/or assigned to teach in a variety of other content areas. In addition to holding several different content area certifications, many teachers hold multiple types of science certifications, or hold a single composite science certification and qualify to teach all science courses at the secondary level. These values were recorded using a binary code and then converted to percentage values at the campus level. The non-collinearity assumption of multiple linear regression has also been met for these predictor variables, as seen in Table 14. This means that the ability to associate the variance in these predictor variables with the variance in the dependent variable is not hindered by covariance between the predictor variables included in the final statistical model.

Research Question 2a. What is the correlation between high school science teachers with non-science certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

Many science teachers are also qualified to teach subjects other than science, specialized populations, or do not have a certification on file with SBEC. Some of the out-of-field certifications that were statistically significant in the base model at the $\alpha = .10$ level were no longer statistically significant at that level once the outliers had been removed from the sample as seen in Table 11. The out-of-field certifications that remained statistically significant in the final model were bilingual education, English language arts (ELA), elementary, health and physical education (PE), and special education. The GT supplemental certification was not statistically significant in the final model. All of the non-science certifications have negative beta weights with the exception of the elementary education certification, which has been bolded in Table 11. The largest negative beta weight is for the ELA certification and had italicized in Table 11. The low collinearity statistics seen in Table 12 are indicators that the amount of covariance of these predictor variables is minimal across the final model.

Table 11

Non-Science Beta Weights and Significance

Final Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	β	Std. Error	*β*		
Bilingual Education	-0.027	0.006	-0.029	-4.700	0.000
ELA	-0.039	0.004	*-0.078*	-9.263	0.000
Elementary	0.011	0.005	**0.014**	2.261	0.024
Health and PE	-0.011	0.004	-0.021	-2.992	0.003
GT	-0.012	0.021	-0.003	-0.606	0.545
SPED	-0.021	0.005	-0.027	-4.454	0.000
Vocational Studies	0.010	0.006	0.009	1.580	0.114
No Certification	-0.013	0.004	-0.026	-3.355	0.001

Table 12

Non-science Confidence Intervals and Collinearity Statistics

Final Model	95.0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
Bilingual Education	-0.038	-0.016	0.805	1.242
ELA	-0.048	-0.031	0.418	2.394
Elementary	0.001	0.021	0.789	1.268
Health and PE	-0.018	-0.004	0.592	1.689
GT	-0.053	0.028	0.938	1.066
SPED	-0.030	-0.012	0.812	1.232
Vocational Studies	-0.002	0.021	0.845	1.183
No Certification	-0.021	-0.006	0.480	2.085

Research question 2b. What is the correlation between non-certified high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

Non-certified teachers produced statistically significant results with a negative beta weight. The beta weight for teachers without any teaching certification on file with SBEC was almost equal to the beta weight of teachers with certifications in health and PE, but was not the most negative beta weight in the certification category.

Research question 2c. What is the correlation between composite science/science certified high school science teachers with the percentage of students on the Exit Level Science TAKS test who met standard?

The relationship between the percentages of high school science teachers at a campus who hold the generic composite science/science teaching certifications with the percentage of students who met standard on the Exit Level Science TAKS test is statistically significant, as seen in Table 13. The composite science/science certification produced a beta weight of -0.029, indicating a negative relationship with student performance. Although this relationship is negative, this is the smallest negative beta weight and the second highest beta weight for the science certifications.

Table 13

Science Certification Beta Weights and Significance

Final Model	Unstandardized Coefficients β	Unstandardized Coefficients Std. Error	Standardized Coefficients β	t	Sig.
Biology	-0.023	0.003	*-0.052*	-7.032	0.000
Chemistry	-0.006	0.005	-0.007	-1.147	0.251
Life Science	-0.022	0.005	-0.031	-4.822	0.000
Life Earth Science	-0.032	0.006	-0.032	-5.406	0.000
Physical Science	0.032	0.004	**0.045**	7.449	0.000
Composite Science	-0.010	0.003	-0.029	-3.652	0.000
Science Other (Physics and Mathematics, Physics, Master Science, Earth Science)	0.005	0.006	0.005	0.800	0.424

Table 14

Science Certification Confidence Intervals and Collinearity Statistics

Final Model	95.0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
Biology	-0.030	-0.017	0.550	1.820
Chemistry	-0.016	0.004	0.757	1.320
Life Science	-0.032	-0.013	0.741	1.350
Life Earth Science	-0.043	-0.020	0.843	1.187
Physical Science	0.023	0.040	0.821	1.218
Composite Science/Science	-0.015	-0.005	0.486	2.056
Science Other (Physics and Mathematics, Physics, Master Science, Earth Science)	-0.007	0.016	0.887	1.128

Research question 2d. What is the correlation between high school science teachers with life science certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

The percentage of teachers holding a life science certification has a statistically significant negative relationship with the percentage of students who met standard on the Exit Level Science TAKS test.

