ELEMENTARY SCIENCE TEACHERS PERCEIVED SELF-EFFICACY: A CORRELATIONAL STUDY BETWEEN TEACHERS WITH CONTENT AND NON-CONTENT MAJOR DEGREES IN NEW JERSEY

by

Tiffany Baskerville

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University

2023

ELEMENTARY SCIENCE TEACHERS PERCEIVED SELF-EFFICACY: CORRELATIONAL STUDY BETWEEN TEACHERS WITH CONTENT AND NON-CONTENT MAJOR DEGREES IN NEW JERSEY

by Tiffany Baskerville

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University, Lynchburg, VA

2023

APPROVED BY:

Amy G. Jones, Ed.D., Committee Chair

Vonda D. Beavers, Ed.D., Committee Member

ABSTRACT

This predictive, correlational study examines the relationship between undergraduate degree type, methods courses taken in undergraduate school, and the number of years teaching the same grade level and elementary science teachers' perceived self-efficacy. In this non-experimental study, participants submitted their online responses to the 25-item survey, Science Teaching Efficacy Belief Instrument (STEBI-A), and their demographic information via Google Forms. The researcher used multiple regression to analyze participants' anonymous responses. In using a multiple linear regression analysis, the researcher examined the results of the STEBI-A to determine how accurately an elementary science teachers' perceived self-efficacy is predicted by the predictor variable of type of undergraduate degree earned, years of teaching the same grade for elementary science teachers. The type of degree and science method courses variables did not display an ability to predict elementary science teacher self-efficacy. The participants for the study came from a snowball sample of elementary school teachers located in New Jersey during the summer semester of the 2022-2023 school year with $N = 138$ with a minimum of $N = 71$. The study revealed a statistically significant relationship between self-efficacy and the number of years of teaching the same grade level; however, undergraduate degree earned, and science methods courses did not show a statistically significant contribution to the overall model. Based on the results of this study a multiple regression study with degree type and subject matter professional development exposure as predictive variables is recommended.

Keywords: elementary science, teacher efficacy, Next Generation Science Standards, pedagogical content knowledge

Dedication

I want to dedicate this dissertation to my mother and father. To the woman who planted this seed so long ago by bringing me to her college class, Kathleen Baskerville, my mother has always inspired me to achieve greatness. The privilege of watching her persevere through some of life's most difficult challenges has shaped me into the woman I am today. My father, Sloan Gordon, Jr., taught me the value of hard work, diligence, and fortitude. Refusing to be shaped by the adverse environment in which he grew up, he refined and passed on those three attributes to me. Now, as I end my terminal degree, I must honor the three gifts of God in the persons of Kathleen Baskerville, Sloan Gordon and Rose Gordon, my second mom. I attribute the completion of this journey to all three of my parents.

I would also like to dedicate this dissertation to my sister, Yashica, and my three adorable children Jesus, Jenna, and Arianna. Thank you for enduring crazy nights and takeout food. I would have never made it this far without your support and smiles. Uncle Frankie wrote a statement in 1993 that I never forgot, "always walk up the down escalator." Today, I believe I have reached the top. Thank you to all my family and friends who believed in me when I struggled.

Table of Contents

List of Tables 10

List of Figures 11

List of Abbreviations 12

CHAPTER ONE: INTRODUCTION 13

Overview 13

Background 13

Historical View 14

Theoretical Background 15

Society-at-Large 16

Problem Statement 17

Purpose Statement 18

Significance of the Study 18

Research Question 20

Definitions 20

CHAPTER TWO: LITERATURE REVIEW 22

Overview 22

Theoretical Framework 22

Social Cognitive Theory 22

Figure 1 23

Self-Efficacy Theory 24

The Underlying Sources of Self-Efficacy 25

Related Literature 27

Teacher Attitudes 28

Elementary Science Teachers with Natural Science Degrees 30

Elementary Science Teachers with Natural Science Degrees and Vicarious Learning 31

Elementary Science Teachers without Natural Science Degrees 31

Elementary Science Teachers without Natural Science Degrees and Vicarious Learning 32

Elementary Science Teachers with Undergraduate Science Methods Courses 33

Elementary Science Teachers without Undergraduate Science Methods Courses 33

Traditional Teacher Programs 34

Traditional Teacher Programs and Social Arousal 35

Traditional Teacher Programs and Performance Accomplishments 36

Traditional Teacher Programs and Vicarious Learning 36

Alternate Route Programs 36

Alternate Route Programs and Social Persuasion 38

Alternate Route Programs and Performance Accomplishments 39

Alternate Route Programs and Vicarious Learning 39

Experience under Five Years 39

Experience under Five Years and Vicarious Learning 41

Five or More Years of Service 41

Purpose of the Study 42

Attrition 45

Pedagogy 46

Professional Development 47

Competence 49

Summary 51

CHAPTER THREE: METHODS 53

Overview 53

Research Design 53

Research Question 54

Hypothesis 54

Participants and Setting 54

Population 55

Participants 56

Sample Size 57

Setting 57

Instrumentation 57

Procedures 59

Data Analysis 60

CHAPTER FOUR: FINDINGS 63

Overview 63

Research Question 63

Null Hypothesis 63

Descriptive Statistics 63

Assumption Testing 65

Independence 65

Linearity 66

Homoscedasticity of Residuals 67

Multicollinearity 68

Tolerance and Variance of Inflation Data Coefficients[a] 69

Significant Outliers 69

Normal Distribution of Residuals 70

Reliability 73

Hypotheses 74

CHAPTER FIVE: CONCLUSIONS 76

Overview 76

Discussion 76

Null Hypothesis 77

Implications 80

Limitations 81

Recommendations for Future Research 82

REFERENCES 83

APPENDIX A 99

APPENDIX B 100

APPENDIX C 101

APPENDIX D 102

APPENDIX E 103

APPENDIX F 104

APPENDIX G 105

APPENDIX H 106

List of Tables

Table 1	Participant Demographic Data	...56
Table 2	Descriptive Statistics	64
Table 3	Regression Model Results	..65
Table 4	Model Summary	.66
Table 5	Tolerance and Variance of Inflation Data	..68
Table 6	Reliability Statistic	.74
Table 7	Coefficients	74

List of Figures

Figure 1 Determining Self-Efficacy…….24

Figure 2 Perceived Self-Efficacy and Outcomes…….42

Figure 3 Scatterplot Dependent Variable: Self-Efficacy……..67

Figure 4 Scatterplot Self-Efficacy Regression Standardized Residual……68

Figure 5 Scatter Plot of Cook's Distance by Self-Efficacy……..69

Figure 6 Normal P-P Plot of Regression Residual……...69

Figure 7 Histogram of Regression Standardized Residuals of Self-Efficacy……..71

Figure 8 Histogram of Standardized Residuals of Degree Type……..71

Figure 9 Histogram of Standardized Residuals of Number of Years Teaching Science……...72

Figure 10 Histogram of Standardized Residuals of Science Methodology Courses…..…….73

Figure 11 Years of Service Graph …….77

Figure 12 Count of Self-Efficacy ……..……78

List of Abbreviations

National Aeronautics and Space Administration (NASA)

Next Generation Science Standards (NGSS)

Science Teaching Efficacy Belief Instrument (STEBI-A)

Self-Efficacy Theory (SET)

Social Cognitive Theory (SCT)

CHAPTER ONE: INTRODUCTION

Overview

Most elementary students receive science instruction from their regular education teachers, who are subject generalists. This study examined the correlation between regular education elementary science teachers' perceived efficacy and the undergraduate degree they earned in New Jersey. The design of this study considers the impact of an undergraduate degree in the natural sciences as opposed to earning a degree in a non-natural science discipline. In this chapter, background information related to this study is provided. The problem statement and the purpose statement are presented. The significance of the study is explained. The research question to which this study responds is shared. Finally, critical terms related to this study are defined.

Background

American elementary science students are scoring lower than their grade-level counterparts worldwide (National Center for Education Statistics [NCES], 2020). Many American students receive science instruction in one-fourth the time they receive reading instruction (Banilower et al., 2018). When science instruction is delivered, teachers lack the necessary resources to effectively provide meaningful experiences for their students (Bradbury & Wilson, 2020), thus, providing a subpar science educational experience for the pupils in the classroom.

Compared to teachers in secondary schools, even if there is much less preparatory work for science subjects and much less time for science teaching, beginning elementary teachers can learn from the sciences for which they are responsible for teaching without a formal intervention or professional development (Berson et al., 2019; Nixon et al., 2018). The findings of Nixon et

al.'s (2018) study contradict several other studies (Bernholt et al., 2018; Carrier, S. J. et al., 2018; Davidson et al., 2020; Deniz et al., 2020; Novak & Wisdom, 2018; Perkins Coppola, 2019; Plöger et al., 2019) that indicate the opposite. Bradbury and Wilson (2020) also noted that elementary teachers face several obstacles, including a lack of equipment, directives from administrators to skip teaching science, and time to prepare.

Historical View

October 4, 1957, marked the first artificial Earth satellite launch (Wilson, 2015). The sophistication and grandeur of the success of the Union of Soviet Socialist Republic (USSR) during that time caused the United States government to make several changes in the educational system. Sputnik, the first artificial satellite in orbit, sparked the United States Government to form the National Aeronautics and Space Administration (NASA). Whether spawned by fear of missing out or fear of the capabilities of the USSR, the United States acted.

The early 1980s ushered in the desire to look within—specifically, the state and quality of elementary, middle, and high school science teaching. A Nation at Risk, the work of the Secretary of Education, revealed very disheartening data. As a result, the country no longer took a passive position in science education. Sputnik fueled the educational reform for science and science education in the United States (Clark, 2017; Guillemin, 2019; Hatzivassiliou, 2019). At this point, the President of the United States began introducing legislation to Congress regarding education.

The Elementary and Secondary Education Act (ESEA) was enacted in 1965 and is the national education law of the United States, demonstrating a long-term commitment to equal opportunity for all students (Duque et al., 2016). ESEA was reauthorized under the Clinton administration and called The Improvement America's Schools Act (IASA) of 1994. This

legislation called for higher academic standards (Riley, 1995). Increased federal funding authorized by President Clinton targeted bilingual and immigrant students. The year 2001 ushered in yet another reform by President George W. Bush. Designed to support the nation's most vulnerable students, the Obama Administration reauthorized ESEA on December 10, 2015, and the name changed to the Every Student Succeeds Act (ESSA), replacing the controversial No Child Left Behind (NCLB) Act (Reedy et al., 2017).

Theoretical Background

Social cognitive theory (SCT) started as the social learning theory (SLT) in the 1960s by Albert Bandura and developed into the SCT in 1986 (Bandura, 1986). The theory posits that learning occurs in a social context with a dynamic and reciprocal interaction of the person, environment, and behavior. Bandura's (1989) agentic perspective formed from SCT. SCT gave birth to self-efficacy theory; thus, personal agency and self-reflection directly affect self-efficacy. As part of his social cognitive theory, Bandura (1997) argued that self-efficacy, defined as the belief in one's ability to organize and carry out the action processes necessary to produce specific achievements, is central to the exercise of human agency.

According to Bandura's (1989) social cognitive theory, efficacy has a significant effect on motivation and persistence: those who believe they can accomplish something are far more likely to attempt that task and are less likely to be dissuaded by failure. Bandura's theory is studied in connection with experiencing personal and social change (Bandura, 1986). Despite ever-changing and fluid situations, people negotiate a highly complex world because their behaviors are neither hardwired nor mere products of their environment (Bergman et al., 2019).

Self-efficacy is a person's belief in his or her ability to achieve a specific desire (Bandura, 1997). The term "self-efficacy" was coined by psychologist Albert Bandura, a Canadian

American psychologist and a professor at Stanford University. Bandura (1977) originally proposed the concept of self-efficacy, in his own words, as a private judgment of "how well one can execute courses of action required to cater to prospective situations" (p. 193). Teachers' expectations of personal self-efficacy "will determine whether or not coping behavior occurs, how much effort expended, and how long it will sustain in the face of obstacles and adverse circumstances"(Bandura, 1977 p. 191). The higher the sense of efficacy, the more considerable the effort and the more stamina and flexibility one brings to the task (Pajares, 1996).

Society-at-Large

The educational institution in the United States is responsible for providing an adequate and appropriate education to its citizens (Kyle, 2020). To that end, the fundamental basics of science education are vital. Thus, consideration of the social ramifications of this phenomenon is necessary.

Social equality depends upon an environment with equal access for all citizens. In the case of schooling, specifically science education, the adequate preparation of its students is paramount. For students to compete for high-paying careers in the 21st century, collegiate opportunities presented themselves to the most prepared students. Science, Technology, Engineering, and Mathematics (STEM) careers still provide higher-level income opportunities. Society introduces a civil rights issue when students receive science instruction from educators who lack confidence or feel underprepared or threatened. To that end, social inequality occurs when students cannot properly position themselves to compete in STEM careers (Davis & Schaeffer, 2020). This inequality, in turn, may lead to lower-paying jobs, directly affecting the type of housing they may afford, thereby exposing them to a lower quality of life.

The global pandemic of 2019 revealed the inability of the nation's most influential individuals to make sound public health decisions and follow the recommendations of the country's Director of the National Institute of Allergy Infectious Diseases and the Chief Medical Advisor to the President. The societal implication of this phenomenon is concerning. Socioscientific issues have a place in the 21st-century classroom, and ignoring them is problematic. However, educators who lack the self-efficacy to engage students in such topics effectively hinder the student's ability to build mental grit (Bercot et al., 2020).

Problem Statement

American students consistently place lower than less-developed nations on The Trends in International Mathematics and Science Study (TIMSS) in mathematics and science. The TIMSS exam offered every four years, reveals that American students score lower than nations like Japan, Finland, Korea, and more (Majoros et al., 2021; NCES, 2020). While this is not new information for the educational community, it is still concerning. America’s students are not thoroughly prepared to meet 21st-century issues, a century nearly one-quarter complete.

Elementary teachers play a significant role in preparing students. The teacher-student relationship positively affects student achievement (Büttner et al., 2019; Chestnut et al., 2019; Watson et al., 2019). Studies show that elementary teachers feel more confident when they receive more professional development in the subject areas and when they teach the same grade level for multiple years (Banilower et al., 2018; Bernholt et al., 2018; Blanco-López et al., 2018; Carrier, S. J. et al., 2018; Davidson et al., 2020; Deniz et al., 2020; Nixon et al., 2018; Novak & Wisdom, 2018; Perkins Coppola, 2019). Moreover, many elementary teachers lacking science content-specific degrees fail to contribute to student achievement positively due to the benefits of a science degree, preservice programs containing methods courses, and in-service years of

teaching science in the same grade level (Asselta et al., 2019). The literature shows a relationship between effective pedagogy and content area degree held and preservice training for elementary teachers. The problem is that there is a gap in research concerning the link between science teaching efficacy and the undergraduate degree earned by in-service elementary teachers (Büttner et al., 2019).

Purpose Statement

The purpose of this quantitative, correlational study is to determine if there is a predictive relationship between the independent and dependent variables. The independent variables are the type of undergraduate degree earned (either natural science or non-natural science), years teaching the same grade for elementary science teachers (either 1-3, 4-6, 7-10, or over 10), and science methodology courses in undergraduate work (either yes or no). The dependent variable is teachers' perceived self-efficacy. This study aims to add to current research by analyzing and determining if a correlation exists among elementary teacher's undergraduate degree, exposure to science methods courses, and the number of years the individual teaches the same grade level and their levels of teacher competence. The participants are elementary teachers from the State of New Jersey, teaching kindergarten through fifth grades. The researcher invited K-5 elementary teachers from across the State of New Jersey who attended the Sumner Summer Institute to participate in the study.

Significance of the Study

This study is essential as schools endeavor to strengthen their students' scientific literacy and preparedness for the 21st century. Content mastery is critical if teachers are expected to prepare students effectively (Banilower et al., 2018). Subject matter knowledge is positively affected by years of experience when veteran teachers teach the same grade (Nixon et al., 2018).

Every effort to ensure a high-quality education for American students is essential. To that end, if allowing an elementary teacher to continue teaching in the same grade level is beneficial, that is an option that researchers should study (Nixon et al., 2018). Forming pedagogical content knowledge constitutes a fundamental problem for pedagogical research and practice (Bernholt et al., 2018). Therefore, a study of this nature is essential.

With the preponderance of studies assessing professional development benefits for preservice and in-service teachers, researchers must focus on the carryover (Berson et al., 2019). The Next Generation Science Standards (NGSS) demand a higher level of cognition from today's students; thus, discipline-based content preservice experiences are beneficial. A preservice engineering experience positively affected the participants' pedagogical content knowledge in this study (Perkins Coppola, 2019).

Preservice teachers carry their knowledge and experiences into the classroom to positively affect students. Studies show that preservice teachers benefit from professional development (Banilower et al., 2018; Bernholt et al., 2018; Berson et al., 2019; Blanco-López et al., 2018; Carrier, S. J. et al., 2018; Davidson et al., 2020; Deniz et al., 2020; Nixon et al., 2018; Novak & Wisdom, 2018; Perkins Coppola, 2019). However, very few studies discuss the link between the self-efficacy the professional development ensues and the professional competence the teacher possesses (Blackmore et al., 2018; Büttner et al., 2019; Naidoo & Naidoo, 2021).