Research question 2e. What is the correlation between high school science teachers with physical science certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

The statistically significant science teaching certification that produced the only positive beta weight described the relationship between the percentage of high school science teachers who held physical science teaching certificates and the percentage of students who met standard on the Exit Level Science TAKS test.

Research question 2f. What is the correlation between high school science teachers with subject specific certifications with the percentage of students on the Exit Level Science TAKS test who met standard?

The categories that described subject-specific science teaching certifications included biology, chemistry, and science other. The category science other represented the combination of physics and mathematics, physics, master science, and earth science. The combination of the certifications in the science other category represented 4.8% of the science certificate subject types. The chemistry certificates represent 8.5% of the science subject area certificates. Neither of these groups was statistically significant at the .05 level. This may have to do with the availability of these certifications due to being newer tests or the number of teachers seeking these certifications. The biology and life earth science certifications were the only subject specific science certification that showed a statistically significant relationship with the percentage of students who met standard on the Exit Level Science TAKS test. The relationship between the percentage of students who met standard and teachers with a biology certification produced the most negative standardized beta weight in this category, as seen in Table 13.

The life earth science certification type had the largest negative unstandardized coefficient and contributes the most negative impact on the unstandardized predictive model. The variances of the variables are set to 1 in order to compare the standardized coefficients between variables when variables with different units or scales are used, such as teacher credentials and student demographic data. Therefore, while the life earth science certification type will have a greater weight in the predictive multiple linear regression equation using the unstandardized beta coefficients, the standardized comparison between the life earth science certification and biology certification indicates that the biology certification has a more negative influence on student performance when variances are considered equal.

Research question 2g. What is the difference in the type of certification held by high school science teachers measured by the percent of students on the Exit Level Science TAKS test who met standard?

At the time of this study, most of the subject specific-science teaching certifications were relatively new and not represented by a large enough portion of the population to become influential in the multiple linear regression model used to predict the percentage of students who met standard on the Exit Level Science TAKS test, with the exception of the biology certification. The broader certifications, life science and physical science, were both statistically significant at the .05 level. The physical science certification was the only certification with a positive beta weight, and is interpreted as the certification most related to student success, measured by the percentage of students who met standard on the Exit Level Science TAKS test. The life science certification produced a relatively large negative beta weight, indicating a stronger negative relationship with the percentage of students who met standard on the Exit Level Science TAKS test than the other certifications used in this analysis. The most general certification, the composite science/science certification category, which allows for teachers to be credentialed to teach all sciences, was statistically significant and the beta weight of -0.029 indicates that a greater percentage of teachers with a teaching certificate in the composite science category has a negative relationship with the overall percentage of students who met standard on the Exit Level Science TAKS test at the campus level.

Research Question 3

What is the correlation between categories of the number of years of teaching experience with the percentage of students on the Exit Level Science TAKS test who met standard?

The years of teaching experience was broken down into the categories of novice teachers with 0-4 years of teaching experience, early-career teachers with 5-10 years of teaching experience, middle-career teachers with 11-20 years of teaching experience, and full-career teachers with 21 or more years of teaching experience. Of the five categories of teaching experience, only two of them were statistically significant at the .05 level, with one category, mid-career, indicating a positive relationship and the other category, full-career, indicating a negative relationship with the percentage of students who met standard on the Exit Level Science TAKS test. These relationships are shown in Table 15, and the confidence intervals and collinearity values for these predictor values are given in Table 16.

Table 15

Experience Level Beta Weights and Significance

	Unstandardized Coefficients		Standardized Coefficients		
Final Model	*β*	Std. Error	*B*	*t*	Sig.
Novice (0-4)	.a				
Early-career (5-10)	0.004	0.003	0.007	1.091	<u>.275</u>
Middle-career (11-20)	0.010	0.003	**0.022**	2.872	.004
Full-career (21 or more)	-0.018	0.004	*-0.037*	-4.528	.000

.[a] Excluded from model

.[b] Not included in the model, but point used in discussion

Table 16

Experience Level Confidence Intervals and Collinearity Statistics

	95.0% Confidence Interval for B		Collinearity Statistics	
Final Model	Lower Bound	Upper Bound	Tolerance	VIF
Novice (0-4)	0.000		0.000	
Early-career (5-10)	-0.003	0.010	0.744	1.345
Middle-career (11-20)	0.003	0.016	0.526	1.901
Full-career (21 or more)	-0.025	-0.010	0.453	2.207

.[a] Excluded from model

.[b] Not included in the model, but point used in discussion

Research question 3a. What is the correlation between novice high school science teachers with 0-4 years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

The 4,835 (35.9%) novice teachers were removed from the model by SPSS® and these relationships can be interpreted as investigating the changes that are seen when more experienced teachers are in the classroom, as indicated in Table 15.