This study may benefit several school districts, science teacher associations, colleges and universities, various state departments of education, policymakers, and elementary science teachers. The results of this study may inform school districts as to the best course of action regarding hiring new staff members. It may inform science associations on new types of

professional development to offer preservice teachers and ongoing refresher courses for teachers implementing their new learning (Berson et al., 2019).

Bandura's (1977) theory of self-efficacy is the theory on which this study is grounded. Self-efficacy speaks to educators' feelings at a particular time in a specific situation. Professional competence speaks to whether educators utilize what they have learned in their respective classrooms. Bringing these two concepts – self-efficacy and professional competence – together is essential. In addition, it is essential to consider these concepts considering the following variables: years of teaching in the same grade level for elementary (K-5), undergraduate degree, and the impact of science methodology courses. The data ascertained from this study may provide solutions for preservice teacher programs as they work to support elementary science teacher candidates.

Research Question

The research question for this study is as follows:

RQ: How accurately can elementary science teachers' perceived self-efficacy be predicted from a linear combination of years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program?

Definitions

1. *Next Generation Science Standards* – is a multi-state effort in the United States to create new education standards that are "rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education." (National Academies Press, 2012).
2. *Pedagogical content knowledge* - Pedagogical content knowledge is knowledge unique to teachers based on the way teachers relate what they know about teaching to what they

know about what they teach. Integrating or synthesizing a teacher's pedagogical knowledge and subject matter knowledge comprises pedagogical content knowledge (Bernholt et al., 2018).

3. *Science instruction* - Science instruction is the process by which a teacher plans for and creates sequential and strategic learning experiences to improve students' knowledge and understanding of science (National Academies Press, 2007).
4. *Self-efficacy* - is an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments (Bandura, 1977).

CHAPTER TWO: LITERATURE REVIEW

Overview

A systematic review of the literature explored the impact of science teaching on K-5 science instruction for those with content-major and non-content degrees in the State of New Jersey. This chapter will review the current literature related to the topic of study using self-efficacy theory as the theoretical framework. The focus is on elemental principles of self-efficacy in teaching. The literature elaborates on preservice teachers' attrition, pedagogy, attitudes, professional development, and their relationship to self-efficacy. In the end, a gap in the literature will be identified, presenting a need for the current study.

Theoretical Framework

Self-efficacy is an individual's faith in their capacity to accomplish a particular want (Bandura, 1977). This concept effectively explains a teacher's view of their ability to teach science by highlighting the underlying sources of self-efficacy. Teachers' expectations of personal self-efficacy determines whether coping will lead to behavior, how much effort is put out, and how long efficacy will sustain it in the face of challenges and unfavorable conditions. The higher the feeling of adequacy, the more impressive the work, and the more endurance and adaptability one brings to the errand (Pajares, 1996).

Social Cognitive Theory

SCT, originally the SLT, was developed in the 1960s by Albert Bandura (Bandura, 1986). In 1986, it changed into the SCT and proposed a set of social contexts and settings that foster learning and allow for a dynamic and reciprocal interaction between the individual, the environment, and behavior. From an agentic vantage point, SCT is formed (Bandura, 1989). Self-efficacy theory emerged from SCT; as a result, self-efficacy is influenced by human agency

and self-reflection. Self-efficacy, which is the conviction that one can plan and carry out the action processes required to attain particular goals, is important to the exercise of human agency, according to Bandura (1997).

According to Bandura's (1989) SCT, efficacy significantly affects motivation and persistence: people who believe they will accomplish something are significantly more likely to try that task and are less likely to be dissuaded by failure. By analyzing cognitive, behavioral, and environmental factors, SCT relates to how one experiences personal and social change. Despite ever-changing and fluid situations, people manage to barter a highly complex world because their behaviors are neither hardwired nor mere products of our surroundings (Bergman et al., 2019).

Figure 1

Determining Self-Efficacy

Note. The Pennsylvania University[infographic] *public domain

Self-Efficacy Theory

The notion of "self-efficacy" was first introduced by famous psychologist Bandura (1977), who also gave it its name. According to Pajares (1996), the more the sensation of efficacy, the greater the effort, and the more endurance and adaptability one gives to the activity. In Bandura's own words, self-efficacy is a personal assessment of one's capacity to carry out the actions necessary to address potential problems. Self-efficacy is the conviction that one can fulfill a certain desire. According to Bandura (1977, p. 191), instructors' expectations about their own personal efficacy "will determine whether or not coping behavior is initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles and adverse circumstances.

The Underlying Sources of Self-Efficacy

Four factors influence self-efficacy: performance accomplishments, vicarious learning, social persuasion, and emotional arousal (Lin & Tsai, 2018).

- Performance outcomes refer to past success with similar scenarios to the present system. Teachers complete a semester-long field service internship before entering the classroom. Implementing the field service experience is meant to provide budding educators with an opportunity to practice their craft and enjoy a level of success. The success achieved serves as a reminder to the novice that they can create more scenarios such as the ones experienced during student teaching. Successful experiences in the classroom before the responsibility of running their class engender confidence (Lin & Tsai, 2018).
- Vicarious outcomes occur when someone watches someone else complete tasks successfully. The field service experience allows preservice teachers to increase teacher efficacy by observing a veteran teacher for 15 weeks, the average length of a college semester. The semester-long participation in student teaching offers a unique convenience and preview into the work of a professional educator. There is intentionality in providing this opportunity to the preservice teacher (Lin & Tsai, 2018).
- Social persuasion is characterized by encouragement. The field service project allows the preservice teacher to receive encouraging words from a veteran teacher in the classroom. Encouraging words are powerful tools to increase teacher efficacy. Veteran teachers play a crucial role in that they are not representatives of the preservice teacher's university. Preservice educators may hold the encouragement of the veteran teacher in higher esteem simply because they are practicing professionals. While there is an evaluative component to the field service experience, it is in no way comparable to the intense evaluation they

will receive upon entering the profession. Therefore, the encouraging words, praise, and affirmation received during this phase of the journey toward teaching are monumental for the incoming professional (Lin & Tsai, 2018).

- Emotional arousal involves the presence of stress, anxiety, and excitement. The field service experience provides the future teacher with an opportunity to work through all the emotions listed above, and in doing so, the preservice teacher increases self-efficacy. The foundation of social cognitive theory is the agentic perspective (Lin & Tsai, 2018).

Teachers' self-efficacy regarding their teaching of science content is a powerful predictor of their behavior in the classroom and their instructional practices (De Neve et al., 2015; Depaepe & König, 2018). Milner et al. (2012) contended that clusters of beliefs around a particular situation form attitudes, and attitudes become action agendas that guide decisions and behavior. Self-reflective elementary educators will shift from a slightly negative attitude to a more positive one (Long, 2019; Michaluk et al., 2017). Herbert and Hobbs (2018) reported that several preservice primary teachers did not experience science in their schools, and if they received science instruction, a specialist science teacher instructed the course. According to Herbert and Hobbs' study, students from primary teachers who did not receive science instruction moved on to kindergarten with less exposure to science. Consequently, those students struggled to catch up with peers who received science instruction from a specialist.

When teachers believe they can influence students' academic performance, they bring more enthusiasm to their teaching, positively affecting student performance (K. R. Kim & Seo, 2018). Elementary teachers are generalists (Aróstegui & Kyakuwa, 2020; Brobst et al., 2017; Bruijns et al., 2021; Büttner et al., 2019; & Herbert & Hobbs, 2018). Therefore, they are expected to provide instruction in English language arts, mathematics, social studies, and

science. With federal mandates looming over the heads of every teacher in the country, the expectation is that students perform well in all content area subjects. Adequate performance is only achievable when exposure to science instruction is of high quality and reflects actual scientific practices, justifying the need to start at the elementary level (Brobst et al., 2017).

Related Literature

More than ever before, scientific literacy gained notoriety in the 21st-century workforce (Gerde et al., 2018; National Academies Press, 2012). Rigorous science education is critical for developing these skills in the U.S. population. According to Ahlgren and Rutherford (1989), "education has no higher purpose than preparing people to lead personally fulfilling and responsible lives" (p. 12). Sadly, "few elementary school teachers have a rudimentary education in science and mathematics. Many junior and senior high school science and mathematics teachers do not meet reasonable standards for preparation in those fields" (p. 15).

New Jersey colleges and universities produce the most significant number of college graduates in the country. A bachelor's degree from a regionally accredited college or university is the minimum educational requirement for teacher certification in New Jersey. In addition, the state requires that potential teachers graduating on or after September 1, 2016, have a grade point average of 3.0 or better on a 4.0 scale (New Jersey Department of Education, n.d.). College natural science major degrees in New Jersey consist of 120 credit hours with 30-35 content-based courses in natural science. In comparison, non-major content degrees in New Jersey consist of 120 credit hours with less than 30 credit-based content courses in the natural sciences. The State of New Jersey remains in the top 10 best states in the country for education. According to the U.S. News and World Report, The Best States 2021 Rankings Performance Throughout All 50 States, New Jersey ranked #1 in the nation (Hubbard, 2021).

Teacher Attitudes

Preservice teachers all maintain a particular attitude towards science education. During this phase of an aspiring teacher's career, they receive exposure to several methods courses. The Test of Science Related Attitudes (Long, 2019) is a measurement tool used as a pre- and post-assessment. The results of such an instrument yield data that support the transition of preservice elementary science teachers to in-service educators. There is consensus within the science education community regarding the critical nature of positive attitudes toward science. Long (2019) assessed elementary preservice teachers' attitudes toward science. Results indicated that preservice teachers benefit from science methods courses, but more important was a positive attitude toward science education. However, one factor used to assess educator effectiveness is state test scores, and a positive attitude toward teaching is not enough to yield successful results. While a correlation may exist between a positive attitude toward teaching science and post-professional development, research suggests that said positive attitude does not translate into high achievement (Prewett & Whitney, 2021).

Teachers frequently approach the classroom to help students achieve varying levels of success. Stress affects teachers' attitudes in the school (Camacho et al., 2018). One such source of stress is that national and state mandates dictate the classroom's daily workings, forcing teachers to make decisions that may or may not be in the best interest of their students. Interestingly, teachers did not report self-efficacy as a cause of their stress. One should ponder the possibility that educators can possess a positive attitude toward teaching an unfamiliar content area while struggling with the anxiety that comes with the mandates of the school district and their employer.

When assessing teacher attitudes, there is a conflict in the literature. Teachers report having experienced stress related to organizational mandates that affect the classroom (Camacho et al., 2018). Nevertheless, research revealed that the factor which imposes the pressure may or may not directly impact student achievement (Prewett & Whitney, 2021). Feelings of stress and anxiety contribute to the feelings and consequently influence the educator's decision regarding the job assignment or placement (Harmsen et al., 2018).

Elementary educators lay the foundation for the educational continuum in one's life. In the mid-2000s in the United States, schools incorporated the disciplines of science, innovation, design, and math progressively after distributing a few vital reports. Prior to this time, those subjects were not emphasized in the classroom, as noted in *Rise Above the Gathering Storm* (National Academies Press, 2007). Specifically, *Rise Above the Gathering Storm*, a U.S. Public Institutes of Science, Designing, and Drugs Report, underlined the connections between success and data serious material career positions to science and innovation and proceeded with development to resolve cultural issues. However, U.S. pupils are not accomplishing STEM disciplines at an identical rate as understudies in numerous nations, thus creating a critical consequence. This consequence also perpetuates the wealth gap in the United States, as there is a correlation between skill attainment and career opportunity. The United States would fail to compete in the global economy, as mentioned in Rise Above the Gathering.

Stress and anxiety complicate an educator's approach to their classroom work. While the opportunity to work through some of the concerns preservice teachers possess during the field experience does not entirely quell all situations simply because they have not yet received their contract to work or classroom assignment. Self-efficacy developed around four pivotal

contributing factors: performance accomplishment, vicarious learning, social persuasion, and emotional arousal (Lin & Tsai, 2018).

Preservice elementary educators are unaware of their future assignments. They are overwhelmed with emotional responses that manifest in stress and anxiety, affecting their attitude and dispositions (Novak & Wisdom, 2018). The literature on math anxiety has shown that teachers' anxiety and perceptions of math impact their teaching and, ultimately, their students' math performance. Once teachers become responsive to their teaching assignments, if they were assigned to teach a subject area they did not prefer, it could negatively impact their attitude (Burte et al., 2020).

Elementary Science Teachers with Natural Science Degrees

An undergraduate degree in the natural sciences provides specialized knowledge in said field of study. Colleges and universities craft a degree completion plan of study in which complexity increases over time. To that end, undergraduate students receive an education that exceeds the minimum understanding elementary teachers require to discharge their duty successfully. While professional development may increase elementary science teachers' confidence levels (Bell et al., 2020), it does not provide the level of subject matter content knowledge to engender self-assurance in elementary teachers of science (Singh, 2022).

It is important to note that veteran teachers with natural science degrees may exhibit novice-like behaviors when teaching (Chang, 2020). Borko et al. (1993) indicated that limited science content knowledge was evident when educators taught the lesson portion that required interactive teaching outside their science specialty. However, pedagogical knowledge aided teachers when they needed to fill content knowledge gaps. When educators teach in their field of competence, the accretion of content knowledge is enhanced, whereas educators assigned to

teach science content outside their specialty display knowledge slippage over time (Lowery, 2010). The need to rely on pedagogical knowledge to fill gaps occurred, denoting overestimating degrees in the natural sciences.

Elementary Science Teachers with Natural Science Degrees and Vicarious Learning

Lab courses engage learners in the lab's protocols, laboratory safety, and hands-on learning. While the preservice educator may realize the value of those courses, their exposure to the coursework gives them firsthand knowledge and confidence to run an inquiry lab or hands-on experience in their class. Incoming novice teachers with a natural science degree participated in lab coursework before graduating from their program of study (Lin & Tsai, 2018).

Demonstrating specific techniques provided by lab professors and the actionable feedback supplied to the preservice teacher is invaluable. The opportunity to watch someone else complete a task successfully positively affects the confidence of the individual on-lookers. Not only is vicarious learning in action, but emotional arousal as well. The excitement of the completion of a successful task motivates one to continue in that vein (Lin & Tsai, 2018).

Elementary Science Teachers without Natural Science Degrees

Elementary science teachers who do not possess an undergraduate degree in science are at a distinct disadvantage. Educators who lack a natural science degree lack exposure to the number of lab courses required for students desiring to obtain a natural science degree. To that end, laboratory techniques, equipment, and inquiry science practices are foreign (Kyle, 2020). The adverse effects of the lack of vicarious learning opportunities and emotional arousal from lab professors and classmates during the preservice stage may negatively impact educators' feelings regarding their preparedness. Educators who possess an undergraduate degree in social

science lack the fundamental scientific knowledge to adequately fulfill their duties (Chang et al., 2020).

The NGSS developers shifted much of the content taught in elementary school to middle and high school levels. Due to the lack of fundamental understanding, the idea was that the generalists (elementary school teachers) would teach the basics, and the specialists (middle and high school teachers) would teach the content that requires a deeper understanding. The frustration of lacking the fundamental skill set to conduct lab investigations competently and the absence of emotional arousal may lead to an educator leaving the profession (Donovan et al., 2018).

Elementary Science Teachers without Natural Science Degrees and Vicarious Learning

Colleges and universities possess varying requirements for degrees in social science. Therefore, educators who do not have a natural science degree span a spectrum regarding exposure to laboratory courses. Thus, it is not easy to assess whether an educator without a natural science degree experienced vicarious learning through laboratory coursework (Lin & Tsai, 2018).

STEM in the elementary classroom is mandated in schools across the country, and teachers who lack the appropriate skills do not effectively serve their students (Herbert, 2018). A laboratory experience is where preservice educators engage in foundational science, technology, and engineering concepts. The laboratory experience undergirds the educator's knowledge of lab protocols, safety, and hands-on learning (Lin & Tsai, 2018). Teachers who do not experience the guidance of a laboratory instructor miss out on the opportunity to refine their skills as science teachers. Educators progress through similar stages in which hands-on tasks or concrete opportunities are vital (Albion & Wu, 2019). Teachers experience firsthand the struggles with

learning science; thus, clarification of the laboratory instructor is essential for the preservice teacher.

Elementary Science Teachers with Undergraduate Science Methods Courses

According to Boyd et al., (2007) teaching professionals enter the profession one of two ways. Professionals are either prepared traditionally or non-traditionally. The traditional route is the predominant pathway into the school. Non-traditional routes to the classroom are called alternate routes. Thus, teaching professionals are either traditionally trained or trained alternatively. The Department of Education falls under the jurisdiction and responsibility of the individual states. Therefore, the New Jersey State Department of Education is the governing body determining the requirements for education professionals entering the field (Boyd et al., 2007).

To meet the growing need for public school employees, schools across the country reduced the rigorous requirements and expectations, thereby removing the barrier to entry into the teaching profession (New Jersey Department of Education, n.d.). The decision made by various school districts may address the need to fill classrooms with adults. It does not, however, ensure the adequate preparation of said adult. Since the barrier of entry is lower for alternative route educators, they enter the classroom lacking the fundamental knowledge necessary to prepare them for success in their new position (Matsko et al., 2021).

Elementary Science Teachers without Undergraduate Science Methods Courses

Science methodology courses serve as a lead-in to the best practice and most up-to-date information on science instruction in the classroom. The preservice teacher who lacks experience in the science methodology course may rely on how they learned science as a student (Canipe & Coronado Verdugo, 2020). Depending upon antiquated techniques in the classroom is a practice

that can be a detriment to the student. Teachers who do not provide relevant experiences to their students inadvertently fail to prepare them to meet STEM challenges in the future. It is imperative that preservice teachers be equipped with alternative ways to close the gap for the teachers lacking science methodology courses (Albion & Wu, 2019).

The strain between content and general pedagogical approaches is not new (Richmond et al., 2018). The introduction of STEM education occurs in elementary school. Therefore, elementary teachers need preparation. Educators who possess a natural science degree have a background in laboratory sciences. However, educators who lack the science methodology course do not have this background, which leads to anxiety when attempting to teach it to students (Canipe & Coronado Verdugo, 2020).

Traditional Teacher Programs

The traditional route to becoming a public-school educator in New Jersey is to major in education or double major in education and another discipline. New Jersey does not require an elementary teacher to hold a degree in any natural science field. However, since all elementary teachers possess an education degree, exposure to science methods courses occurs, depending on the university one attends. Science method course offerings appear in preservice education programs for all education majors (Singh, 2022). Therefore, elementary teachers benefit from the methodology of science instruction (Colson et al., 2021; Cowley et al., 2020; Long, 2019).

Preservice teachers exposed to science methods courses display a positive attitude toward teaching the assigned content (Long, 2019). To dismiss the benefits of science methods courses excludes one of the most critical parts of the preservice education process and experience. Science methods courses expose preservice teachers to subject-specific practices such as theories that support science instruction, lesson planning, inquiry-based instruction, project-based

instruction, and assessments. Many people perceive science classes as complicated, intimidating, or uninteresting. Thus, science method courses are necessary for the success of the future teacher (Long, 2019).

Traditional Teacher Programs and Social Arousal

The traditional teacher preparation program provides opportunities for preservice teachers to experience what Lin and Tsai (2018) called social arousal. Colleges and universities that offer the traditional route to teaching arrange opportunities for preservice teachers to engage in classroom instruction before being hired. The design of the field experience is such that the individuals completing this route receive actionable feedback, praise, tips, and tricks of the profession. The experience also supplies the novice with a veteran educator who may or may not work in the same school and thus an individual in a non-evaluative position to support the novice upon entering the field of education.

Most teacher preparation programs do not prepare primary and elementary teachers to incorporate engineering practices into their classrooms, which is one source of diminished efficacy in science. A preservice educator will only gain experience in teaching science if the field experience occurs with a veteran science teacher. Since teachers are inadequately prepared to teach the required science, alternative methods need exploration (Carrier, S. J.et al., 2018). The United States has become increasingly dependent on technology. The *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* developed by the National Research Council identified vital scientific and engineering practices that all students should learn during K-12 education (Hammack & Ivey, 2017).

With the release of the NGSS, there has been a call to shift how science is taught: from teaching facts to having students construct explanations of phenomena. Pedagogical content

knowledge and confidence in implementing the standards are essential to student success. The critical thinking component of science education is prominent and must not go unaddressed. The country's shift in science standards and scientific education quality must reflect the level educators must meet. Thus, social arousal experienced by the preservice teacher is vital. Said experience can only come through time spent with the veteran teacher (Donovan et al., 2019).

Traditional Teacher Programs and Performance Accomplishments

Traditional route teachers can engage in fieldwork. The fieldwork allows the teacher trainee to perform classroom tasks without the total pressure of state and district mandates. During this time, veteran teachers mentor teachers in training in the classroom. Positive experiences during this period support the teacher trainee in future scenarios when they begin to grapple with their efficacy (De Neve et al., 2015; Depaepe & König, 2018). Past experiences allow novice teachers to reflect on successful classroom practices (Milner et al., 2012). It is in the reflection that an educator trainee has a reference point (Bandura, 1997).

Traditional Teacher Programs and Vicarious Learning

Teachers who participate in the field service opportunity benefit from the eyes and ears of veteran teachers (Bandura, 1997). Educators receive feedback from mentoring teachers on what they do well. They can do better, thereby providing the incoming educator with the opportunity to build confidence before signing the contract to teach. Teachers must believe they affect student performance positively (Kim & Seo, 2018).

Alternate Route Programs

Alternate route teaching education programs provide qualified teaching staff to districts needing educators (Chen et al., 2016). In response to a shortage of qualified teachers in the United States in the mid-1980s, alternative (to university-based teacher education) routes into

teaching became more common. Since then, alternative certification programs have become even more numerous (Kara et al., 2021). More often than not, many alternate route teachers acquire teaching positions in urban school districts. Educators seeking a teaching license in New Jersey must meet several qualifications. The qualifications are as follows:

- possess a bachelor's degree,
- a grade point average of 3.0 on a 4.0 scale,
- and a certificate of eligibility that requires 50 hrs. of pre-professional experience, and
- pass a state and federal background check.

Alternate route teachers are allowed to complete the 50-hour requirement while teaching students. Alternatively, traditional route teachers must meet the following criteria:

- possess a grade point average of 3.0 on a 4.0 scale,
- possess a certificate of eligibility with advanced standing, which requires 175 hours of clinical experience, with at least 100 hours occurring the semester before the full-time clinical practice, and
- teach in a school setting full-time, 40 hours over five days for one semester.

The alternate route programs have lower standards and provide school districts with educators who practice teaching on the go. It is essential to mention that while the barrier of entry into the profession is lower for alternate route teachers, it does not speak to their level of intelligence or motivation to successfully discharge the duties of a classroom teacher. In contrast, traditional route teachers practice the craft of teaching under the watchful eye of a veteran educator before an offer of employment by any one school district (New Jersey Department of Education, n.d.).

Alternate Route Programs and Social Persuasion

Encouraging words and praise characterize social persuasion. Individuals who choose the alternate route to teaching receive social persuasion while experiencing training on the go (Lin & Tsai, 2018). The self-efficacy of the alternate route teacher encounters a host of emotions when they enter the classroom for the first time. Depending upon the university they are associated with, the classes they are required to take start several weeks after the school year. If the alternate route teacher waits before entering their coursework, a challenge to their self-efficacy occurs before starting training. Alternate route programs intend to flatten the curve of the teacher shortage crisis, but the design of many programs is lacking (Boyd et al., 2006).

Teach for America is a well-established program that provides extensive training for individuals who choose the alternative path to teaching. Founded in 1989, Teach for America works diligently to provide the most qualified educators possible (Duncan & Secretary, n.d.). Seminars, training classes, and coaching start way in advance of the alternate-route teaching. Teach for America is an anomaly because the structure is like many traditional route programs. Thus, Teach for America participants experience social persuasion. Teachers report a higher self-efficacy from role-playing to lesson development and actionable feedback on implementing strategies learned in class. Notably, alternate route teachers who receive some preservice training report higher self-efficacy (Bandura, 1986; Bergman et al., 2019).

Social persuasion promotes high self-efficacy in preservice teachers. To that end, a direct challenge ensues when alternate route teachers enter the classroom. Elementary teachers spend just 6% to 13% of their instructional time teaching science (NCES, 2012), and preschool teachers devote even less time (4%-8%) to promoting science experiences (Gerde et al., 2018). With directives from supervisors and school administrators that promote math and literacy instruction

at the expense of science education, educators are indirectly encouraged to avoid an entire content area. Interestingly, the content omitted is the same subject matter area that promotes the skills school districts taut as necessary. Critical thinking, problem-solving, collaboration, and social responsibility are among those skills (Lin & Tsai, 2018).

Alternate Route Programs and Performance Accomplishments

Performance accomplishments are necessary for the growth and development of teacher trainees (Lin & Tsai, 2018). Unfortunately, teachers entering the field through the alternate route program are at a disadvantage. Although teachers experience coursework while employed, the opportunity to develop as an educator and build previous accomplishments does not exist. The alternate route pathway allows for a teacher's placement without prior fieldwork experience. Therefore, an educator lacks the preparation period to refine instructional practices (Colson et al., 2021).

Alternate Route Programs and Vicarious Learning

Teachers participating in alternate route programs lose out on the field experience process. Since the opportunity to build efficacy before entering the classroom is nonexistent, the encouragement to educators is to build effectiveness along the way. Building self-efficacy before the accountability of classroom success far outweighs the learn-as-you-go model (De Neve et al., 2015).

Experience under Five Years

Bandura's (1997) hypothesis of self-efficacy recommends that adequacy might be the most malleable during early opportunities for growth. Consequently, the principal year of instructing could be an introductory period in advancing educator viability. Herein is the connection between vicarious learning and social persuasion. In particular, the backings they

experience in their school setting are weighty for their prosperity (Gordon & Lowrey, 2017; Ingersoll, 2001). One method of supporting teachers is to provide another teacher on which the novice may bounce ideas. The veteran teacher becomes the main point of contact for the novice, thereby providing opportunities for the novice teacher to learn vicariously. The veteran teacher mentor also provides emotional arousal for the novice teacher. The positive arousal supplies the novice with much-needed support and increased efficacy in the new role (Lohwasser et al., 2020).

Traditionally, teachers with less than five years of experience possess less effective classroom practices than their veteran counterparts (Brown et al., 2018). Novice teachers with less than five years of experience in the classroom must master many new skills. Among the many skills to master are classroom management, school and district policies, standard operational procedures, and state mandates, including but not limited to standardized testing and students' social and emotional needs. Beginner educators face many difficulties during the principal years in their instructing professions. These difficulties range from swarmed study halls, responsibility pressure, different needs of students, various ability levels, and students testing the constraints of homeroom rules (Kara et al., 2021). While these matters play an essential role in the classroom, the focus on curriculum may be in the background of concern. Research suggests that teacher turnover is exceptionally high during the first year of teaching, with 40%–50% of new teachers in the United States leaving within the first five years of entry into teaching (Ingersoll, 2001; Kara et al., 2021). A novice teacher's most vital practices are a strong understanding of the curriculum and time-tested instructional strategies (Craven & Trygstad, 2020). However, teacher experience was not a significant predictor of leaving a teaching career, according to Ryan et al. (2017).

Experience under Five Years and Vicarious Learning

Among the many tasks of newly minted educators, support from administrators and supervisors is one of the most sought-after matters (Wang & Zhang, 2021). The overwhelming expectations placed on new teachers are substantial, and therefore support in the form of modeling lessons, providing needed supplies, and actionable feedback are encouraging to new educators. Simply modeling lessons for new teachers has been shown to increase self-efficacy, according to a study conducted by (Kara et al., 2021).

Self-efficacy in teaching is the belief that one's teaching efforts can influence how well all students learn, including those unmotivated or demanding. In considering this powerful mindset, one can conclude that teachers not only hold themselves to a high standard but stake their professional reputation on the achievement of their students (Bandura, 2018; Cordier et al., 2015).

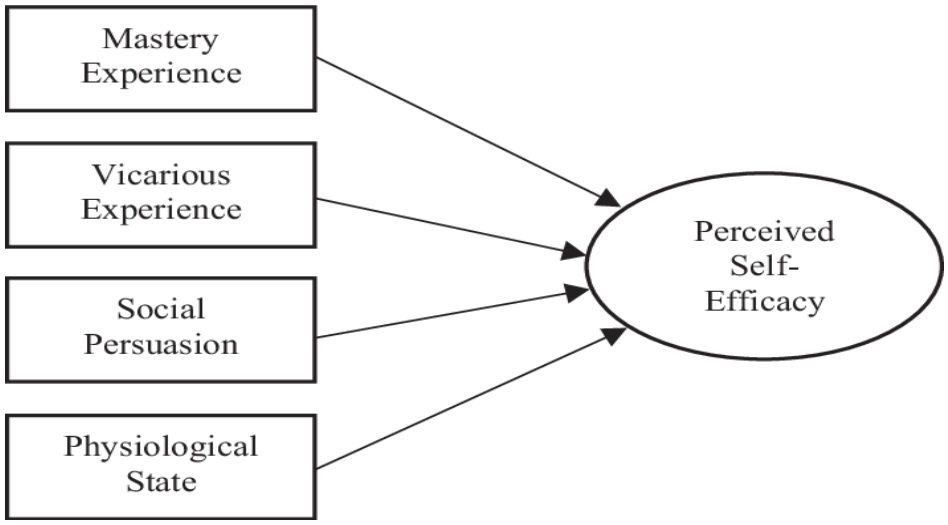
Five or More Years of Service

When turning attention to curriculum and instruction, 68% of elementary novice teachers report that mathematics instruction should focus on ideas in depth, even if that means covering fewer topics. In comparison, 80% of their veteran counterparts know that covering mathematics topics in depth is superior to not (Craven & Trygstad, 2020). Nixon et al.'s (2018) study affirmed that the number of years an educator teaches encourages the development of subject matter knowledge for the topics taught. Interestingly, (Campbell et al., 2016) determined that although content area teachers provide coherent, sophisticated, content-focused explanations, teachers did not use subject matter knowledge to determine how to sequence topics. The number of years of service and the degree type did not influence the sequence decisions either, indicating an overemphasis placed on five or more years of teaching experience. According to Cologon et al.,

(2020), the longer an educational professional teaches content not within their expertise, the more content-specific knowledge dissipates.

Figure 2

Perceived Self-Efficacy and Outcomes



Note. Bandura's sources of the model of self-efficacy and outcomes. *public domain

Purpose of the Study

The self-efficacy of primary and elementary science teachers is not as high as one would like (d'Alessio, 2018). Mastery experience, vicarious experience, social persuasion, and physiological state work together to form how the educator will view their effect in the classroom. Teachers' beliefs about their content self-efficacy are essential because it has implications for their teaching practice and student outcomes (Gerde et al., 2018). Sometimes, the emotion is caused by receiving a teaching assignment in which the educator has low efficacy. Negative emotions are related to teaching behavior and discontent to attrition (Harmsen et al., 2018).

Consequently, the decline of science instruction in the elementary classroom is detrimental to student achievement and only widens the achievement gap. Elementary teachers

spend a negligible amount of their instructional time teaching science (NCES, 2012), and preschool teachers devote even less time instructional time promoting science experiences (Gerde et al., 2018).

NCLB required state testing and accountability reporting. Currently, science must be tested and reported publicly in three grades—at least one grade in elementary, middle, and high school levels. However, teachers reportedly focus on literacy and mathematics while minimizing time on tasks in science (Gerde et al., 2018; Milner et al., 2012).

In the State of New Jersey, the elementary science test occurs in the fifth grade. The fifth-grade standardized science test assesses science content from Grades K through 5. Therefore, the efficacy of elementary science teachers in Grades K through 5 is significant to content delivery. While there are other contributing factors, unfortunately, declining instructional time in the elementary science class is among those factors that impede students' ability to demonstrate proficiency on state-level standardized science exams (Gerde et al., 2018; Milner et al., 2012).

Teacher self-efficacy refers to the extent to which a teacher believes they will have the capacity to affect a student's performance (Bandura, 1977, 1989, 1999; Bruijns et al., 2021). Furthermore, according to SCT, self-efficacy is a significant determinant of underlying behaviors (Bandura, 1989). Elementary science teachers need both a breadth and a depth of knowledge to accurately convey science and engineering practices to their students (Hammack & Ivey, 2017).

Science teaching efficacy depends on teachers' pedagogical and content knowledge, as evidenced in the science and engineering practices in the NGSS, specifically the practice of engineering (d'Alessio, 2018; Hammack & Ivey, 2017). Engineering standards are new to teachers in all grade levels; however, elementary science teachers are at a disadvantage (Hammack & Ivey, 2017). Teachers possess little control over the school, district, and state-level

mandates (Bandura, 2000). Professional development opportunities will aid in increasing elementary teachers of science confidence amid the aggressive expectations of NGSS (Bell et al., 2020; Chen et al., 2016).

Along with the new engineering standards, the nature of science (NOS) is embedded within the NGSS (Achieve, 2013). Prior to the development of NGSS, science education was rudimentary and skill-based. However, with the institution of the NGSS, habits of mind in the form of NOS are now interwoven in the fabric of the science standards precipitating another level of anxiety resulting in low science teaching efficacy in elementary science teachers. The primary issue within the world of science education is that of the underprepared classroom teacher. With the lack of preparation of the primary and elementary school teachers, the practice leads to low self-efficacy. Teachers with high efficacy also hold their students to a higher standard. Teacher self-efficacy is highly departmentalized. Primary and elementary teachers have varying degrees of content knowledge concerning literacy, math, and science. Since there is a large degree of variation regarding content knowledge level, students are at the educational mercy of the educator before them (Gerde et al., 2018).

A secondary issue in the elementary science classroom is the amount of instructional time routinely stolen from the time allocated to teach science. National trend data show a decline in instructional time in the elementary grades on science instruction over the past two decades (Gerde et al., 2018). Elementary teachers spend little instructional time teaching science (NCES, 2012) and preschool teachers devote far less time instructional time to promoting science experiences. State-level data show a wide variation in the amount of class time spent on science education and a positive relationship between the amount of class time and student achievement

scores in science as measured by the National Assessment of Educational Progress Grade 4 assessment (Gerde et al., 2018).

Attrition

The term *burnout*, coined by psychologist Freudenberger, is "a feeling of exhaustion and fatigue" (Caruso, 2019, p. 1). There is a connection between attrition and emotional arousal due to the experience of stress and anxiety (Lin & Tsai, 2018). The teaching profession is highly stressful (Harmsen et al., 2018; L. E. Kim et.al., 2019), and there are times when the teaching assignment causes stress which in turn causes a stress response. Approximately one-third of teachers report being stressed or extremely stressed. Often the response, especially in the first five years of teaching, leads to build-up, resulting in an educator leaving the profession (Farmer, 2020; Roberts et al., 2021).