Research question 3b. What is the correlation between early-career high school science teachers with 5-10 years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

Early-career teachers were not statistically significant in the final multiple linear regression model used to predict the percentage of students who met standard on the Exit Level Science TAKS test. This indicates that none of the teachers who have less than 10 years of teaching experience make a difference in the multiple linear regression model used to predict the percentage of students who met standard on the Exit Level Science TAKS test.

Research question 3c. What is the correlation between middle-career high school science teachers with 11-20 years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

The middle-career category was one of two experience categories with a *p* value that was statistically significant at the .05 level in this model as seen in Table 15. This is the only experience category with statistically significant positive relationship with the percentage of students who met standard on the Exit Level Science TAKS test.

Research question 3d. What is the correlation between full-career high school science teachers with 21 or more years of experience with the percentage of students on the Exit Level Science TAKS test who met standard?

The beta weight in Table 15 for the full-career category indicated a statistically significant negative relationship with the percentage of students who met standard on the Exit Level Science TAKS test.

Research Question 4

What combination of degree level (no baccalaureate or higher, baccalaureate, master, or doctoral), certification type (composite science, life science, physical science, science subject specific, GT, non-science, or not certified), and years of teaching experience (novice, early-career, middle-career, or full-career) show a significant positive or negative relationship with student achievement as measured by scores on the Exit Level Science TAKS test?

The interaction between all of the teacher credential variables were combined into a final multiple linear regression model with the total variance accounted for value, R^2, being 0.607. This means that the final model explains 60.7% of the variance in the percentage of students passing the Exit Level Science TAKS test. Tables 17 and 18 include the beta weights for the demographic predictor variables and the teacher credential predictor values that produced *p* values that were statistically significant at the .05 level in the final model. The predictor variables that were not statistically significant have been italicized, but not included in the discussion or final regression equation and do not have a variable designation. The largest positive beta weight is bolded and represents the percentage of students enrolled in a career and technology course. This indicates that a higher enrollment in career and technology courses has a positive relationship with students being successful on the Exit Level Science TAKS test, measured by the percentage of student who met standard. The most negative beta weight is underlined and represents the value for campus type. The campus types were coded 1 for an instructional unit and 2 for an alternative instructional unit. This indicates that schools identified as instructional units tend to have a larger percentage of students who met standard on the Exit Level Science TAKS test.

Table 17

Beta Weights and Significance Values for Demographic Values

Final Model	Variable in Equation	Unstandardized Coefficients β	Standardized Coefficients β	Sig.
(Constant)		120.557		.000
Students reported as Asian	x_1	0.033	.028	.000
Students reported as African American	x_2	-0.091	-.219	.000
Students reported as Hispanic	x_3	-0.052	-.232	.000
Students reported as economically disadvantaged	x_4	-0.065	-.237	.000
Students in an ESL program	x_5	-0.183	-.165	.000
Students in a career and technology course	x_6	0.027	.069	.000
Students in a GT program	x_7	0.026	.030	.000
Students in a SPED program	x_8	-0.220	-.127	.000
Campus Type	x_9	-22.083	-.392	.000
Average Base Pay	x_{10}	0.000	.053	.000
Average Stipend Pay	x_{11}	0.000	-.026	.000
Percentage of teachers female	x_{12}	-0.024	-.059	.000

The contributions of teacher credentials are listed in Table 18. A large portion of teachers (29.2%) have a baccalaureate degree and are novice teachers with 0-3 years of teaching experience. Both of these categories were removed from the model and therefore the final model indicates the changes that are predicted when teacher credentials deviate from either novice teachers or teachers with baccalaureate degrees as the highest degree attained.

Table 18

Contributions of Teacher Credentials in the Final Model

Final Model	Variable in Equation	Unstandardized Coefficients *B*	Standardized Coefficients *β*	Sig.
No baccalaureate degree		*0.020*	*0.006*	*0.273*
Baccalaureate degree		.a	.b	
Master degree	x_{13}	0.009	0.021	0.001
Doctoral degree	x_{14}	**0.046**	**0.030**	0.000
Bilingual Education	x_{15}	-0.027	-0.029	0.000
ELA	x_{16}	-0.039	-0.078	0.000
Elementary	x_{17}	**0.011**	**0.014**	0.024
Health and PE	x_{18}	-0.011	-0.021	0.003
GT		-0.012	*-0.003*	*0.545*
SPED	x_{19}	-0.021	-0.027	0.000
Vocational Studies		*0.010*	*0.009*	*0.114*
No Certification	x_{20}	-0.013	-0.026	0.001
Biology	x_{21}	-0.023	-0.052	0.000
Chemistry		*-0.006*	*-0.007*	*0.251*
Life Science	x_{22}	-0.022	-0.031	0.000
Life Earth Science	x_{23}	-0.032	-0.032	0.000
Physical Science	x_{24}	**0.032**	**0.045**	0.000
Composite Science	x_{25}	-0.010	-0.029	0.000
Science Other (Physics and Mathematics, Physics, Master Science, Earth Science)		*0.005*	*0.005*	*0.424*
Novice (0-4)		*.a*	*.a*	
Early Career (5-10)		*0.004*	*0.007*	*0.275*
Middle Career (11-20)	x_{26}	**0.010**	**0.022**	0.004
Full Career(21 or more)	x_{27}	-0.018	-0.037	0.000