Between the years 2000 and 2010, 76,319 traditionally prepared teachers left their careers, while 76,269 alternate route teachers decided to leave the profession, suggesting that the pathway teachers choose for entering the education profession alone does not affect attrition (Bailes & Guthery, 2019). Several studies investigated various reasons for this phenomenon (Harmsen et al., 2018; Ingersoll, 2001; L. E. Kim et.al., 2019). There are many factors, such as teacher evaluations, disrespectful students, overbearing parents, retirement, the breakdown of the nuclear family, community disengagement, and administration, contributing to why teachers exit the career. An educator's teaching assignment may increase the stress level of an educator when one considers those factors mentioned above. Constant interactions with unresolved negative social arousals lead to a high level of attrition (Lin & Tsai, 2018).

Schools, districts, and, most notably, students are affected by the rate of teacher attrition (Dailey & Robinson, 2017). Several studies (Dunn et al., 2017; Farmer, 2020; Garcia & Weiss,

2019; Geiger & Pivovarova, 2018) agree that low salaries, quality of teacher preparation programs, overwhelming workload, and poor working conditions account for the teacher shortage in the United States. According to the NCES, 8% of teachers leave the profession yearly, and another 8% move to other schools, bringing the total annual turnover rate to 16%. Nearly 24% of teachers leave after one year, 33% leave after three years, and 40-50% leave within their first five years (Geiger & Pivovarova, 2018; Raab, 2017). Teachers having experienced preservice science training aid in mitigating the attrition rate for urban science teachers. The study also suggests a connection between the earned natural science degree and the target science training received by participants (Friedman et al., 2019).

Pedagogy

Teachers are most self-efficacious when their experiences provide them with the tools they need to be effective: pedagogical strategies, an understanding of how to use educational resources, and knowledge of the content they teach (Chen et al., 2016; Cisterna et al., 2018). One such educational resource available to teachers is the use of instructional videos. However, there is no framework for developing online science videos, which teachers can easily find on YouTube (Kulgemeyer, 2018).

Donovan et al., (2018) reported that very few studies had explored elementary teachers' knowledge of and confidence in NGSS Science and Engineering Practices (SEP) instruction. The framework of the NGSS is based on a rich and growing body of research on teaching and learning in science, as well as on nearly two decades of efforts to define foundational knowledge and skills for K-12 science and engineering (National Academies Press, 2012). The difference between teachers and scientists is pedagogy (Donovan et al., 2018). Thus, demanding research-

based, adequate professional development opportunities are of paramount importance, especially in instructional practices (Colson et al., 2021).

One of the primary jobs of a teacher is to uncover student misconceptions and gaps in the understanding of the students sitting in the classroom. When teachers lack fundamental science subject matter knowledge, ascertaining gaps in the student's learning or lack of understanding becomes increasingly challenging for the educator. Cisterna et al (2018) commented that understanding the content makes it difficult for elementary teachers to interpret and respond to student ideas. Lack of pedagogy impedes student academic achievement. The expertise elementary teachers may develop for one particular science topic taught at a specific grade level does not transfer to the teaching of another science topic at a different grade level.

Pedagogical content knowledge is a necessity to teach science authentically. While elementary teachers may be able to point out some misconceptions, academic language is essential (Cisterna et al., 2018). When students receive teacher feedback that does not contain academic language, the student may not make the necessary connections. Teachers draw upon a wealth of knowledge daily to deliver accurate science content; however, being equipped with nuanced knowledge in several areas of science is vital. It is at this juncture that pedagogy and training come together. Brockway et al.'s (2020) findings showed that these 40 teachers struggled more with noticing how specific activities related to addressing student misunderstandings and taking into consideration students' prior knowledge and experiences when selecting lesson activities.

Professional Development

Teachers are in a precarious situation because the art of teaching is delicately intertwined with science and how science is practiced daily in the industry. Teachers should avoid

elementary memory-based science (National Academies Press, 2007). Teachers may rely on mastery experiences, such as preservice and professional development training, to meet students' needs and increase student achievement. Therefore, professional development opportunities are viable solutions to bridging the gap between minimal pedagogical and content understanding and complete confidence, as displayed by the teacher. There is a real opportunity to focus on developing student teachers' pedagogical content knowledge (Loughran & Nilsson, 2012). Participation in professional development opportunities provides the educator with performance accomplishments. Performance accomplishments are critical to the success of an educator because it flows seamlessly when professional development offerings are positive experiences for the educator. Teachers reported feelings of increased efficacy due to their involvement in professional development offerings (Lin & Tsai, 2018).

Professional development structured around existing evidence for effective professional development in science education positively influences teachers' self-efficacy (Bandura, 1989, 2000; Mallon et al., 2020). Several studies state that professional development during the preservice stage of a teacher's career has shown promise in strengthening subject matter knowledge (Nixon et al., 2018). Studies have long supported the concept of new teacher mentorship and training (Cisterna et al., 2018; Loughran & Nilsson, 2012; Nixon, 2018). Preservice teachers have shown a positive attitude and efficacy when exposed to science training courses. Notably, teachers specifically trained to teach science in urban school districts mitigate attrition in a high-needs area, such as science education (Friedman et al., 2019). A two-year study conducted by Barata et al. (2019) indicated that when an educator is exposed to professional development, they gain new approaches to teaching content. The attainment of new methods and strategies encourages positive self-efficacy and provides mastery experiences for

educators. Professional development centered around inquiry-based learning is another opportunity for educators to gain experience supporting students in knowledge acquisition (Lin & Tsai, 2018). To that end, professional development is a crucial component in aiding elementary teachers of science. Professional development may limit the misconceptions passed on by well-intended, less-informed educators. Cisterna et al (2018) comments that elementary teachers must engage students in developing, using, and critiquing models instead of explaining the model to the students. Professional development is vital because students are expected to create, revise, and critique the models of others. Bandura (2018) informs researchers of the need for mastery experiences to support self-efficacy, and professional development provides the space and resources to accomplish that goal.

Competence

Loughran and Nilsson (2012) claimed that subject matter knowledge, coupled with remaining in the same grade level, enhances teaching self-efficacy. Büttner et al. (2019) states that competent teachers provide high-quality instruction, affecting student progress. The dismal reality is far different. While qualified teachers affect student enthusiasm, a link to student achievement did not occur. Self-efficacy remains a significant influencer on student achievement. A teacher's perception of their subject matter competence is also an essential factor.

Loughran and Nilsson's (2012) revelation suggests that teachers who switch classes and grade levels are ill-prepared to teach the science in that new grade-level thereby, supporting the statement that elementary science teachers are not attaining content mastery. They are simply teaching at the level of science presently known. If educators experience performance accomplishment by achieving a minimal amount of success, their efficacy is high (Bandura,

1997). When said educator moves to another grade level, an action outside of their control (Bandura, 2000), arousal anxiety will arise (Lin & Tsai, 2018), thereby diminishing the educator's self-efficacy. While this serves the immediate need to fill a teaching position, it does not promote the deep level of understanding necessary to provide a foundation upon which middle and high school teachers may build.

With directives from supervisors and school administrators that promote math and literacy instruction at the expense of science education, educators are indirectly encouraged to avoid an entire content area. Interestingly, the content area omitted is the same content area that promotes all of the skills school districts taut as necessary. Critical thinking, problem-solving, collaboration, and social responsibility are among those skills. Elementary teachers spend just 6% to 13% of their instructional time teaching science (NCES, 2012), and preschool teachers devote even less time (4%-8% of instructional time) to promoting science experiences (Gerde et al., 2018).

Self-determination theory explicitly states how teacher behavior relates to students' motivation and engagement (Deci & Ryan, 2008; Goudsblom et al., 2018). The intrinsic motivation construct explained within self-determination theory is also considered cognate to intrinsic valuing (Burns et al., 2019). Self-efficacy is closely related to competence (Castelijns et al., 2012); however, a lack of competence, or the perception of the lack thereof, affects motivation (Carr, 2020) because a basic psychological need is unfulfilled (Castelijns et al., 2012).

Social persuasion is a factor that supports or erodes an educator's self-efficacy. The environment in which a teacher serves is crucial to the success of said educator. Words of affirmation from veteran colleagues, supervisors, and administrators motivate an educator to

seek resources that will support their role in the classroom and thus boost the efficacy and competence of the classroom teacher. Conversely, a toxic environment, constant berating of educators, lack of support from families, schools, and lack of resources erodes self-efficacy because it causes one to question if they are competent enough to make up for their deficits (Lin & Tsai, 2018).

Summary

Teachers play a significant role in the lives of their students. Bal-Taştan et al. (2018) reported a significant impact of teacher self-efficacy and motivation on academic achievement in science education. However, a lack of motivation on the part of preservice teachers (Yilmaz-Tuzan, 2008) was evident in the time spent educating students on science content within the classroom (Gerde et al., 2018; Milner et al., 2012). Individuals enter the teaching profession for different reasons. Some want to shape the next generation's minds or pass the wisdom of their content knowledge on to children. Either way, intrinsic motivation is vital (den Brok et al, 2018).

More than ever, scientific literacy is recognized in the 21st-century workforce (National Academies Press, 2012). Developing students to compete successfully in a marketplace that demands their understanding of the natural world is the most challenging task for the educators in front of said students. The NGSS require a higher level of cognition from today's students; thus, discipline-based content preservice experiences are also beneficial. With that understanding, the idea for this study came to be. To that end, traditionally, elementary school teachers are generalists with a limited background in the sciences (d'Alessio, 2018).

Human agency, personal proxy specifically, is well documented in research (Bandura, 2000). Teachers, however, have no direct control over institutional practices. Institutional practices fall within the purview of their school district and the State Department of Education.

Very little data exists on the perception of professional competence of elementary science teachers. To complicate further performance expectations, vicarious learning, social persuasion, and emotional arousal directly affect efficacy (Bandura, 2000). Therefore, this study will extend the growing body of research in self-efficacy regarding teacher perception of their science teaching efficacy.

CHAPTER THREE: METHODS

Overview

This chapter includes the basic methodology of a quantitative, non-experimental correlation research study. The chapter begins by using standard multiple regression data analysis to address the research question. The researcher defined all variables and examined the relationship between the three predictor variables and criterion variables. The research question addressed the predictive ability of the type of undergraduate degree earned, years of teaching the same grade for elementary science teachers, and science methodology courses in undergraduate work measured by the STEBI-A. The participants, setting, data collection methods, and sample selection were examined in detail. Instrumentation, data collection procedures, and data analysis plans follow.

Research Design

The researcher used a quantitative, non-experimental predictive correlation design to investigate the relationship between the type of undergraduate degree earned, years teaching the same grade for elementary science teachers, science methodology courses in undergraduate work, and teachers' perceived self-efficacy. According to Borg et al. (2007), correlation research examines the relationships between variables by using correlation statistics in a single study. Correlation research also allows for the degree of the relationship to be assessed. The current study determined if the predictor variables, the type of undergraduate degree earned, years of teaching the same grade for elementary science teachers, and science methodology courses in undergraduate work predict elementary science teachers' perceived self-efficacy.

The predictor variable, undergraduate degree earned, was a bachelor's degree in any of the natural sciences or related fields, such as biology, chemistry, physics, earth science, and

mathematics. An example list of natural science degrees was provided at the bottom of the datasheet. Participants selected the appropriate box: natural science or non-natural science. Years of experience referred to the number of years an educator taught science in the same grade level. Science methodology courses referred to undergraduate courses that build the knowledge and skills of educators based on current ideas and research about how teachers learn to teach science and how students learn science. Participants indicated participation in said course or courses by checking yes or no on the participant demographic data sheet. According to the research conducted by Riggs and Enochs (1990a), the criterion variable, self-efficacy, develops specific beliefs concerning one's coping ability. No variables were manipulated, and the study's goal was to answer the research question.

Research Question

RQ: How accurately can elementary science teachers' perceived self-efficacy be predicted from a linear combination of years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program?

Hypothesis

$H_0$1: There is no significant predictive relationship between the criterion variable, self-efficacy, and the predictor variables undergraduate degree earned, methods course in undergraduate studies, and years of teaching the same grade level.

Participants and Setting

Sunnyvale Public Schools employs 586 teachers. Based upon The State of New Jersey funding requirements, four of the 10 schools receive Title I funding, splitting the school district into two categories, with 40% of the school district considered to have a low socio-economic

status and 60% being high socio-economic status. For this study, the total number of participants sampled was 71, more than the minimum required number of 66 (Borg et al., 2007).

Population

A population of elementary science teachers from one school district in New Jersey was used in this study and a snowball sample was drawn. The educators represented elementary teachers from a suburban school district. Participants represented both genders and multiple age ranges. The target population consisted of elementary teachers from kindergarten through fifth grade.

Table 1

Participant Demographic Data

Gender	
Male	4
Female	67
Do not wish to disclose	0
Age	
20-29	10
30-39	27
40-49	16
50-59	16
over 60	2
Degree type	
[a]Natural Science	9
[b]Non-natural science	62
Years of elementary science teaching	
1-3	8
4-6	13
7-9	7
over 10	43

Did you participate in a science methodology course?	
Yes	29
No	42

Gender	
Male	4
Female	67
Do not wish to disclose	

Age	
20-29	10
30-39	27
40-49	16
50-59	16
over 60	2

Degree type	
[a]Natural Science	9
[b]Non-natural science	62

Years of elementary science teaching	
1-3	8
4-6	13
7-9	7
over 10	43

Did you participate in a science methodology course?	
Yes	29
No	42

Note. [a]Natural science degrees include astronomy, biochemistry, biology, chemistry, earth, environmental, geological science, and physics. The non-science-related degrees include all other degree types.

Participants

The participants for the study came from a snowball sample of elementary school teachers located in New Jersey during the 2022-2023 academic school year. The Sunnyvale Public School superintendent received a letter explaining the study's purpose and requesting permission to contact teachers who participated in the summer workshops. The letter included

disclosure, privacy, and survey submission procedures. School districts were not privy to individual survey results, as explained in the letter received by the Sunnyvale Public School personnel. The introduction letter to the superintendent of the Sunnyvale Public School appears in Appendix A.

Sample Size

The minimal sample size requirement for multiple linear regression is at least 66 participants (Warner, 2013). Therefore, this study required at least $N = 66$ participants. The information above details how the participants were selected. Considering incomplete surveys, a reasonable minimum of participants was $N = 125$. The recommended sample size for correlation research designs is a minimum of $N = 66$ for a medium effect size with a statistical power of .70 at the .05 alpha level (Borg, 2007).

Setting

Data were collected through an online survey during the 2022-2023 academic school year. Before starting the online survey, participants were asked to read the consent document. The information also stated that proceeding to the actual survey questions constituted agreeing to all consent document elements. Participants accessed the STEBI-A survey via an email with a link to Survey Monkey. The email containing the link to the survey appears in Appendix B.

Instrumentation

The STEBI (see Appendix C) is designed to measure science teaching self-efficacy. Designed by Riggs and Enochs (1990), the purpose of this instrument was to determine the need for subject-specific teacher efficacy tools. Science beliefs and attitudes equal behavior; thus, a tool that assesses both is essential in this study.

According to research conducted by Riggs and Enochs (1990), researchers thoroughly studied the interrelationship between attitude and behavior in teachers. However, the connection between the role of belief, specifically, the part of belief and its influence on the attitudes and behaviors of elementary science teachers in the classroom, had not been examined previously. Thus, Riggs and Enochs sought to develop a valid and reliable belief instrument for elementary science teachers. The STEBI is used to measure science teaching self-efficacy and outcome expectancy with in-service elementary teachers. This 25-item instrument gathers data using the survey method. The instrument was used in several studies (Alarfaj et al., 2017; Naidoo & Naidoo, 2021; Novak & Wisdom, 2018).

Riggs and Enochs (1990) conducted a factor analysis to determine construct validity. The personal science teaching efficacy belief scale has a Cronbach's alpha of .91, and the science teaching outcome expectancy scale has a Cronbach's alpha of .73. Both parts of the tool are reliable and valid. The STEBI has 25 items and possesses a final Cronbach's alpha of 0.92 and 0.77, respectively. There are two sets of numbers because the researchers gathered initial information, which yielded the first set of Cronbach's alpha. They then removed items from the instrument and reran the analysis, which yielded the second set of Cronbach's alpha data. Seven different validity criteria were measured, and they are as follows: number of college science classes, number of high schools' science classes, a choice to teach science, use of activity-based teaching, science teaching self-ratings, subject preference, and self-efficacy scale. All criteria were assessed using Pearson's r, and each criterion was significantly positively correlated to at least one scale. This 25-item instrument gathers data using the survey method. The STEBI uses a five-point Likert scale with choices ranging from *strongly agree* to *strongly disagree*. Responses will follow the format: *Strongly Agree* = 5, *Agree* = 4, *Neutral* = 3, *Disagree* = 2, and *Strongly*

Disagree = 1. However, the scores were reversed for negatively worded items. The negatively worded items are 1, 2, 4, 5, 7, 9, 11, 12, 14, 15, 16, 18, & 23. In order to produce consistent values, score reversals were needed. The reversals do not occur on every other item. The STEBI has 25 items with two subscales. The STEBI is a scale, and a copy of the tool is found in Appendix C. Permission was granted by the developers to use the instrument, and the permission can be found in Appendix D. The use is for noncommercial educational research purposes, and a fee will not be charged.

The STEBI has a minimum score of 25 and a maximum of 125. Scores that fall between 25 and 62 are considered low efficacy, while scores between 63 and 125 are considered high efficacy. Thirteen items assess personal science teaching efficacy, and 12 measure science teaching outcome expectancy. Since each item can be scored from 1 to 5, a score of 3 or higher represents self-efficacious teachers, and a score less than 3 represents low efficacy. Survey completion typically takes no longer than 15 minutes.

Procedures

The researcher applied to the Institutional Review Board (IRB). The researcher gained IRB approval before the data collection process (see Appendix E). The superintendent of Sunnyvale Public School received an email requesting permission to conduct research and describing the purpose and rationale of the study, the researcher's background, and school affiliation (see Appendix A). This request was emailed approximately one month prior to the date of the study. Once the researcher received permission from the IRB, a recruitment letter was given to the institute's director, asking for his assistance in recruiting teachers for this study (see Appendix B).

Once teachers consented to participate in the study, they received electronic instructions to complete the survey on their own devices and outside regular work hours. The researcher provided the opportunity for participants to enter a drawing to receive one of two gift cards in the amount of $150 as compensation for completing the survey. The time to complete the survey was approximately 5-10 minutes, including the demographic section. Participants received a one-week reminder letter to complete the survey (see Appendix F) and a final reminder letter via email (see Appendix G). The permission to use the Sunnyvale Public School participants is located in Appendix H. Data were electronically submitted to the researcher via SurveyMonkey™. All participants will remain anonymous.

All information identifying the participants was protected at all data collection stages. Data were stored securely on a password-protected computer, and only the researcher was able to access the records. While data was not in use, the computer remained stored in a locked drawer. The data will be retained for five years after the completion of the research study and then permanently deleted. After downloading the completed survey data from SurveyMonkey™, the results were analyzed using IBM Statistical Package for the Social Sciences (SPSS).

Data Analysis

In the current quantitative, non-experimental correlational study, the researcher used a multiple linear regression approach to analyze data from the STEBI survey collected from teacher participants. Data was used to determine the predictive relationship between the criterion variable, elementary science teacher self-efficacy, and the combination of predictor variables years teaching the same grade level, undergraduate degree type, and methods course taken as undergraduates. The most appropriate choice, multiple linear regression, allowed the researcher to reject or fail to reject the null hypothesis. Multiple linear regression allowed the researcher to

analyze the relationship of one criterion variable on a continuous scale with two or more predictor variables that have not been manipulated (Borg et al., 2007; Warner, 2013). The researcher collected data from a single population group, elementary science teachers. Within the models generated by the multiple linear regression, an alpha level of .05 is chosen as the threshold of significance for the individual predictor variables. Also, the 95% confidence interval (CI) reported provides information about the amount of sampling error associated with the change in odds. The coefficient of determination effect size, R^2, revealed how much shared variance was in the model.

The researcher coded data using a nominal scale, with each predictor variable representing a category (Borg et al., 2007). The predictor variables – years teaching the same grade level, undergraduate degree type, and methods courses taken as an undergraduate – were coded using a dummy-coded variable (Warner, 2013). Degree type was coded as 1 for natural science and 2 for non-natural science participants. Years teaching the same grade level was coded as follows: 1 for years 1-3, 2 for years 4-6, 3 for years 7-9, and 4 for over 10 years, and methods courses were coded as 1 for yes and 2 for no. The criterion variable is a continuous variable. These results were secured on a password-protected computer during and after the completion of the study.

The researcher used SPSS Version 26 to analyze data from the STEBI and the demographic survey. Data were used to determine the predictive relationship between the predictor variables – years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program – and the variable criterion, self-efficacy. The researcher conducted preliminary screenings by visually inspecting for missing data points and inaccuracies. Assumptions for multiple linear

regression included the assumption of bivariate outliers, multivariate normal distribution, and no multicollinearity. Descriptive statistics of mean and standard deviation were reported for the criterion variable.

The researcher used scatter plots between all pairs of independent variables (the type of undergraduate degree earned and science methods course in their undergraduate program) and a criterion variable (self-efficacy). Assumption of linearity and bivariate normal distribution focused on a linear relationship between each pair of variables. If the variables were not linearly related, the power of the test was reduced. To test this assumption, the researcher plotted a scatterplot for each pair of predictor variables, the type of undergraduate degree earned, the science methods course in their undergraduate program, and the criterion variable (self-efficacy). At this point, the researcher looked for the classic "cigar shape."

If one predictor variable (the type of undergraduate degree earned and science methods course in their undergraduate program) is highly correlated with another predictor variable, the same information about the criterion variable is known. There are times when the variables are difficult to assess. The variance inflation factor (VIF) will indicate that with a value greater than 10 (Warner, 2013). At that point, the assumption of multicollinearity is violated. If the VIF falls between one and five, it is acceptable. If no assumptions are violated, the researcher will reject or fail to reject the null hypothesis at the 95% confidence level (Borg et al., 2007).

CHAPTER FOUR: FINDINGS

Overview

The quantitative, non-experimental correlational research study aimed to explore if the degree type earned, years of teaching the same grade level, and science methodology courses in undergraduate work predict elementary science teachers' perceived self-efficacy. The predictor variables were the type of undergraduate degree earned, years of teaching the same grade, and science methodology courses in undergraduate work, and the criterion variable was self-efficacy. This chapter includes four sections: the research question and null hypothesis, descriptive statistics for the variables and scale score, the results of multiple regression analysis for each predictor variable, and a summary of the study.

Research Question

RQ: How accurately can elementary science teachers' perceived self-efficacy be predicted from a linear combination of years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program?

Null Hypothesis

$H_0$1: There is no significant predictive relationship between the criterion variable, self-efficacy, and the predictor variables: undergraduate degree earned, methods course in undergraduate studies, and years of teaching in the same grade level.

Descriptive Statistics

The participants for this survey were drawn from a sample population of 138 elementary science teachers employed in a diverse Title I school district located in a northern region of New Jersey, an urban school district during the 2022-2023 school year. Prior to analyses, all categorical data was entered into SPSS Version 26 and coded as either 1 or 2, such

as degree type, science methodology courses, and years of service. The researcher removed 67 of the 138 surveys from the analysis due to non-completion. Therefore, 71 completed and usable surveys were collected ($N = 71$). This number exceeds the minimum of 66 participants required (Warner, 2013). Of the 138 teachers who accessed the survey, 71 teachers participated in the study (see table 2). Of the 71 who participated in the survey, there were more females (94.37%) than males (5.63%).

The participants' responses to the STEBI-A were also analyzed. The five-point Likert scale scores for the STEBI-A were tallied to determine each participant's composite score. Self-efficacy was the criterion variable in this study. The STEBI-A composite scores yielded a mean score of 59.13 ($SD = 9.94$) with a minimum score of 25 and a maximum score of 125, where high scores suggest the participant has high self-efficacy and confidence in teaching elementary science.

Table 2

Descriptive Statistics

	N	Minimum	Maximum	*M*	*SD*
Choose the applicable degree type	71	.00	2.00	1.3944	.85321
Please indicate the number of years you have taught science	71	1.00	32.00	12.4085	7.61498
Did you participate in a science methodology course?	71	1.00	2.00	1.5915	.49505
Valid N (listwise)	71				

Assumption Testing

The multiple linear regression analysis was used to assess if there is a statistically significant predictive relationship between elementary science teacher self-efficacy, defined by their cumulative score measured by the Riggs and Enochs (1990) STEBI-A, and each of the predictor variables. Attempting to determine whether the assumptions for conducting the multiple linear regression analysis were met, assumption testing of independence, linearity, homoscedasticity of residuals, multicollinearity, no significant outliers, and normal distribution were conducted using SPSS Version 26 before assessing the relationship between the criterion (self-efficacy) and the predictor variables (years teaching the same grade for elementary, the type of undergraduate degree earned, and science methods courses). Cronbach's alpha coefficients were used in the study to determine reliability. Table 3 provides the regression model results.

Table 3

Regression Model Results

Model		*SS*	*df*	*MS*	*F*	*Sig.*
1	Regression	866.169	3	288.723	3.197	.029[b]
	Residual	6051.690	67	90.324		
	Total	6917.859	70			

a. Dependent Variable: Self - Efficacy
b. Predictors: (Constant), Did you participate in a science methodology course? Choose the applicable degree type. Please indicate the number of years you have taught science.

Independence

The assumption of independence of observation assesses each participant's responses to determine if the responses are independent of each other (Warner, 2013). The assumption of independence was assessed using the Durbin-Watson statistic. The Durbin-Watson statistic can range from 0 to 4. A value of approximately 2 indicates that there is no correlation between

residuals. Based upon the Durbin-Watson result 1.888, there is a slightly positive correlation. However, it also appears that the residuals are uncorrelated. Therefore, the assumption is tenable (see Table 4).

Table 4

Model Summary

Model	*R*	R^2	Adjusted R^2	*SE*	Durbin-Watson
1	.354[a]	.125	.086	9.50388	1.888

a. Predictors: (Constant), Did you participate in a science methodology course? Choose the applicable degree type. Please indicate the number of years you have taught science.

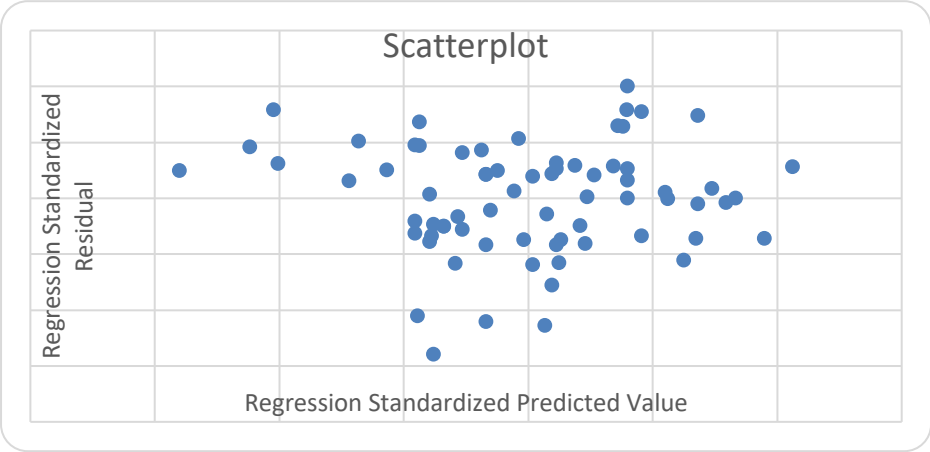
b. Dependent Variable: Self Efficacy

Linearity

The assumption of linearity determines if there is a linear relationship between the dependent and independent variables. The visual inspection of a scatterplot of the residuals suffices (Warner, 2013). Upon visual inspection of the scatterplot, if points fall between -3 and 3, the assumption is tenable.

Figure 3

Scatterplot Dependent Variable: Self-Efficacy

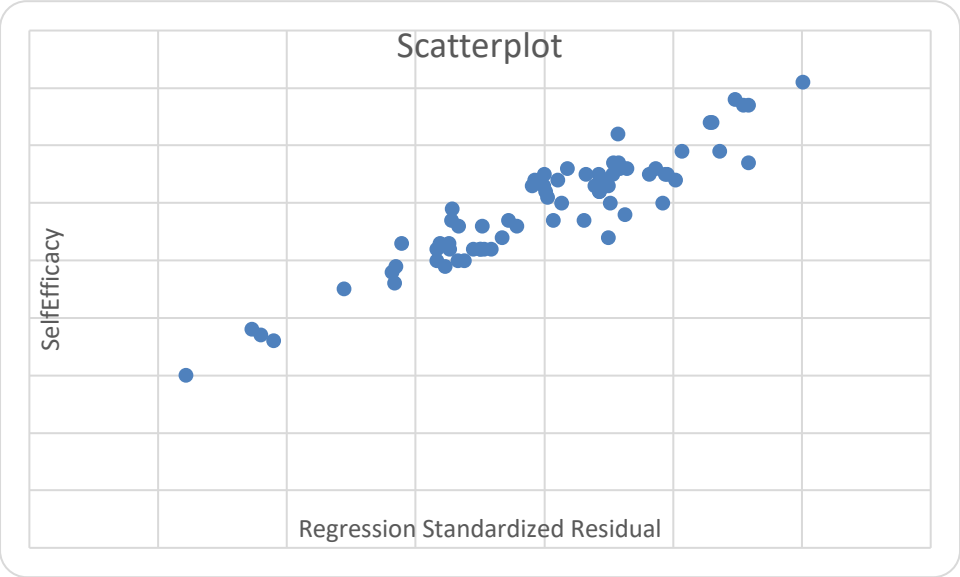


Homoscedasticity of Residuals

The homoscedasticity assumption determines if the variances of the populations being compared are equal (Warner, 2013). This assumption is tested by visually inspecting a scatterplot in which the unstandardized residuals are plotted against standardized predictor variables. The researcher is looking for a constant spread across the fitted values. This assumption appears to be met (see Figure 4).

Figure 4

Scatterplot Self-Efficacy: Regression Standardized Residual



Multicollinearity

The multicollinearity assumption refers to the amount of intercorrelation among predictor variables (Warner, 2013). This assumption is tested by analyzing correlation coefficients, Tolerance, and VIF values. Independent variables should have values greater than 0.7 and VIF values lower than 10. The assumption of no multicollinearity appears to be met (see Table 4).

Table 5

Tolerance and Variance of Inflation Data Coefficients[a]

	Unstandardized		Standardized			Correlations			Collinearity	
Model	*B*	*SE*	*Beta*	*t*	*Sig.*	Zero-Order	Partial	Part	Tolerance	VIF
1	63.241	4.487		14.094	<.001					
	-1.532	1.341	-.132	-1.142	.257	-.169	-.138	-.131	.985	1.015
	-.400	.151	-.306	-2.652	.010	-.314	-.308	-.303	.980	1.021
	1.874	2.303	.093	.814	.419	.072	.099	.093	.993	1.007

a. Predictors: (Constant), Did you participate in a science methodology course? Choose the applicable degree type, Please indicate the number of years you have taught science.

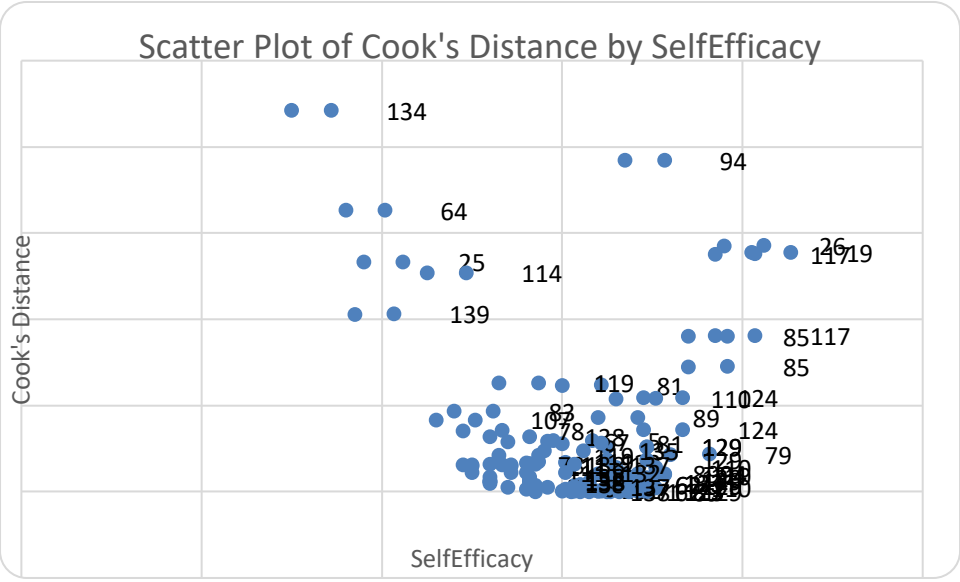
b. Dependent Variable: Self Efficacy

Significant Outliers

The possible presence of outliers was assessed using Cook's distance. The data set did not yield a value >1.0. Data cases yielding a value >1.0 would indicate a concern with the data. Case 134 yielded a value of 0.09, representing the value furthest from the cluster. These data did not return an outlier; thus, the assumption of significant outliers is tenable (see Figure 5).

Figure 5

Scatter Plot of Cook's Distance by Self Efficacy



Normal Distribution of Residuals

The P-P plot was used to test the assumption of normality (see Figure 6). The normality assumption is met when the points fall predominantly on the line of best fit. Data that fall far from the line of best fit suggests that the assumption of normality needs to be met. Upon visual inspection of these data, the assumption of normality for the regression is tenable. However, upon visual inspection of the histograms for each independent variable, two variables were not normally distributed (see Figures 7, 8, 9, and 10).