.a Excluded from model

b Not included in the model, but point used in discussion

The most beneficial combination of credentials that were statistically significant or excluded from the model at the .05 level described teachers with a doctoral degree, elementary and physical science certifications, and 11-20 years of teaching experience. These predictor variables are bolded in Table 18. The least beneficial combination of credentials described teachers with the minimum state requirement of a baccalaureate degree, ELA and biology certifications and have 21 or more years of teaching experience, based on the standardized relationships. The beta weights for these credentials are underlined in Table 18. The total multiple linear regression model is:

$$y = 120.557 + 0.033x_1 - 0.091x_2 - 0.052x_3 - 0.065x_4 - 0.183x_5 + 0.027x_6 + 0.026x_7 - 0.220x_8 - 22.083x_9 + 0x_{10} - 0x_{11} - 0.024x_{12} + 0.009x_{13} + 0.046x_{14} - 0.027x_{15} - 0.039x_{16} + 0.011x_{17} - 0.011x_{18} - 0.021\,x_{19} - 0.013x_{20} - 0.023x_{21} - 0.022x_{22} - 0.032x_{23} + 0.032\,x_{24} - 0.010x_{25} + 0.010x_{26} - 0.018x_{27}$$

CHAPTER 5

DISCUSSION

Conclusions from Canonical Correlation Analysis

It is not a surprise that years of experience and the total pay that a teacher receives has a greater correlation than the relationship among the teacher degree level, number of certifications, and percent of students who met standard, or earned a passing score, on the Exit Level Science Texas Assessment of Knowledge and Skills (TAKS) test. Total pay is directly determined based on years of teaching experience using guidelines set by the local school board. Student performance is positively related to the number of certifications and the degree level held by a teacher and negatively related to the teacher not holding any certification. These results indicate that there is more to creating an effective classroom environment for student learning than the credentials of the teacher in the classroom. Similar to the conclusion made in the Clotfelter et al. (2010) study, demographic information about the school and the teacher were needed to explain more of the variance in the percent of students passing the Exit Level Science TAKS test.

Interpretation of Results from Multiple Linear Regression

Research Question 1 – Degree Level

Both of the graduate degree levels had p values that were statistically significant at $\alpha = .05$, whereas baccalaureate degrees were removed from the model and the 'no baccalaureate or higher' category was not statistically significant. This may be a result of the distribution of degree types. A baccalaureate degree is the highest level of degree on file for the majority of teachers in Texas and is the minimum educational requirement. Therefore, the education level portion of multiple linear regression equation indicates changes in student performance when teachers have degrees other than the minimum required.

It is logical that the category describing teachers without a baccalaureate degree or higher is not statistically significant, because that category only describes 53 science teachers, which is 0.3% of the population. The beta weights for both types of graduate degrees were both positive, which indicates that there is a positive relationship between teachers having higher degrees and more students meeting the standard on the Exit Level Science TAKS test. This is consistent with the experiential theory of learning because graduate degrees allow for a greater amount of practice in acquiring and applying knowledge. It is possible that the differences in the beta weights have a direct relationship with the amount of application type requirements involved in completing the higher degree levels.

Research Question 2 – Certification Subject

The certification types held by teachers are influential in describing the percentage of students who met standard on the Exit Level Science TAKS test. Similar to the results seen by Clotfelter et al. (2010) in North Carolina, some certifications held by teachers provide a noticeably more beneficial relationship with the percentage of students who met standard on the Exit Level Science TAKS test than others. Most of non-science certifications that were significant are specialized for high-needs populations that are common in Texas. The significance of the elementary certification could have resulted from teachers changing positions, working at schools that include early childhood (EC) to Grade 12, or teachers who are holding and EC – 8 certification that technically allow the certified teacher to move up to Grade 9, that is usually located in a high school. The health and PE certification is for individuals who desire to teach the general physical education and health classes. Many times, these certified teachers are also assigned to teach life science courses. It is possible that science teachers are being trained to identify and accommodate the needs of the gifted students in our classroom through other professional development opportunities and choosing to not become state certified. This certification is often issued at the district level because it is a supplemental certification and allows for districts to tailor the professional development around the needs of the specific gifted population in their district. The large negative relationship between teachers with an English Language Arts (ELA) certification and student performance may be a result of the populations where this certification is common for a science teacher. These schools may have large bilingual or English as second language (ESL) populations, although the multicollinearity statistics for ELA certifications and percentage of students enrolled in an ESL program were minimal. The predictor variable describing the percentage of bilingual students was removed during the development of the base model and may have eventually provided high multicollinearity statistics along with the ELA certification predictor variable had it remained in the model.

The type of science teacher certification was divided into two categories for comparison between the subject area certifications: those issued prior to September 1, 1999 and those issued after September 1, 1999. The earlier certificates included provisional and professional certificates. These were issued under the older certification laws and did not have specific course hour requirements in order to sit for the Texas Examination of Current Administrators and Teachers (TECAT). Those issued after September 1, 1999 include standard and probationary certifications. These certifications were issued after the legislation requiring a minimum of 12 hours in the content area with a minimum grade point average (GPA) requirement in order to enroll in a teacher preparatory program as specified in rule 227.10 of the Texas Administrative Code. Table 19 provides the distribution of science certification types based on being issued before or after the law changed for each subject certification type.

Table 19

Distribution of Science Certifications by Certification Type

Type	Certification prior to 1999 law change Number (%)	Certifications after 1999 law change Number (%)	Total Certifications
Biology	2,242 (78%)	615 (22%)	2,857
Chemistry	594 (59%)	415 (41%)	1,009
Life Science	0 (0%)	1,155 (100%)	1,155
Life Earth Science	455 (87%)	70 (13%)	525
Physical Science	693 (55.0%)	568 (45.0%)	1,261
Composite Science	1,506 (33%)	3,044 (67%)	4,550
Science Other			
Master Science	0 (0%)	2 (100%)	2
Earth Science	190 (84%)	36 (16%)	226
Physics	201 (73%)	74 (27%)	275
Physics and Math	0 (0%)	73 (73%)	73

Science other and chemistry certifications were not statistically significant at the .05 level. The science other category represents 853 teachers, or 6.3% of the population, and the chemistry category represents 1,009 teachers, or 7.5% of the population. The only category that had a positive beta weight and was statistically significant was the physical science certification (0.045). The most negative beta weight was for the biology certification (-0.052). Both of these certifications are represented by a large majority of teachers with certification types that were discontinued in 1999, which may be explained by the years of teaching experience. Composite science and life science are the only certification types that were represented with a large majority of certifications issued after 1999 and were represented more than 275 teachers (not grouped into science other category). The beta weights for these two categories are both -0.029, and -0.31, respectively. These negative beta weights should not be interpreted as teachers with certifications in these areas as not being needed, but that the balance of the certifications among the teachers employed at a campus needs to be more equally distributed.

Fewer teachers are certified to teach physical science courses, including chemistry, physics, and integrated physics and chemistry. It is possible that these teachers are usually assigned a full load of these courses. Teacher certified in life sciences, including anything related to biology, are more abundant and may be assigned a few sections of a physical science course to meet the scheduling needs of individual campuses. The large positive relationship between teachers who are certified in physical science and student performance on the Exit Level Science TAKS test can be attributed to the social learning theory because the subjects taught under a physical science certification include topics that are abstract and where students are encouraged to make connections between the concepts being taught and previous life science coursework. These teachers are called to learn new methods in order to model information for students regularly. This practice reinforces life science concepts while teaching physical science concepts. The reverse may not happen in life science courses because they tend to be taken by students earlier in their career and these concepts are generally more conducive to visual investigation by students. Concepts that students can experience and see for themselves are more concrete for the learner and therefore, require less imagination to understand.

Research Question 3 – Years of Teaching Experience

It is logical that novice teachers were removed from the multiple linear regression model because this category represented 4,835 (35.9%) science teachers, which is much greater than any of the other categories. The early-career teacher category represents 2,958 (22.0%) science teachers and was not statistically significant in this model. The distribution of science teachers by experience level is presented in Table 20.

Table 20

Distribution of Teachers Based on Experience Categories

	Number of Teachers (N = 13,469)
Novice Teacher (0-4)	4,835 (35.9%)
Early-career Teacher (5-10)	2,958 (22.0%)
Middle-career Teacher (11-20)	3,199 (23.8%)
Full-career Teacher (21 or more)	2,477 (18.4%)

The only statistically significant experience categories were middle- (teachers with 11-20 years of teaching experience) and full-career (teachers with 21years or more of teaching experience) teachers. The middle-career teachers showed a positive beta weight (0.022) and the full-career teachers showed a larger, but negative beta weight (-0.037). This can provide an indication that teaching effectiveness peaks somewhere between the first 11-20 years of teaching experience and then begins to diminish as teachers enter the last phase of their careers. The improvement of student performance with established teachers is congruent with the experiential learning theory in that these teachers have had the opportunity to sharpen their skills through their classroom experiences.