Figure 6

Normal P-P Plot of Regression Residual

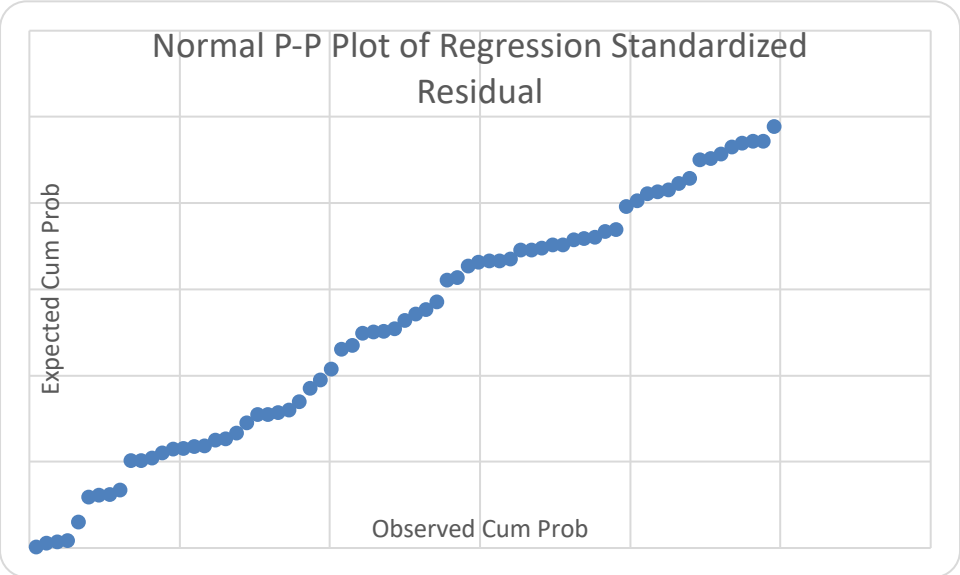


Figure 7

Histogram of Regression Standardized Residuals of Self Efficacy

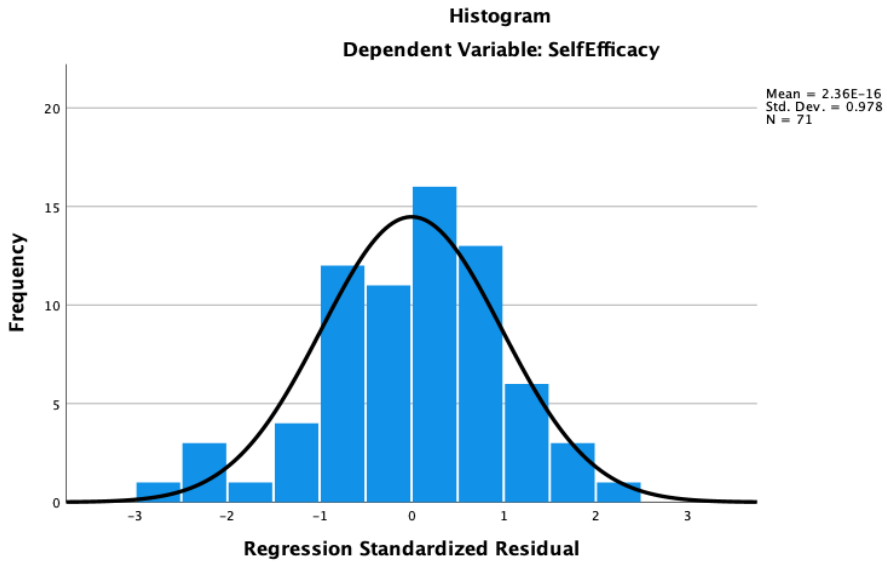


Figure 8

Histogram of Standardized Residuals of Degree Type

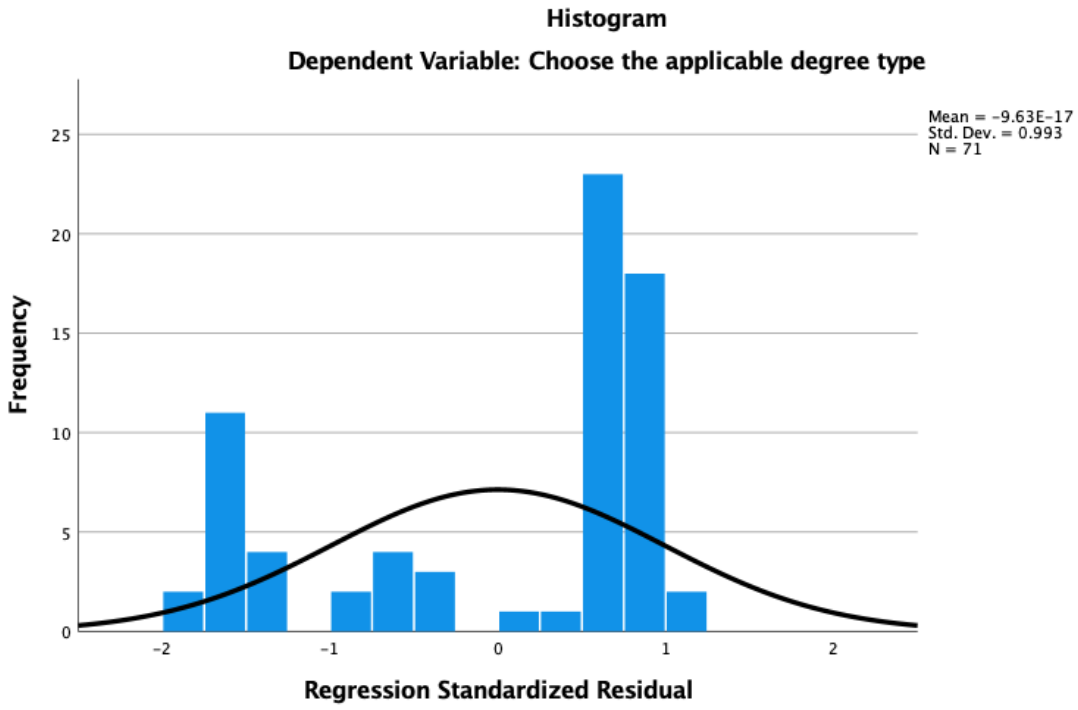


Figure 9

Histogram of Standardized Residuals of Number of Years Teaching Science Years of Teaching Science

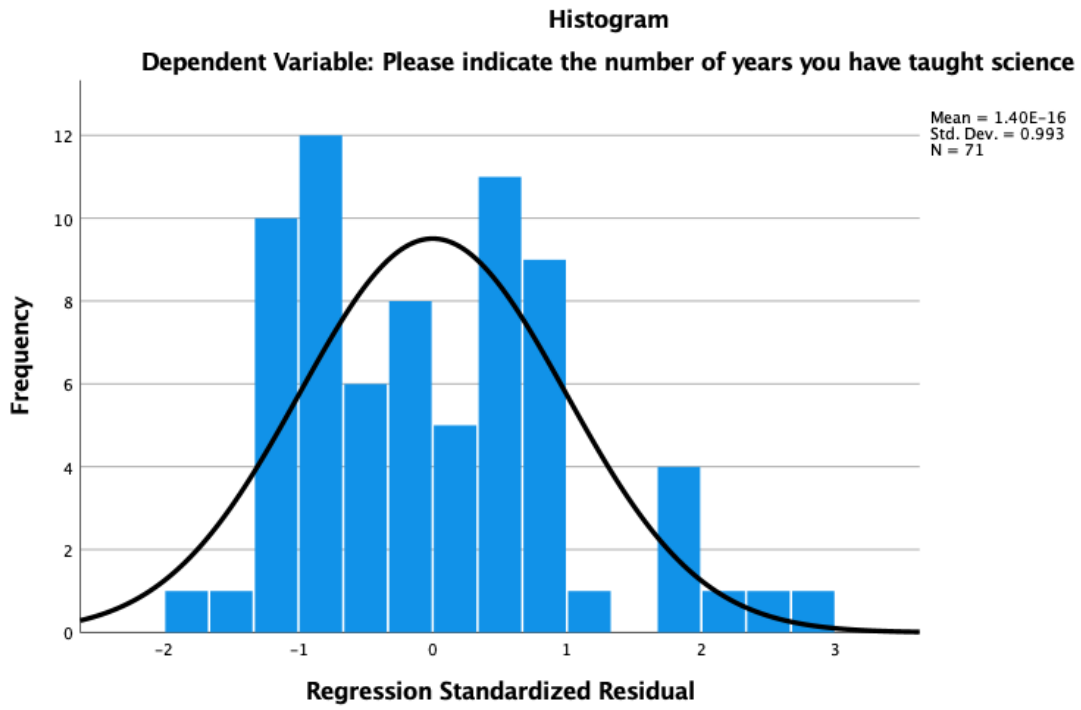
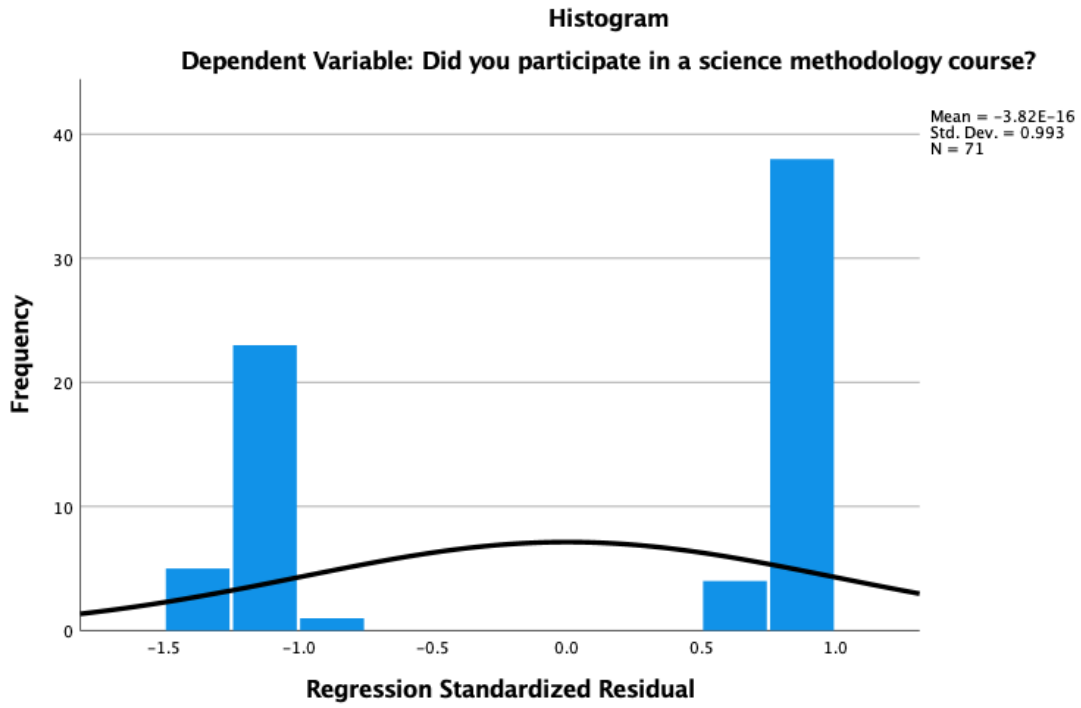


Figure 10

Histogram of Standardized Residuals of Science Methodology Courses



Reliability

Riggs and Enochs (1990) conducted a factor analysis to determine construct validity of the STEBI. The personal science teaching efficacy belief scale has a Cronbach's alpha of .91, and the science teaching outcome expectancy scale has a Cronbach's alpha of .73. Both parts of the tool are reliable and valid. The STEBI possesses a final Cronbach's alpha of 0.92 and 0.77, respectively. Due to the relatively high-reliability scales, this instrument and analogous data were relevant for the analysis. Cronbach's alpha for the overall tool is .832.

Table 6

Reliability Statistics

Cronbach's Alpha	N of Items
.832	25

Hypotheses

Null Hypothesis

The null hypothesis states there is no statistical predictive relationship between elementary science teachers' self-efficacy, years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program. Model 1 overall regression was statistically significant, with an $F(3.197),\ p = .029,$ R^2=.125. Thus, the researcher rejected the null hypothesis. The regression model explains that 12.5% of the variance accounted for self-efficacy by years of experience teaching in the same grade, type of degree earned, and science methodology courses. Thus, the null hypothesis is rejected. Number of years of service is significant based upon its p-value of p = .010. See table 6 below.

Table 7

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	*SE*	*Beta*	t	Sig.
1	Constant	63.241	4.487		14.094	<.001
	Methodology courses	-1.532	1.341	-.132	-1.142	.257
	Years of service	-.400	.151	-.306	-2.652	.010
	Degree type	1.874	2.303	.093	.814	.419

a. Predictors: (Constant), Did you participate in a science methodology course? Choose the applicable degree type. Please indicate the number of years you have taught science.
b. Dependent Variable: Self-Efficacy

CHAPTER FIVE: CONCLUSIONS

Overview

Every effort to ensure a high-quality education for American students is essential. Social inequality occurs when students cannot properly position themselves to compete for STEM careers (Davis & Schaeffer, 2020). Therefore, a study of this nature is essential, and the findings of such a study can add to the body of knowledge of additional factors that may impact student academic progress. In anticipation of addressing the lack of student achievement in science education, this quantitative study investigated the following predictive relationships between an undergraduate degree earned, a science methods course in undergraduate studies, and years of teaching the same grade level. This chapter presents a discussion of the findings, implications, limitations of the study, and recommendations for future research.

Discussion

This quantitative, non-experimental correlational research study aimed to explore if the type of undergraduate degree earned, science methodology courses in undergraduate, and years of teaching the same grade for elementary science teachers predict elementary science teachers perceived self-efficacy.

Bandura's (1977, 1986) self-efficacy and SCT formed the theoretical frameworks for this study. The study revealed a statistically significant relationship between self-efficacy and the number of years of teaching the same grade level; however, undergraduate degree earned and science methods courses did not show a statistically significant contribution to the overall model. A multiple linear regression analysis was conducted to investigate the following research question: How accurately can elementary science teachers' self-efficacy be predicted from a linear combination of years teaching the same grade for elementary (K-5), the type of

undergraduate degree earned, and the science methods course in their undergraduate program?

To establish relationships between predictor variables of perceived science elementary science teacher self-efficacy and the criterion variable and the predictor variables: years of teaching the same grade level, type of undergraduate degree earned, and science methodology courses; a non-experimental predictive correlation design, such as the multiple regression analysis, was the most appropriate (Borg et al., 2007; Warner, 2013).

Null Hypothesis

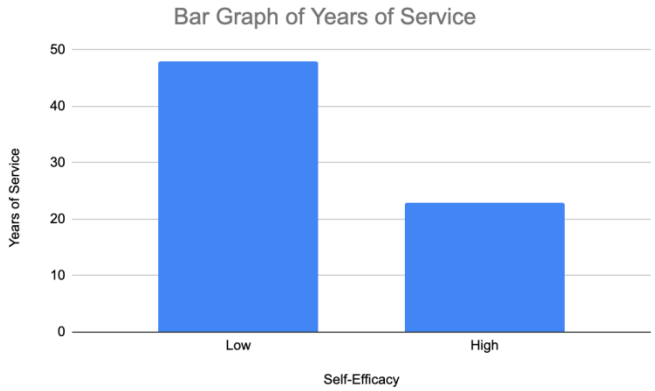
The research question asked, "How accurately can elementary science teachers' perceived self-efficacy be predicted from a linear combination of years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program?" The null hypothesis was rejected. Nixon et al.'s (2018) study affirmed that the development of subject matter knowledge for the topics taught is impacted by the number of years an educator teaches. The current study adds to the current body of knowledge that supports that idea. Campbell et al. (2016) determined that although content area teachers provide coherent, sophisticated, content-focused explanations, teachers did not use subject matter knowledge to determine how to sequence topics; thus, the number of years of service and the degree type did not influence the sequence decisions either, placing an overemphasis on five or more years of teaching experience.

Despite the findings of Campbell et al.'s (2016) study, further evidence suggests that years of service may, in fact, impact the self-efficacy of elementary science educators, whether or not they hold a natural science degree. This study further supports Campbell et al.'s (2016) study that years of service is a significant predictor of self-efficacy in educators who do not possesses a natural science degree. In addition, the study also suggests that while an educator may serve as

an elementary science teacher, they may not necessarily display high self-efficacy. As indicated in Figure 11, years of service indicate that teachers in the study have spent a significant amount of time in the classroom. Of the elementary science educators surveyed, 59 (83%) represent those with >5 years of service, and 43 (61%) represent >10 years of service.

Figure 11

Years of Service

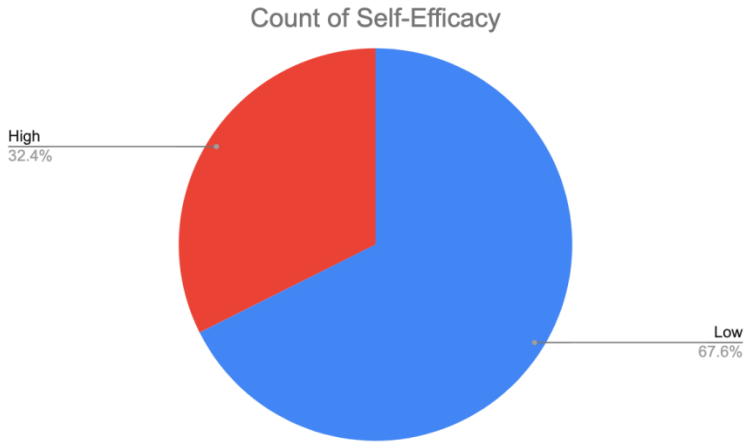


Educators with a natural science degree are exposed to a more in-depth learning experience than those who choose a different degree type. While elementary teachers do not need to hold a natural science degree, there are benefits to doing so (Campbell et al., 2016). An advantage of exposure to natural science courses for elementary science teachers is that they will have content-specific knowledge. While professional development may increase elementary science teachers' confidence levels (Bell et al., 2020), it does not provide the level of subject matter content knowledge to engender self-assurance in elementary teachers of science (Singh, 2022). To that end, the findings of this study were interesting. The findings of this study suggest no statistical significance; thus, the correlation between degree type and efficacy is not apparent see table 6.