Teachers who hold certifications issued more than10 years prior to the data collected in this study did not require continued professional education (CPE) in order to retain certification. This requirement applies primarily to novice and early-career teachers who must complete 150 clock hours of CPE over a span of 5 years. Both of these categories were not statistically significant, therefore this issue should be revisited when more teachers from these categories are able to obtain more experience. This negative shift may be attributed to the larger generational gap between the teachers and students, which could potentially contribute to difficulties in communication between teachers and students.

Research Question 4 – Combined Variables of the Study

Based on the results from each credential category in the final regression model, the credential type with the largest positive beta weights out of each credential category with *p* values less than .05 are considered to be the most influential credential types that have a positive relationship with student performance. The credential combination (with beta weights) that meets this criterion describes teachers with a doctoral degree (0.030), elementary (0.014) and physical science certifications (0.045), and middle-career teachers with 11-20 years of teaching experience (0.022). These teachers have been teaching long enough to be able to sharpen their skills and learned from advanced coursework and personal experiences. The teachers have a variety of experiences to draw from as they implement practices that help make science relevant to their students' lives.

This is congruent with the theoretical basis of this study in that best teaching practices have been modeled, possibly discussed among fellow high school educators either in the work place or in graduate classes, and adapted to be useful and effective in the classroom. However, of this combination of credentials, doctoral degrees and physical science certifications have the largest beta weights, 0.030 and 0.045, respectively. The elementary certification and experience classification of experience teachers have beta weights that are approximately one third and one half, respectively, of the beta weight for physical science certifications. This indicates that the type of science certification is the most influential for student performance than an out-of-field certification or experience in this situation. A conclusion that can be made from is that the specific type of science training that a teacher pursues is more important than the amount of teaching experience and non-science training.

The credential combination (with beta weights) that produce the most negative result in the predicted value for the percentage of students who on the Exit Level Science TAKS test described teachers the minimum state requirement of a baccalaureate degree (0, because the model uses this as a point of reference), ELA (-0.078) and biology certifications (-0.052), and 21 years of teaching experience or more (-0.037). In this combination, the non-science certification and experience categories have the larger magnitudes and the education and science certification have the smaller magnitudes. This is the opposite of what was seen in the previous combination, which is logical, because these combinations represent opposite extremes.

The large contribution from the ELA certifications may be attributed to the demographic distribution of the particular campus. The percentage of bilingual students in Texas schools is so great across the state that this value was almost constant, and therefore removed from the baseline model by SPSS® early in the process. Campuses that have a large bilingual population may value teachers with ELA training, but may also have other demographic variables that present additional challenges. Since the percentage of the population of students being bilingual was removed from the demographic model, the variance inflation factor (VIF) values for the ELA certifications and the bilingual populations were not able to shed light on this possibility.

The biology certification allows for teachers to lead coursework that can be seen and experienced in a more concrete manner than physical science courses. As a result, these teachers may not have needed to practice and sharpen their skills that would allow for them to teach concepts that reinforce cross-curricular concepts. The teachers with biology and life science certifications provide a valuable contribution to student's education, which the physical science teachers are able to build from. However, the disproportionate amount of biology teachers across the state has its downfall that is evident in student performance on the Exit Level Science TAKS test, which assesses life sciences and physical sciences equally. These results have the potential to be drastically different when data becomes available to evaluate student performance on the subject specific Student Assessment of Academic Readiness (STAAR) exams.

Limitations

Data describing teacher credentials were organized at the campus level as a result of the data reporting student performance were only available at the campus level. Student data available through public records requests or through Education Service Centers (ESCs) are organized such that individual students cannot be linked to individual teachers. The way to obtain these data would be to work with school districts individually in order to gain access to their Public Education Information System (PEIMS) records. Schools are not required to provide all of the information that they input into PEIMS to the state. Therefore, the data available through public information requests are limited to what has been reported. Obtaining access to the records of all 1,102 school districts would be a lengthy process with the possibility of excluding data on the basis of availability. The public records requests limited this study to clustering at the campus level, but allowed for all teachers in the target population of high school science teachers in the state of Texas to be included in the analysis.

Implications for Future Research

An area of future research may be an investigation into the relationship associated with the novice teacher’s learning curve of the first five years of teaching and the attrition rate of teachers who leave the profession after the first five years. Figure 8 shows a dramatic drop in teachers with baccalaureate degrees with five or more years of experience, yet the amount of teachers with master and doctoral degrees remain relatively constant across the number of years of experience. There are several possibilities to explain why these teachers are not as well represented after this point. Some of them may completely leave the teaching profession, while others may complete a graduate degree and choose to teach at a college or move into an administrative position. Investigation into the positions that these teachers pursue after this initial period can provide valuable information regarding what can be done to retain more of these novice teachers.

Deeper investigation needs to look into the issue regarding teachers in the classroom without certifications or degrees. The Texas Education Code has made an allowance for teachers with established credentials in industry to lead a class; however it also requires schools to inform parents when the teacher in the classroom does not have a valid teaching certification. The distribution of experience level for teachers in this category, the geographic distribution of these teachers, and the amount, although small, was not what was expected when this study began.

Further investigation should be focused on the different classifications and types of both science and non-science certifications. A comparison of the effectiveness of teachers with out-of-field certifications in addition to science certifications or science only certifications could be an interesting topic. Additionally, an investigation of science certifications can be useful when the certifications are grouped to describe larger categories. One of the groupings could be used to investigate the impact of the requirements to obtain and maintain the certifications issued after 1999. Those results can be used to evaluate if the CPE credits required to retain the newer certifications have a relationship with the learning curve experienced by novice teachers. An additional grouping of certifications could be divided into subject specific, generic field (life science and physical science), and composite. This evaluation may be useful in determining the level of specialization that is most beneficial for student success on the Exit Level Science

TAKS test. With implementation of the subject-specific STAAR exams, dramatic changes regarding teacher credentialing may become more important.

Another area for future research is the use of structural equation modeling to evaluate the path coefficients between the predictor variables. This will allow for a greater understanding of the interdependence of the predictor variables. For example, there may be a relationship between the population demographics and the teachers that are attracted by particular schools and school districts. This type of analysis can be useful in further clarifying the intricacies of successful schools.

Implications for Practice

While it would be convenient to state that a school should only hire teachers that fall into the categories that have a positive relationship with student performance statistically, this is not a practical procedure. Teachers with more education and experience in the teaching field should be called upon to mentor and guide those with less experience and provide encouragement for their colleagues to remember that learning is an ongoing, lifelong process.

The final statistical model explained 60.7% of the variance in student performance. This leaves room for teachers and students to have potential and qualities that are not accounted for in personnel files that allow for some portion of the 49.3% of the variance in student performance to be left unexplained. While this portion is not accounted for in this study, it provides evidence that the success of students can be impacted through other influences, most likely at the individual level. These results further confirm the findings from Clotfelter et al. (2010) in that while educators should be strongly encouraged to set the example of lifelong learning through their own studies, there are other influences in the interpersonal relationships that are not accounted for in the academic vitae that come across the desks of administrators.

APPENDIX A

IRB APPROVAL LETTER

UNT
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Discover the power of ideas.

OFFICE OF THE VICE PRESIDENT FOR RESEARCH AND ECONOMIC DEVELOPMENT
Research Services

September 15, 2011

Diana Mason
Department of Chemistry
University of North Texas

RE: Human Subjects Application No. 11401

Dear Dr. Mason:

In accordance with 45 CFR Part 46 Section 46.101, your study titled "Factors Influencing Student Performance in Chemistry, a STEM Subject" has been determined to qualify for an exemption from further review by the UNT Institutional Review Board (IRB).

No changes may be made to your study's procedures or forms without prior written approval from the UNT IRB. Please contact Jordan Harmon, Research Compliance Analyst, ext. 3940, if you wish to make any such changes. Any changes to your procedures or forms after three years will require completion of a new IRB application.

We wish you success with your study.

Sincerely,

Patricia L. Kaminski, Ph.D.
Associate Professor
Chair, Institutional Review Board

PK:sb

1155 Union Circle #305250 | Denton, Texas 76203-5017 | TEL 940.565.3940 | FAX 940.565.4277
TTY 940.369.8652 | http://research.unt.edu

APPENDIX B

INITIAL PUBLIC INFORMATION REQUEST

TEA

Public Information Request Form

Date:	October 27, 2011
Requestor Full Name:	Anna George
Organization:	University of North Texas
Street Address:	[redacted]
City/State/Zip:	Denton, TX 76201
Telephone Number:	n/a
Cell Number:	[redacted]
Fax Number:	n/a
Email Address:	AnnaBayless@my.unt.edu

If available, would you accept an electronic format of the responsive documents? ☒ **Yes** ☐ **No**

Detailed Description of your request: I would like a copy of the teaching certification information, list of the degrees held, and the service records, including teaching assignments and number of years of teaching experience for all science teachers who taught science in a Texas public high school durring the 2009-2010 school year.

***NOTE:** Certain exceptions to disclosure exist under the Texas Open Records Act to protect against the disclosure of confidential or privileged information. If it appears that an exception to disclosure exists, an opinion will be sought from the Office of Attorney General regarding your request.