Interestingly, one metric of the study, the values that equate to either high or low efficacy, should be considered. To measure self-efficacy, the tool assessed had a maximum score of 125. Participants scoring <65 are low efficacious educators (see Figure 12). Although years of service statistically predicts self-efficacy, the participants in this study had low self-efficacy. Due to the lack of lab courses and the limited number of natural science courses required, laboratory techniques, equipment, and inquiry science practices are foreign (Kyle, 2020).

Figure 12

Count of Self-Efficacy



Implications

The purpose of this study was to determine if elementary science teachers perceived self-efficacy was correlated to the years of teaching the same grade for elementary (K-5), the type of undergraduate degree earned, and the science methods course in their undergraduate program. A gap exists in the literature addressing the combination of the variable mentioned years of teaching the same grade level, type of undergraduate degree earned, and science methodology courses. Many studies have investigated the same variables in this study in isolation; however, the combination of variables was not examined. The study suggests that while the regression model is statistically significant, one may argue that based on the survey results, educators have low efficacy.

Bandura's (1977) self-efficacy theory is well-studied and documented across multiple fields of study. Efficacy is an individual's faith in their capacity to accomplish a particular want. The higher the feeling of adequacy, the more impressive the work and the more endurance and adaptability one brings to the errand (Pajares, 1996). According to Bandura's (1989) SCT, efficacy significantly affects motivation and persistence: people who believe they will accomplish something are way more likely to try that task and are less likely to be dissuaded by failure. When teachers believe they can influence students' academic performance, they bring more enthusiasm to their teaching, positively affecting student performance (K. R. Kim & Seo, 2018). Given elementary teachers' perceived science teaching self-efficacy, having a statistically significant influence on years of teaching the same grade level in this study, this upholds the tenets of Bandura's self-efficacy theory rooted in the SCT. Thus, the self-efficacy theory supports the findings of a positive association between self-efficacy and years of teaching at the same grade level.

Lastly, the results of this study determined a statistically significant relationship between years of teaching at the same grade level and self-efficacy. The additional degree type and science method course variables contributed little to the overall regression model. However, both variables support the need for more research in this area. The results of this study add value to research regarding professional development opportunities. Donovan et al., (2018) reported that only a few studies had explored elementary teachers' knowledge of and confidence in NGSS's SEP instruction. A significant portion of the participants in this study do not hold natural science degrees. Thus, a real opportunity exists to focus on developing teachers' content knowledge (Loughran & Nilsson, 2012). Based on this study, school districts can reference this work to craft professional development sessions for elementary science teachers.

Limitations

The findings and implications from this study may be utilized to provide recommendations for further research. A non-experimental predictive correlational design was used to determine the relationship. This study established a correlation, but it did not establish causality. Although the study yielded a statistically significant relationship between self-efficacy and years of teaching at the same grade level, one must not conclude a causal relationship. This limitation can be addressed using a qualitative design, with teacher interviews included.

Snowball sampling was used to obtain a sample population of 138 elementary science teachers. An obvious limitation of this technique is that there is no way to accurately record the overall population. Another limitation of this technique is acquiring an accurate reading of the target population (Borg et al., 2007). Of the 138 elementary teachers, only 71 teachers participated in the study. Another limitation of this study was the disproportionately large number of female teachers. These further limits the study's generalizability to female teachers.

Slightly more than half of the elementary teachers participated in the survey. Several participants opened the survey, acknowledged their consent, and skipped through it altogether without completing it. Surveys that were completed were reflected in the results.

Recommendations for Future Research

Based upon the findings in this study and the literature review that informed the design, further research is recommended to assess the predictive relationship of degree type on the self-efficacy of elementary science teachers. Most of the teachers who participated in the study held degrees outside the STEM fields. To that end, a multiple regression study with self-efficacy as the criterion variable with degree type and subject matter professional development exposure as predictive variables is recommended (Bandura & Wood, 1989; Bandura, 2000, 2018; Mallon et al., 2020). An additional study should be conducted to include subscales of each question that relate to subject matter-specific questions. This recommendation would necessitate a change in the instrument used for the study.

A replication of this study can also focus on school districts that do not receive Title I funds. Changing the population would add to the current body of research concerning elementary teachers and their efficacy in teaching science. A replication of this study with a focus on gender will also add another layer of information to the current body of research. Based on the finding of this study, female participants significantly outweighed that of their male counterparts. Further studies need to be conducted to determine generalizability, including attracting male elementary teachers. Another recommendation to consider is to replicate the study with the addition of a science coach supporting the K-5 classroom teacher.

REFERENCES

Achieve. (2013). *Understanding the Standards*. Next Generation Science Standards. https://www.nextgenscience.org/understanding-standards/understanding-standards

Alarfaj, M. M., Kahveci, A., Kahveci, M., & Mansour, N. (2017). Exploring science teachers' affective states: Pedagogical discontentment, self-efficacy, intentions to reform, and their relationships. *Research in Science Education*, *48*(6), 1359–1386.

Albion, P., & Wu, T. (2019). Investigating remote access laboratories for increasing pre-service teachers' STEM capabilities. *Educational Technology & Society*, *22*(1), 82–93.

Ahlgren, A., & Rutherford, F. J. (1989). *Science for all Americans: Summary*. American Association for the Advancement of Science.

Aróstegui, J. L., & Kyakuwa, J. (2020). Generalist or specialist music teachers? Lessons from two continents. *Arts Education Policy Review*, *122*(1), 19–31.

Asselta, L., Catalano, A., & Durkin, A. (2019). Exploring the relationship between science content knowledge and science teaching self-efficacy among elementary teachers. *IAFOR Journal of Education*, *7*(1), 57–70.

Bailes, L. P., & Guthery, S. (2019). Patterns of teacher attrition by preparation pathway and initial school type. *Educational Policy*, *36*(2), 223–246.

Bal-Taştan, S., Bersanov, A. S., Boiarchuk, A. V., Davoudi, S. M., Kurbanov, R. A., Masalimova, A. R., & Pavlushin, A. A. (2018). Correction on the impacts of teacher's efficacy and motivation on student's academic achievement in science education among secondary and high school students. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(12), 2353–2366.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice Hall.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, *44*(9), 1175–1184.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* Freeman

Bandura, A. (1999). Social cognitive theory: An agentic perspective. *Asian Journal of Social Psychology*, *2*(1), 21–41.

Bandura, A. (2018). Toward a psychology of human agency: Pathways and reflections. *Perspectives on Psychological Science*, *13*(2), 130–136.

Bandura, A. (2000). Exercise of human agency through collective efficacy. *Current Directions in Psychological Science*, *9*(3), 75–78.

Bandura, A., & Wood, R. E. (1989). Effect of perceived controllability and performance standards on self-regulation of complex decision-making. *Journal of Personality and Social Psychology, 56,* 805-814.

Banilower, E. R., Gordon, E. M., Hayes, M. L., Malzahn, K. A., Plumley, C. L., & Smith, P. S. (2018). *The national survey of science and mathematics education* (pp. 13–14). Horizon Publishing Inc.

Barata, R., Carvalho, N., Gaio-Oliveira, A., & Martins-Loução, G. (2019). Inquiry-based science learning in the context of a continuing professional development programme for biology teachers. *Journal of Biological Education*, *54*(5), 497–513.

Bell, R. L., Maeng, J. L., Sterling, D. R., & Whitworth, B. A. (2020). The effect of professional development on elementary science teachers' understanding, confidence, and classroom implementation of reform based science instruction. *Science Education*, *104*(2), 326-353.

Bercot, F., Petrocola, M., Rodrigues, E., & Schnorr, S. (2020). Risk society and science Education. *Science & Education*, *30*, 209–233.

Bergman, M. M., Bergman, Z., & Thatcher, A. (2019). Agency and Bandura's model of triadic reciprocal causation: An exploratory mobility study among metrorail commuters in the Western Cape, South Africa. *Frontiers in Psychology*, *10*, 411.

Bernholt, A., Heinze, A., Kleickmann, T., Kunter, M., Rink, R., & Tröbst, S. (2018). Teacher knowledge experiment: Testing mechanisms underlying the formation of preservice elementary school teachers' pedagogical content knowledge concerning fractions and fractional arithmetic. *Journal of Educational Psychology, 110*(8), 1049–1065.

Berson, E., Borko, H., Busch, K., Fishman, E., Gomez Zaccarelli, F., Osborne, J., Reigh, E., & Tseng, A. (2019). Impacts of a practice-based professional development program on elementary teachers' facilitation of and student engagement with scientific argumentation. *American Educational Research Journal*, *56*(4), 1067–1112.

Blackmore, K., Howard, C., & Kington, A. (2018). Trainee teachers' experience of primary science teaching, and the perceived impact on their developing professional identity. *European Journal of Teacher Education, 41*(4), 529–548.

Blanco-López, Á., Cebrián-Robles, D., & Franco-Mariscal, A.-J. (2018). Preservice elementary science teachers' argumentation competence: Impact of a training programme. *Instructional Science, 46*(5), 789–817.

Borg, W. R., Gall, J. P., & Gall, M. D. (2007). *Educational research: An introduction* (8th ed.). Pearson.

Borko, H., Lockard, J. D., & Sanders, L. R. (1993). Secondary science teachers' knowledge base when teaching science courses in and out of their area of certification. *Journal of Research in Science Teaching*, *30*(7), 723–736.

Boyd, D., Goldhaber, D., Lankford, H., & Wyckoff, J. (2007). The effect of certification and preparation of teacher quality. *Future of Children, 17*(1), 45-68

Boyd, D., Grossman, P., Lankford, H., Loeb, S., & Wyckoff, J. (2006). "How changes in entry requirements alter the teacher workforce and affect student achievement," *Education Finance and Policy, 1*(2), 176-216

Bradbury, L. U., & Wilson, R. E. (2020). Questioning the prevailing narrative about elementary science teachers: An analysis of the experiences of science teacher enthusiasts. *Science Education*, *104*(3), 421–445.

Brobst, J., Markworth, K., Ohana, C., & Tasker, T. (2017). Comparing the preparedness, content knowledge, and instructional quality of elementary science specialists and self-contained teachers. *Journal of Research in Science Teaching*, *54*(10), 1302–1321.

Brockway, D., Ciofalo, J., Jin, H., Mikeska, J. N., & Ritter, S. (2020). Examining variability in elementary science teachers' pedagogical content knowledge about phase change: Implications for teacher development and assessment. *Journal of Science Teacher Education*, *32*(4), 400–424.

Brown, P. C., McDaniel, M. A., & Roediger III, H. L. (2018). *Make it stick: The science of successful learning*. Belknap Harvard.

Bruijns, B., Burke, S., Johnson, A. M., Tucker, P., & Truelove, S. (2021). Comparing Canadian generalist and specialist elementary school teachers' self-efficacy and barriers related to physical education instruction. *Journal of Teaching in Physical Education*, *40*(1), 10-20.

Burns, E. C., Collie, R. J., & Martin, A. J. (2019). Examining the yields of growth feedback from science teachers and students' intrinsic valuing of science: Implications for student and school level science achievement. *Journal of Research in Science Teaching*, *56*(8), 1060-1082.

Burte, H., Gardony, A. L., Hutton, A., & Taylor, H. A. (2020). Elementary teachers' attitudes and beliefs about spatial thinking and Mathematics. *Cognitive Research: Principles and Implications*, *5*(1).

Büttner, G., Decker, A.-T., Decristan, J., Fauth, B., Hardy, I., Klieme, E., & Kunter, M. (2019). The effects of teacher competence on student outcomes in elementary science education: The mediating role of teaching quality. *Teaching and Teacher Education*, *86*, 102882.

Camacho, D. A., Phalen, P., Scardamalia, K., & Vera, E. (2018). What are urban teachers thinking and feeling? *Psychology in the Schools*, *55*(9), 1133–1150.

Campbell, B. K., Luft, J. A., & Nixon, R. S. (2016). Effects of subject-area degree and classroom experience on new chemistry teachers' subject matter knowledge. *International Journal of Science Education*, *38*(10), 1636–1654.

Canipe, M. M., & Coronado Verdugo, J. Y. (2020). The influence of a science methods course on prospective elementary teachers' visions of science teaching. *Journal of Educational Research and Practice*, *10*(1).

Castelijns, J., Kools, Q., Koster, B., & Vermeulen, M. (2012). Measuring student teachers' basic psychological needs. *Journal of Education for Teaching*, *38*(4), 453–467.

Carr, S. (2020) Dampened motivation as a side effect of contemporary educational policy: A self determination theory perspective. *Oxford Review of Education, 46*(3), 331-345.

Carrier, S. J., Corsi-Kimble, B. S., Minogue, J., & Whitehead, A. N. (2018). Novice elementary teachers' developing visions of effective science teaching. *Research in Science Education, 50*(4), 1521–1545.

Carrier, S., Di Francesca, D., Lee, C., Thomson, M. M., & Walkowaik, T. A. (2018). Changes in teaching efficacy beliefs among elementary preservice teachers from a STEM-focused program: Case study analysis. *Journal of Interdisciplinary Teacher Leadership*, *1*(3), 29–43.

Caruso, G. (2019). Facing EL teachers' burnout through motivation. *Journal of Pedagogical Research*, *3*(1), 1–14.

Chang, S. H., Goodway, J. D., & Ward, P. (2020). The effect of a content knowledge teacher professional workshop on enacted pedagogical content knowledge and student learning in a throwing unit. *Physical Education and Sport Pedagogy*, *25*(5), 493–508.

Chen, J. A., Morris, D. B., & Usher, E. L. (2016). Reconceptualizing the sources of teaching self-efficacy: A critical review of emerging literature. *Educational Psychology Review, 29*(4), 795–833.

Chestnut, S. R., Curtin, S. J., Hajovsky, D. B., & Oyen, K. A. (2019). Teacher–student relationship quality and math achievement: The mediating role of teacher self-efficacy. *Psychology in the Schools*, *57*(1), 111–134.

Cisterna, D., Hanuscin, D. L., & Lipsitz, K. (2018). Elementary teachers' pedagogical content knowledge for teaching structure and properties of matter. *Journal of Science Teacher Education*, *29*(8), 665–692.

Clark, J. (2017). In the shadow of Sputnik: A transnational approach to Menzies support for science education in Australia, 1957–1964. *Paedagogica Historica*, *53*(5), 623–639.

Cologon, K., Graham, L. J., Pianta, R. C., & White, S. L. J. (2020). Do teachers' years of experience make a difference in the quality of teaching? *Teaching and Teacher Education*, *96*, 103190.

Colson, T., Smothers, M., & Xiang, Y. (2021). How professional development in co-teaching impacts self-efficacy among rural high school teachers. *The Rural Educator*, *42*(1), 20–31. https://doi.org/10.35608/ruraled.v42i1.897

Cordier, R., Falkmer, T. Falkmer, M., Sim, A., Scott, M., Vaz, S. M., & Wilson, N. (2015). Factors associated with primary school teachers' attitudes towards the inclusion of students with disabilities. *PLoS ONE, 10*(8).

Cowley, K., Cribbs, J. D., Day, M., & Duffin, L. (2020). Mathematics and science teacher training program improves inquiry practices for teachers. *School Science and Mathematics*, *120*(8), 443–455.

Craven, L. M., & Trygstad, P. J. (2020). A Comparison of Novice and Veteran Mathematics Teachers: Data from the 2018 NSSME+. *The National Survey of Science and Mathematics Education*, 32–40.

d'Alessio, M. A. (2018). The effect of microteaching on science teaching self-efficacy beliefs in preservice elementary teachers. *Journal of Science Teacher Education*, *29*(6), 441–467.

Dailey, D., & Robinson, A. (2017). Improving and sustaining elementary teachers' science teaching perceptions and process skills: A postintervention study. *Journal of Science Teacher Education*, *28*(2), 169–185.

Davidson, S. G., Jaber, L. Z., & Southerland, S. A. (2020). Emotions in the doing of science: Exploring epistemic affect in elementary teachers' science research experiences. *Science Education, 104*(6), 1008–1040.

Davis, N. R., & Schaeffer, J. (2020). Troubling troubled waters in elementary science education: Politics, ethics & black children's conceptions of water [justice] in the era of Flint. *Cognition and Instruction, 37*(3), 91–113.

Deci, E. L., & Ryan, R. M. (2008). Self-Determination Theory: A macrotheory of human motivation, development, and health. *Canadian Psychology, 49*(3), 182-185.

den Brok, P. J., Jansen in de Wal, J., Martens, R. L., & van den Beemt, A. (2018). The relationship between job demands, job resources and teachers' professional learning: Is it explained by self-determination theory? *Studies in Continuing Education*, *42*(1), 17–39.

De Neve, D., Devos, G., & Tuytens, M. (2015). The importance of job resources and self-efficacy for beginning teachers' professional learning in differentiated instruction. *Teaching and Teacher Education, 47*, 30-41.

Deniz, H., Erdogan, K., Newley, A., & Yesilyurt, E. (2020). Measuring computational thinking teaching efficacy beliefs of preservice elementary teachers. *Journal of College Science Teaching, 49*(6), 55–64.

Depaepe, F., & König, J. (2018). General pedagogical knowledge, self-efficacy and instructional practice: Disentangling their relationship in pre-service teacher education. *Teaching and Teacher Education, 69*, 177-190.