You may submit the form by mail, fax, e-mail or in person:

Attn: Public Information Request
Texas Education Agency
William B. Travis Building
1701 N. Congress Avenue
Austin, TX 78701-1494

Tel: (512) 463-9734
Fax: (512) 463-9838
Email pir@tea.state.tx.us

APPENDIX C

INITIAL RELEASE OF PUBLIC RECORDS

PIR 16217 (George) Making Documents Available

PIR [pir@tea.state.tx.us]
Sent: Thursday, November 17, 2011 1:23 PM
To: George, Anna
Attachments: PIR 16217 (George) cc906 c~1.xls (2 MB)

Open Records Request
Release Documents at No Charge
November 17, 2011

Anna George
University of North Texas
[redacted]
Denton, TX 76201

TEA PIR #16217

Dear Ms. Anna George:

On September 21, 2011, the Texas Education Agency (TEA) received your request for open records. Based on your request, TEA has information responsive to your request. The information you requested is provided to you with this letter and includes a copy of your original request. Additionally, there are no charges for fulfilling this request and this particular request is considered closed.

If you have any questions or wish to discuss this matter further, please contact me at (512) 463-9734 or by email at PIR@tea.state.tx.us.

Sincerely,

Alejandra M Gallegos
TEA Open Records Coordinator

Enclosure: Original Request
TEA Responsive Documents

APPENDIX D

SECOND PUBLIC INFORMATION REQUEST

TEA

Public Information Request Form

Date:	November 1, 2011
Requestor Full Name:	Anna George
Organization:	University of North Texas
Street Address:	[redacted]
City/State/Zip:	Denton, TX 76201
Telephone Number:	n/a
Cell Number:	[redacted]
Fax Number:	n/a
Email Address:	AnnaBayless@my.unt.edu

If available, would you accept an electronic format of the responsive documents? ☒ **Yes** ☐ **No**

Detailed Description of your request: Student perfromance, defined by percentage met standard and percentage achieved commended status, on the EXIT Level Science TAKS test by campus for the 2009-2010 School year. Iwould also like these data broken down into special populations, such as ethnicicity, gender, economically disadvantaged, special education, and LEP, as seen on the AEIS school reports.

***NOTE:** Certain exceptions to disclosure exist under the Texas Open Records Act to protect against the disclosure of confidential or privileged information. If it appears that an exception to disclosure exists, an opinion will be sought from the Office of Attorney General regarding your request.

You may submit the form by mail, fax, e-mail or in person:

Attn: Public Information Request
Texas Education Agency
William B. Travis Building
1701 N. Congress Avenue
Austin, TX 78701-1494

Tel: (512) 463-9734
Fax: (512) 463-9838
Email pir@tea.state.tx.us

APPENDIX E

SECOND RELEASE OF PUBLIC RECORDS

PIR 16462 (George) Release Docs

AAPIR [aapir@tea.state.tx.us]
Sent: Tuesday, November 08, 2011 10:51 AM
To: George, Anna
Cc: Kallus, Richard [Richard.Kallus@tea.state.tx.us]
Attachments: PIR #16462_TAKS_Data.zip (161 KB) ; PRR George Nov 1.doc (46 KB)

Public Information Request
Release Documents at No Charge
11/8/2011

TEA PIR # 16462

Dear Anna George:

On 11/1/2011, the Texas Education Agency (TEA) received your request for public information. Based on your request, TEA has information responsive to your request. The information you requested is provided to you with this letter and includes a copy of your original request. Additionally, there are no charges for fulfilling this request and this particular request is considered closed.

The data provided by the Student Assessment Division to PIR # 16462 are for ALL students tested. These data are not the same as the AEIS data that are based on subset of students.

The AEIS results can be accessed either by viewing the AEIS reports for the individual districts or campuses or by downloading all or selected data from the reports electronically for all districts and/or campuses in the state. For example, the following provides instructions for accessing the 2010 AEIS results available via the download site located at:

http://ritter.tea.state.tx.us/perfreport/aeis/2010/download.html

From this page, choose the Data Download option. Next, choose Download of Selected Data and the option for Campus Aggregates for the Whole State. This page will ask that you choose the fields you are interested in downloading. For example, the TAKS results for each campus in Texas, such as the grade 11 results on the science test, can be found under the various TAKS files listed in the pull-down menu. You can choose to download the selected data fields as comma-delimited, tab-delimited, or fixed column files that can then be loaded into either Excel or SAS.

All of this information is available free of charge and can be downloaded for the 1993-04 through the 2009-10 school years. The 2010-11 AEIS results will be available to download from the public site by Friday, November 18, 2011.
If you have any questions, please contact me directly by email or telephone as listed below.

Enclosure: Original Request
TEA Responsive Documents

Aaron Bradley
Public Information Coordinator
AAPIR@tea.state.tx.us
512-475-3523

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