Donovan, C., Kang, E. J. S., & McCarthy, M. J. (2018). Exploring elementary teachers' pedagogical content knowledge and confidence in implementing the NGSS science and engineering practices. *Journal of Science Teacher Education, 29*(1), 9-29.

Donovan, C., Kang, E. J. S., & McCarthy, M. J. (2019). Elementary teachers' enactment of the NGSS science and engineering practices. *Journal of Science Teacher Education*, *30*(7), 788–814.

Duncan, A., & Secretary, F. U. S. E. (n.d.). *Our history*. Teach For America. https://www.teachforamerica.org/what-we-do/our-history

Dunn, A. H., Farver, S., Guenther, A., & Wexler, L. J. (2017). Activism through attrition?: An exploration of viral resignation letters and the teachers who wrote them. *Teaching and Teacher Education*, *64*, 280–290.

Duque, M., McEachin, A., Polikoff, M. S., Saultz, A., &Wrabel, S. L. (2016). The Politics of elementary and secondary education act waivers. *Educational Policy*, *32*(1), 117–140.

Enochs, L. G., & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. *School Science and Mathematics*, *74*(6), 625–637.

Enochs, L. G., & Riggs, I. M. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education*, *74*(6), 625–637.

Farmer, D. (2020). Teacher attrition: The Impacts of Stress. *Delta Kappa Gamma Bulletin*, *87*(1), 41-50.

Friedman, A. A., Marco., Bujosa, L. M., & McNeill, K. L. (2019). Becoming an urban science teacher: How beginning teachers negotiate contradictory school contexts. *Journal of Research in Science Teaching*, *57*(1), 3–32.

Garcia, E., & Weiss, E. (2019, May 9). *Low relative pay and high incidence of moonlighting play a role in the teacher shortage, particularly in high-poverty schools: The third report in 'The perfect storm in the teacher labor market' series*. Economic Policy

Institute. https://www.epi.org/publication/low-relative-pay-and-high-incidence-of-moonlighting-play-a-role-in-the-teacher-shortage-particularly-in-high-poverty-schools-the-third-report-in-the-perfect-storm-in-the-teacher-labor-marke/

Geiger, T., & Pivovarova, M. (2018). The effects of working conditions on teacher retention. *Teachers and Teaching*, *24*(6), 604–625.

Gerde, H. K., Pierce, S. J., Lee, K., & Van Egreen, L. A. (2018). Early childhood educators' self efficacy in science, math, and literacy instruction and science practices in the classroom. *Early Education & Development, 29*(1), 70-90.

Gordon, E., & Lowrey, K. A. (2017). The mentoring web – coming together to make a difference. *Improving Schools*, *20*(2), 178–190.

Goudsblom, J., Hornstra, L., Roskamp, C., Stroet, K., & van Eijden, E. (2018). Teacher expectation effects on need-supportive teaching, student motivation, and engagement: A self-determination perspective. *Educational Research and Evaluation*, *24*(3-5), 324–345.

Guillemin, J. (2019). C.P. Snow, Sputnik and the Cold War. *European Review*, *27*(1), 80–86.

Hammack, R., & Ivey, T. (2017). Examining elementary teachers' engineering self-efficacy and engineering teacher efficacy. *School Science and Mathematics*, *117*(1-2), 52–62.

Harmsen, R., Helms-Lorenz, M., Maulana, R., & van Veen, K. (2018). The relationship between beginning teachers' stress causes, stress responses, teaching behaviour and attrition. *Teachers and Teaching*, *24*(6), 626–643.

Hatzivassiliou, E. (2019). The view from NATO: Sputnik as a catalyst, 1957–8. *The International History Review*, *42*(6), 1137–1154.

Herbert, S., & Hobbs, L. (2018). Pre-service teachers' views of school-based approaches to pre-service primary science teacher education. *Research Science Education, 48*, 777-809.

Hubbard, K. (2021, March 9). *These Are the 10 Best States for Education*. U.S. News & World Report. https://www.usnews.com/news/best-states/slideshows/10-best-states-for-education

Ingersoll, R. M. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Educational Research Journal, 38*, 499-534.

Kara, Y., Wilhelm, A. G., & Woods, D. (2021). Supporting change in novice alternative certification teachers' efficacy. *Psychology in the Schools*, *58*(10), 1902–1918.

Kim, K. R., & Seo, E. H. (2018). The relationship between teacher efficacy and students' academic achievement: A meta-analysis. *Social Behavior and Personality: An International Journal*, *46*(4), 529–540.

Kim, L. E., Jörg, V., & Klassen, R. M. (2019). A Meta-analysis of the effects of teacher personality on teacher effectiveness and burnout. *Educational Psychology Review*, *31*(1), 163–195.

Kulgemeyer, C. (2018). A framework of effective science explanation videos informed by criteria for instructional explanations. *Research in Science Education*, *50*(6), 2441–2462.

Kyle, W. C. (2020). Expanding our views of science education to address sustainable development, empowerment, and social transformation. *Disciplinary and Interdisciplinary Science Education Research*, *2*(1).

Lin, T. J., & Tsai, C. C. (2018). Differentiating the sources of Taiwanese high school students' multidimensional science learning self-efficacy: An examination of gender differences. *Research in Science Education*, *48*(3), 575–596.

Lohwasser, K., Tasker, T., & Windschitl, M. (2020). Learning to plan during the clinical experience: How visions of teaching influence novices' opportunities to practice. *Journal of Teacher Education, 72*(4), 405–418.

Long, C. (2019). The effect of science education classes on preservice elementary teachers' attitudes about science. *Journal of College Science Teaching*, *48*(06), 77–83.

Loughran, J., & Nilsson, P. (2012). Exploring the development of pre-service science elementary teachers' pedagogical content knowledge. *Journal of Science Teacher Education*, *23*(7), 699–721.

Lowery, N. V. (2010). Construction of teacher knowledge in context: Preparing elementary teachers to teach mathematics and science. *School Science and Mathematics*, *102*(2), 68–83.

Mallon, B., Murphy, C., Redman, E., & Smith, G. (2020). Teaching about sustainability through inquiry-based science in Irish primary classrooms: The impact of a professional development programme on teacher self-efficacy, competence and pedagogy. *Environmental Education Research*, *26*(8), 1112–1136.

Majoros, E., Rosén, M., Johansson, S., & Gustafsson, J.-E. (2021). Measures of long-term trends in mathematics: Linking large-scale assessments over 50 years. *Educational Assessment, Evaluation and Accountability*, *33*(1), 71–103.

Matsko, K. K., Nolan, H. G., & Ronfeldt, M. (2021). How different are they? Comparing teacher preparation offered by traditional, alternative, and residency pathways. *Journal of Teacher Education*, *73*(3), 225–239.

Michaluk, L., Stoiko, R., Stewart, G., & Stewart, J. (2017). Beliefs and attitudes about science and mathematics in pre-service elementary teachers, STEM, and non-STEM majors in

undergraduate physics courses. *Journal of Science Education and Technology*, *27*(2), 99-113.

Milner, A. R., Sondergeld, T. A., Demir, A., Johnson, C. C., & Czerniak, C. M. (2012). Elementary teachers' beliefs about teaching science and classroom practice: An examination of pre/post NCLB testing in science. *Journal of Science Teacher Education*, *23*(2), 111–132.

Naidoo, K., & Naidoo, L. J. (2021). Designing teaching and reflection experiences to develop candidates' science teaching self-efficacy. *Research in Science & Technological Education, 41*(1), 211-231. https://doi.org/10.1080/02635143.2021.1895098

National Academies Press. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*.

National Academies Press. (2007). *Rising above the gathering storm energizing and employing America for a brighter economic future*.

National Center for Education Statistics. (2012). *Fast Facts*. National Center for Education Statistics (NCES) Home Page, a part of the U.S. Department of Education. https://nces.ed.gov/FastFacts/

National Center for Education Statistics. (2020, December). *Trends in international mathematics and science study (TIMSS)*. https://nces.ed.gov/timss/results19/index.asp#/science/intlcompare

New Jersey Department of Education. (n.d.). *New Jersey Department of Education*. Induction. https://www.nj.gov/education/rpi/induction/

Nixon, R. S., Smith, L. K., & Sudweeks, R. R. (2018). Elementary teachers' science subject matter knowledge across the teacher career cycle. *Journal of Research in Science Teaching*, *56*(6), 707–731.

Novak, E., & Wisdom, S. (2018). Effects of 3D printing project-based learning on preservice elementary teachers' science attitudes, science content knowledge, and anxiety about teaching science. *Journal of Science Education and Technology*, *27*(5), 412–432.

Pajares, F. (1996). Self-efficacy beliefs in educational settings. *Review of Educational Research, 66*(4), 543-578.

Perkins Coppola, M. (2019). Preparing preservice elementary teachers to teach engineering: Impact on self-efficacy and outcome expectancy. *School Science and Mathematics, 119*(3), 161–170.

Plöger, W., Seifert, A., Scholl, D., & Schüle, C. (2019). Development of trainee teachers' analytical competence in their induction phase – A longitudinal study comparing science and non-science teachers. *Teaching and Teacher Education, 85*, 215–225.

Prewett, S. L., & Whitney, S. D. (2021). The relationship between teachers' teaching self efficacy and negative affect on eighth grade U.S. students' reading and math achievement. *Teacher Development*, *25*(1), 1–17.

Raab, R. R. (2017). A statistic's five years: A story of teacher attrition. *Qualitative Inquiry*, *24*(8), 583–591.

Reedy, M. A., Winn, K. M., & Young, M. D. (2017). Every Student Succeeds Act: Strengthening the focus on educational leadership. *Educational Administration Quarterly*, *53*(5), 705–726.

Richmond, G., Floden, R. E., & Drake, C. (2018). Research that illuminates enduring dilemmas in teacher education. Journal of Teacher Education, 69(4), 327–329.

Riley, R. (1995, September). *The Improving America's Schools Act of 1994*. Archived: The Improving America's Schools Act of 1994. https://www2.ed.gov/offices/OESE/archives/legislation/ESEA/brochure/iasa-bro.html.

Roberts, A. M., Taylor, S. G., & Zarrett, N. (2021). A brief mindfulness-based intervention (bMBI) to reduce teacher stress and burnout. *Teaching and Teacher Education*, *100*, 103284-103298.

Ryan, S. V., von der Embse, N. P., Pendergast, L. L., Saeki, E., Segool, N., & Schwing, S. (2017). Leaving the teaching profession: The role of teacher stress and educational accountability policies on turnover intent. *Teaching and Teacher Education*, *66*, 1–11.

Singh, M. (2022). E-6 preservice teachers and elementary science teaching: Assessing confidence and content knowledge. *Journal of College Science Teaching*, *51*(3), 51–58.

Warner, R. M. (2013). *Applied statistics*. SAGE.

Wang, Y., & Zhang, W. (2021). The effects of principal support on teachers' professional skills: The mediating role of school-wide inclusive practices and teacher agency. *International Journal of Disability, Development and Education*, *68*(6), 773–787.

Watson, P. W., Flint, A., Garrett, L., McDonald, L., Meissel, K., Peterson, E. R., & Rubie-Davies, C. M. (2019). Teacher gender, and expectation of reading achievement in New Zealand elementary school students: Essentially a barrier? *Gender and Education*, *31*(8), 1000–1019.

Wilson, J. (2015). *NASA history overview*. NASA. https://www.nasa.gov/content/nasa-history-overview.

Yilmaz-Tuzan, O. (2008). Preservice elementary teachers' beliefs about science teaching. *Journal of Science Teacher Education, 19*(2), 183-204.

APPENDIX A

Request for Permission to Conduct Research

[redacted]

Dear [redacted]

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate in curriculum and instruction. The title of my research project is Elementary Teachers' Perceptions of Self-efficacy: Difference between those with content major degrees and non-content major degrees in New Jersey and the purpose of my research is to explore the relationship between elementary teachers and three variables: undergraduate degree earned, received methods course in the undergraduate program, and number of years teaching the same grade level among at least 66 elementary science teachers.

I am writing to request your permission to contact participants in the summer professional development sessions to participate in my research study. Participants will be asked to complete an anonymous, online survey. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time. Thank you for considering my request. If you choose to grant permission, please respond by email to trbaskerville@liberty.edu.

Sincerely,

Tiffany Baskerville

Liberty University Doctoral Candidate

APPENDIX B

Participant Recruitment Email

Dear [Participant],

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree in curriculum and instruction.

You will be asked to take a brief survey consisting of 25 questions. It should take approximately 10-15 minutes for you to complete the survey. Your participation will be completely anonymous, and no personal identifying information will be required.

To participate, please go to (insert survey monkey link), click on the link provided, and complete the survey. A consent document is located on the webpage prior to the survey. The consent document contains additional information about my research, but you do not need to sign and return it. Please click on the survey link at the end of the consent information to indicate that you have read the consent information and would like to take part in the survey. Please log on to the website from a personal device outside of your working hours.

Sincerely,

Tiffany Baskerville

Liberty University Doctoral Candidate

APPENDIX C

STEBI-A

Science Teaching Efficacy Belief Instrument*

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = Strongly Agree
A = Agree
UN = Uncertain
D = Disagree
SD = Strongly Disagree

1.	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2.	I am continually finding better ways to teach science.	SA A UN D SD
3.	Even when I try very hard, I don't teach science as well as I do most subjects.	SA A UN D SD
4.	When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5.	I know the steps necessary to teach science concepts effectively.	SA A UN D SD
6.	I am not very effective in monitoring science experiments.	SA A UN D SD
7.	If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
8.	I generally teach science ineffectively.	SA A UN D SD
9.	The inadequacy of a student's science background can be overcome by good teaching.	SA A UN D SD
10.	The low science achievement of some students cannot generally be blamed on their teachers.	SA A UN D SD
11.	When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12.	I understand science concepts well enough to be effective in teaching elementary science.	SA A UN D SD
13.	Increased effort in science teaching produces little change in some students' science achievement.	SA A UN D SD
14.	The teacher is generally responsible for the achievement of students in science.	SA A UN D SD
15.	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA A UN D SD
16.	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	SA A UN D SD
17.	I find it difficult to explain to students why science experiments work.	SA A UN D SD
18.	I am typically able to answer students' science questions.	SA A UN D SD
19.	I wonder if I have the necessary skills to teach science.	SA A UN D SD
20.	Effectiveness in science teaching has little influence on the achievement of students with low motivation.	SA A UN D SD
21.	Given a choice, I would not invite the principal to evaluate my science teaching.	SA A UN D SD
22.	When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.	SA A UN D SD
23.	When teaching science, I usually welcome student questions.	SA A UN D SD
24.	I don't know what to do to turn students on to science.	SA A UN D SD
25.	Even teachers with good science teaching abilities cannot help some kids learn science.	SA A UN D SD

*In Riggs, I., & Knochs, L. (1990). Towards the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*, 625-637.

APPENDIX D

Permission to Use Instrument

Iris Riggs <IRiggs@csusb.edu>
To: Baskerville, Tiffany R

Hello Tiffany,

You are welcome to use the STEBI in your study. There is no copyright on the instrument, only the article.

Best wishes,
Iris Riggs

Iris Riggs, Ph.D.
Professor Emeritus
Department of Teacher Education and Foundations
California State University, San Bernardino
5500 University Parkway
San Bernardino, CA 92407

APPENDIX E

IRB Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

December 19, 2022

Tiffany Baskerville
Amy Jones

Re: IRB Exemption - IRB-FY22-23-458 ELEMENTARY SCIENCE TEACHERS PERCEIVED SELF-EFFICACY: A CORRELATIONAL STUDY BETWEEN TEACHERS WITH CONTENT AND NON-CONTENT MAJOR DEGREES IN NEW JERSEY

Dear Tiffany Baskerville, Amy Jones,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,
G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

APPENDIX F

One-Week Participant Reminder Email

Dear [Participant],

Recently, you received an email from me that asked for your participation in a short survey."

If you have already responded, thank you very much for your input. If not, please do so by clicking on the link below.

At the end of the survey, you will have the option to enter a drawing to win one of two $150 gift certificates to Amazon.com. If you have completed the survey, thank you very much for your assistance in this very important research.

Click this link to begin the survey:

Sincerely,

Tiffany Baskerville
Liberty University Doctoral Candidate

APPENDIX G

Final Participant Reminder Email

Dear [Participants],

Thank you to all participants who shared their input on the survey sent last week. This is a final reminder that all responses are due.

If you have already responded, thank you very much for your input. If not, please do so by clicking on the link below.

Do not forget, you will have the option to enter a drawing to win one of two $150 gift certificates to Amazon.com. If you have completed the survey, thank you very much for your assistance in this very important research.

Click this link to begin the survey:

Sincerely,

Tiffany Baskerville
Liberty University Doctoral Candidate

APPENDIX H

Permission to Conduct Research

[redacted]

Morning Tiffany!

Congratulations on receiving the green light from IRB. Now the fun can begin:)

Do you have a certain date that you would like this completed by? The staff in our district go on winter break this Friday and return the first week of January. Would you like me to wait to share this document until they return? This may be the better option for a higher response rate. But, it depends on a date you would like this completed by. I can also share the document this week before staff go on break.

Let me know what you think.

Best,

Jeremy
Jeremy Cohen, Ph.D.
Director of Curriculum, Instruction, and Assessment
Township of Union Public School District
(908) 851 6556